ISSN: 2613-5817; E-ISSN:2613-5825, DOI PREFIX: 10.36962/PIRETC

VOLUME 24 ISSUE 03 2023

PROCEEDINGS

OF THE INTERNATIONAL RESEARCH, EDUCATION & TRAINING CENTER

JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
REFERRED & REVIEWED JOURNAL

Platform & workflow by OJS/PKP

https://bsj.fisdd.org/index.php/piretc

The beautiful thing about learning is nobody can take it away from you—B. B. King

ISSN: 2613-5817; E-ISSN:2613-5825, DOI PREFIX: 10.36962/PIRETC

VOLUME 24 ISSUE 03 2023

PROCEEDINGS

OF THE INTERNATIONAL RESEARCH, EDUCATION & TRAINING CENTER

JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
REFERRED & REVIEWED JOURNAL

JOURNAL INDEXING

CROSSREF
Europub IF (2021)-0.79

TALLINN, EESTI 2023

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 24 ISSUE 03 2023

ISSN: 2613-5817; E-ISSN: 2613 – 5825; UDC: 0 (0.034); DOI: 10.36962/PIRETC
PROCEEDINGS OF THE INTERNATIONAL RESEARCH, EDUCATION & TRAINING CENTER

©Publisher: NGO International Center for Research, Education and Training. R/C: 80550594
MTÜ Rahvusvaheline Teadus-, Haridus- ja Koolituskeskus.
©Publisher: NGO Azerbaijan International Diaspora Center in Georgia.
Management Board Member and founder of organization: Seyfulla Isayev.
©Editorial office: Harju county, Tallinn, Lasnamäe district, Väike-Paala tn 2, 11415
Narva mnt 5, 10117 Tallinn, Estonia.
©Typography: NGO International Research, Education & Training Center. The Baltic Scientific Journals.
Registered address: Narva mnt 5, 10117 Tallinn, Estonia.
Tel: +994 552 80 70 12; +994 55 241 70 12; +994 518 64 88 94
E-mail: info@scia.website**,** sc.mediagroup2017@gmail.com
Website: https://scia.website/, https://bsj.fisdd.org/

OFFICIAL REPRESENTATIVES-COORDINATORS
Namig Isazade (EU, Azerbaijan)
Mob: +994 552 80 70 12; +994 518 64 88 94
Whatsapp: +994 55 241 70 12;

Accepted for publication in this edition 15.05.2023

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 24 ISSUE 03 2023

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

TABLE OF CONTENTS

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

AN INTELLIGENT TRAFFIC CONTROL SYSTEM FOR BAKU

Nijaat Zaman
Azerbaijan State Oil and Industry University, Information Technology and Management Faculty, Instrumentation Engineering Department, zamannicat9@gmail.com

ABSTRACT

This article introduces a new traffic control system framework, Mobile Intelligent Traffic Management System (MITCS), designed for Baku for the next generation. According to statistics, every year people lose 154 hours in traffic on average. 1.3 million people die in accidents. The system combines micro-mechanical and electrical technologies embedded system, wireless transmission, image processing, and solar module. The objectives of this study are:
1. Research and design new and multifunctional traffic controller in the box;
2. Design a cost-effective basis contribution to the communication network;
3. Use image processing methods of developing a detector of non-interfering means for control of traffic dynamics;
4. Using artificial intelligence adapt traffic dynamics and update traffic control strategies;
5. Propose a special concept for mobile intelligent traffic control Center.
Finally, an experimental system consisting of Virtual Traffic Police (VTP), Status Monitor Agent (SMA) and Traffic Control Integration Module (TCIM). There will be a system highly efficient, self-organized and self-coordinated support motion control mechanism.
Keywords: Transportation, artificial intelligence, information technologies.

Introduction

Traffic control system information and communication technologies prevent traffic control systems from benefiting from the benefits of information and communication technologies, such as compact devices, thin, mobile, wireless, etc. For example, traffic the controller may have the following restrictions:
1. The controller is usually in the form of a box near traffic signals. If the box is big, it can get in the way view of drivers and pavement. Hence the size. Control boxes should be reduced.
2. A controller usually manages a specific control a device such as a traffic signal, variable message sign, car detector or closedcircuit television. These are devices are usually not interoperable. Thus, complex functions cannot be provided.
3. A controller usually manages a specific control a device such as a traffic signal, variable message sign, car detector or closedcircuit television. These are devices are usually not interoperable. Thus, complex functions cannot be provided. Recently, in-house systems have been used for some studies develop advanced traffic control system devices [1]-[6]. Embedded systems are light, thin, compact and portable. These are features help overcome limitations described above. These are the functions of embedded systems it looks like a personal computer.
This study assumes internal characteristics systems.
1) a multifunctional new study and design traffic controller in a box;
2) affordable design the main contribution to the communication network;
3) use image processing techniques to develop a non-intrusive tool detector to monitor traffic dynamics;

4) use artificial intelligence to adapt traffic dynamics and update traffic control strategies;
Propose a mobile-specific concept Center for Intelligent Transport Management. Finally, experimental A system including Virtual Traffic Police (VTP) was established,
Status Monitor Agent (SMA) and Traffic Control Integration Module (TCIM). The system will support high efficiency, self-organized and self-coordinated movement control mechanism.

The structure of MITCS.
This section describes how internal systems are interconnected Traffic control devices at MITCS. Figure 1 shows that system managers can assess and closely coordinate traffic conditions connected intersections for better control. Coordination depends on the wireless access point and the corresponding radio frequency (RF).
The RF value should be as low as possible, while the RF range should be as wide as possible.

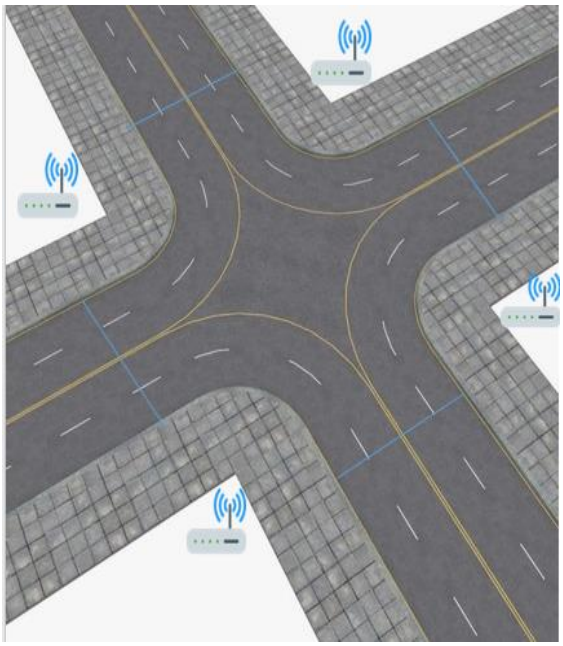


Figure 1: Non-intrusive vehicle detectors.

A non-intrusive vehicle detector such as an optical one. The detector used in this system collects the traffic immediately parameters such as traffic light cycle length, division and offset of intersections in the same group for sign controllers to determine optimal control.
Figure 2 shows that MITCS can combine several groups for coordinated control over a larger scale network.
The reference number should be placed after the last word of the figure name without any spaces, and the dot should be placed after the reference.
The communication traffic is denser than group control. However, if the right RF is chosen, wireless technology can support both group and area control [3].
Once the architecture is established and the contribution is scaled sufficiently large, MITCS should provide robust information infrastructure. Traffic parameters can be usefully processed information such as journey time, service level and route instructions [4]. MITCS can also

provide information and communication platform for traffic and non-traffic integration information (Figure 3).

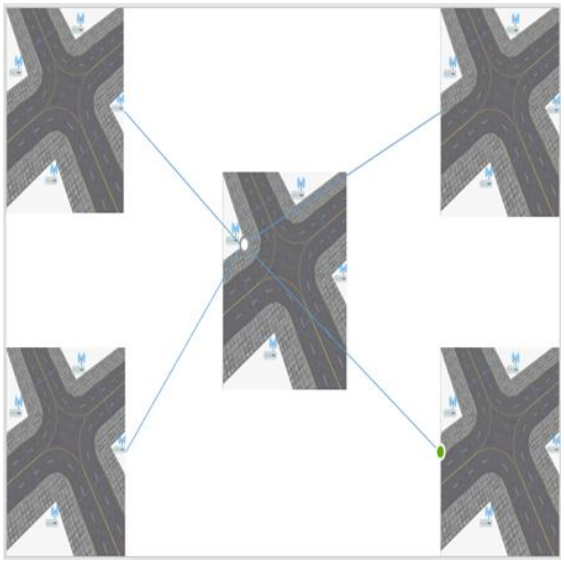


Figure 2: MITCS

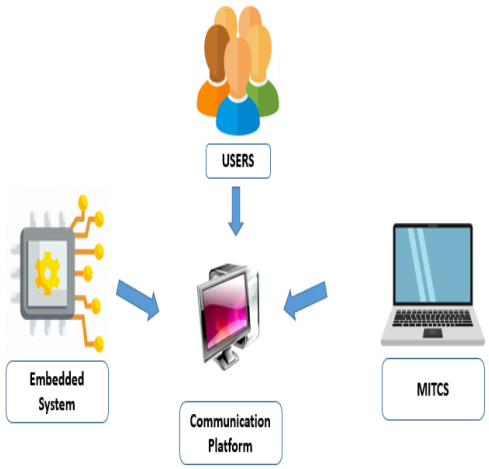


Figure 3: How users can view the data through platform.

The propsed traffic control system

The developed system was used to develop the prototype a new traffic control system, MITCS, as operated in Figure 4. The prototype has 3 units: closed-circuit television (CCTV), system and embedded system (single board computer). Units can be applied to control the intersection. Concept application is created in Figure 5.

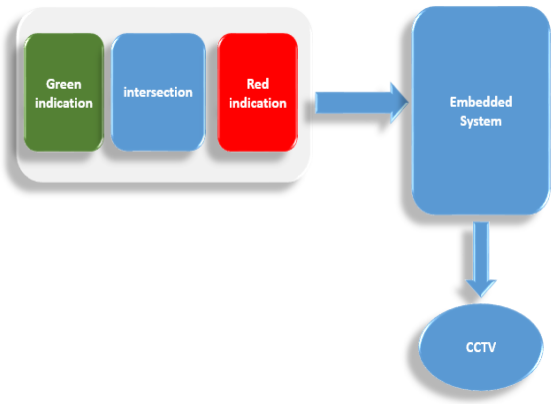


Figure 4: Prototype of the proposed traffic signal control system.

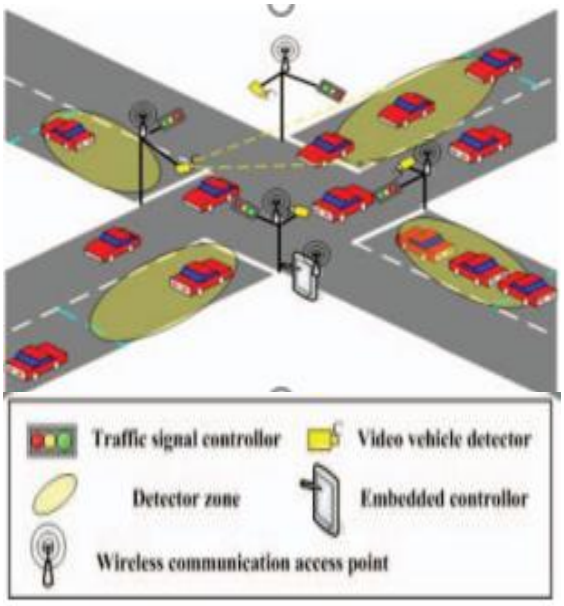


Figure 5. MITCS application concept.

A prerequisite in this project is to enter each vehicle with an RFID tag. RFID
the reader reviews the vehicle tag and recognizes the vehicle for activity management.
If the first tag discharges to the RFID reader, the frame grabber is individually authenticated. When the second label is empty, the frame determines that it is an emergency vehicle meanwhile, red flag applications show environmental safety and an alphanumeric display line "emergency detected". If the third tag is recognized, it indicates that the vehicle is stolen buzzer sounds. After that, an SMS message "Stolen car detected" is sent to the police station [7].
If the car tries to jump the signal, the IR sensor sends the signal to the processor,
which in turn displays on the display board "Penalty" and finally a predetermined inscription amount is deducted from his bank balance [6].

Closed-circuit televisions monitor traffic from outside intersection. MITCS evaluates and delivers traffic appropriate control strategy for instantaneous traffic conditions. MITCS consists of embedded systems, it has big advantages:

1. Delicate and Compatible

MITCS is compact and convenient. None of the supervisors MITCS devices require a large cabin for storage. Controllers can access traffic 139 light control and managers can add new control devices as it should be [8].

2. Economically Based Communication Network Contribution

Unlike cable, MITCS with wireless communication provides a low-cost fundamental contribution to the module communication network.

3. Non-intrusive detection

Organized optical detectors for MITCS Easy to see wireless detection with inductive loop car detectors.

4. Intelligent Control

MITCS can be used with adaptive artificial intelligence update traffic dynamics and traffic control strategies.

5. Portable Control Center.

MITCS can be used to support the above advantages non-recursive event handling for a nearby field a hot place like stadium.

The function of MITCS

A. Virtual Traffic Police (VTP)

VTP is a fault tolerance that can connect adjacent traffic signal controllers to establish small-scale control group and perform traffic control while connecting communication between the controllers and the control center is lost [9].

B. Status Monitor Agent (SMA)

SMA consists of status monitoring and exception management procedures that control software and hardware MITCS to avoid unstable execution. These procedures keep the system running for optimal traffic control [10]. SMA reports faults to the control center via VTP as shown in Figure 6. Warnings can be issued for:

1. Software system execution.
2. Operation of hardware devices.

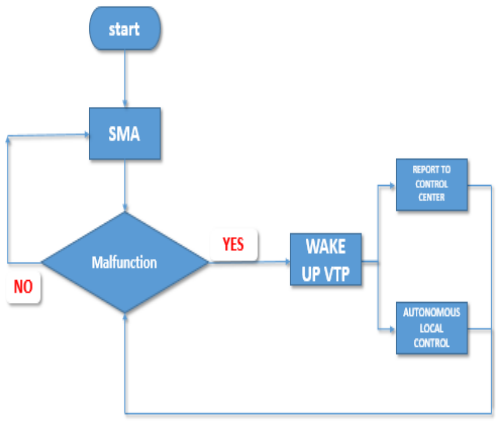


Figure 6. SMA and VTP

C. Traffic Control Integration Module (TCIM).
TCIM traffic signal, variable message sign, closed circuit television, car detector and smart algorithms for managing traffic approaching an intersection. TCIM allows MITCS to easily install any control device, similar to adding a printer to a desktop PC system. TCIM can also evaluate traffic dynamics itself arrange adjacent intersections into the same control group for group control [12].
It is based on the idea of predictive control in cloud theory traffic weight matrix oriented control system.
According to the short-term forecast data of the network real-time control of cloud-based artificial intelligence cloud-based distribution prediction of traffic flow can be performed using the shortest route obtained to guide and plan the journey combining route and traffic flow distribution method for users designing an intelligence forecasting and dispatch scheme cloud management system. Based on actual industrial equipment operating data, a virtual industrial system matching the real industry the system is built through learning and optimization. With software and hardware interface support, in two systems operation in the process of information interaction, coordination development, based on collection acquiring and gradually improving knowledge in the learning process virtual system together with actual operating data, for assess the state of the industrial facility and the evolution calculation. The experiment design scenario helps to predict the future trend management of a complex real industrial system, on a real industrial system after implementation controls a virtual industrial system of real-time data. Feedback to make a follow-up assessment, these two are similar continuous interaction system over time. ITN virtualization technology can virtualize physical transform the transport network into a virtual transport network consists of multiple virtual transport subnets the basic idea of using virtualization software to control and manage traffic network and computational simplification and traffic cloud operation through automatic placement function. Intelligent mobile traffic control closed circuit television connection system (MITCS), replaceable message sign, car detector and traffic light autonomously control the traffic approaching the intersection. The system also includes a smart algorithm dynamically predict traffic parameters and develop strategies for the next stage of control. Strategies can produce optimal signal timing for each signal cross-sectional, control group, control area and in general system too.

Conclusions

This document proposes mobile intelligent traffic control closed circuit television connecting system (MITCS), replaceable message sign, car detector and traffic light autonomously control traffic approaching the intersection. The system also incorporates a smart algorithm dynamically predict traffic parameters and develop strategies for the next control phase. Strategies can produce optimal signal timing for each individual signal cross-sectional, control group, control area, and overall system too. In addition, using wireless communication technology, the proposed system does not need expensive infrastructure communication contribution. cooperation between the core components, VTP and SMA, support fault tolerance hardware or software failure. In addition, devices MITCS consumes less energy than conventional energy. System managers may consider solar power to provide MITCS partial or autarkic power. Finally, MITCS is expected becomes one of the most suitable traffic control systems for Baku [11].

REFERENCES

1. Fongray Frank Young, Jhao-You Hong, Liang-Tay Lin and Jim-Min Lin, "Investigation Studies for Hierarchical ZigBee WiMAX Combined Networks.", Fourth Workshop on Wireless Ad Hoc and Sensor Networks, pp. 117-123, 2008
2. Fongray Frank Young, Liang-Tay Lin, Jim-Min Lin, Chiung-Yu Chen, "The application of communication technology and intelligent traffic control system based on U-Taiwan architecture.", The magazine of the Chinese institute of civil and hydraulic engineering, Vol. 35, No.6, pp.63-69, 2008.
3. Jim-Min Lin, Liang-Tay Lin, Fongray Frank Young, Kuo-Ming Fang, and Kuo-Su Hong, "Supporting Integrated Traffic Signal Controllers using Embedded System and Software Agent.", Journal of Computers, January 2009.
4. Liang-Tay Lin, Chang-Ming Hsieh, Jim-Min Lin, Fongray Frank Young, Hung-Jen Huang, "A Framework for Next-Generation Intelligent Traffic Control Systems." Computer and Communications, Vol.26, no. 4, pp.62-67, 2008.
5. X.F. Chen, Z.K. Shi, and K. Zhao, "Research on an Intelligent Traffic Signal Controller," Proceedings of IEEE Intelligent Transportation Systems, IEEE Press, pp.884-887, 2003.
6. Department of Transportation, Taiwan, NTCIP-compatible wireless ATMS 1 & 2, 2005-2006.
7. Meng D, Jia Y. Finite-time consensus for multiagent Systems, IEEE, 2017tems via terminal feedback iterative learning. IET Control Theory & Applications, 2011, 5(8):
8. Nascimento J C, Silva J G, Marques J S, Lemos J M. Manifold learningfor object tracking with multiple nonlinear models. IEEE Transactions onImage Processing, 2014,
9. Xue J, Shi Z. Short-time traffic flow prediction based on chaos time seriestheory. Journal of Transportation Systems Engineering and InformationTechnology, 2014, 8(5)
10. Polson N G, Sokolov V O, Deep learning for short-term traffic flowprediction. Transportation Research Part C Emerging Technologies, 2017, 79, 1−17
11. Kumar S V, Traffic flow prediction using filtering technique. ProcediaEngineering, 2017.
Luo X L, Jiao Q Q, Niu L Y, Sun Z W. Short term traffic flow predictionbased on deep learning. Application Research of Computers, 2017.

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 24 ISSUE 03 2023

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

CARDIAC ARRHYTHMIAS ANALYSIS BASED ON THE PHASE PORTRAIT OF ECG SIGNAL

Shafag Samadova
Chief Engineer, Azerbaijan State Oil and Industry University, shafaq.samedova@mail.ru

ABSTRACT

The article illustrates the development of virtual system in LabVIEW software environment for processing and analysis of electrocardiographic signals. In the system, the issues of processing ECG signal with classical methods and in phase space have been considered, the comparison of these methods have been carried out, characteristic changes of the shapes of ECG phase portraits corresponding to the change of diagnostic signs haveb been analyzed, and additional diagnostic signs determined on the the base of phase portrait in order to increase the reliability of ECG diagnosis have been interpreted. As a result of the analysis of the sequence of RR intervals using the developed program, a histogram, a scatterogram, a fast Fourier transform, an autoregressive spectrum, a short-term Fourier transform and the corresponding informative parameters characterizing heart rate variability were obtained: the average length and standard deviation of RR intervals, the mean value and standard deviation heart rate, spectral parameters, etc. The results obtained during the processing and analysis of ECG files taken from the MIT BIH databases using the HRV analysis program and the determination of informative parameters implemented in the LabVIEW environment confirm the adequacy of the developed program.
Keywords: ECG signal, phase space, phase portrait, RR intervals, LabVIEW software, heart rate, QRS complexes.

Introduction

Currently, cardiovascular diseases take the first place among all diseases from the point of view of danger to human life. The most common symptoms of cardiovascular diseases are heart rhythm disturbances - arrhythmias. The characteristic features of arrhythmias are determined based on the results of heart rate variability (HRV) analysis. Electrocardiography remains the most commonly used, inexpensive, objective diagnostic method in the examination of cardiovascular system. ECG signal carries information about heart's functional capabilities, such as heart rhythm, conductivity system, blood supply, and characteristics of myocardial exchange processes, as well as it stores information about its deviations from anatomical structure. Thanks to the modern development of for his treatment in the future. Recently, there has computer technologies and processing methods, the diagnosis of cardiological pathologies based on the analysis of ECG signal has reached qualitatively new stage. However, the sensitivity and specificity of innovative approach can be attributed to the possibilities of computer diagnostics according to the phase portrait of ECG signal [1-3]. One of the main ways of development of modern electrocardiography is the expansion of the application of automated analysis of electrocardiographic (ECG) signals. Automated analysis of ECG enables cardiologists to more accurately determine the parameters of electrocardiographic signals, objectively and quickly evaluate the condition of the heart, and increase the probability of making the right decision about the patient and recommendations been a significant increase in the number of algorithms assigned for the automated analysis of ECG, as well as, expansion of their scope. This is related to two main factors. First, unfortunately, the

number of cardiovascular diseases is increasing, most of which are caused by arrhythmias. The second is the significant increase in the capabilities, power and speed of computer technologies, which allows to implement even mathematically complex signal processing algorithms without fundamental difficulties, including in real-time space.

Problem statement and objective of the research

The issue of the accuracy of determining the boundaries of QRS complexes in ECG signals is of fundamental importance in the diagnosis of arrhythmias and in the recognition of signals with clinical manifestations in general. Existing methods for the detection of QRS complexes can be divided into two large groups: the first group includes high-precision methods designed for basic clinical examinations using several separations; and the second group includes the methods used in mobile electrocardiographic devices that allow real-time analysis and are intended for heart disease patients.

The description of ECG in phase-space coordinates is one of the modern methods for the analysis of electrocardiographic data. The effectiveness of this method is primarily due to the fact that both the sequence of the diffusion path and diffusion speed of depolarization and repolarization waves throughout the myocardium are changed during various myocardial injuries [4]. Therefore, differentiated ECG carries additional valuable information about the state of patient's cardiovascular system. Therefore, the development and software implementation of ECG signal processing and analysis algorithms for the diagnosis of arrhythmias based on modern computer technologies and innovative methods is one of the urgent issues. Based on this, the aim of the research is to develop a virtual system to determine the informative parameters of ECG signal in phase space and real time space for the diagnosis of arrhythmias. In the research, these systems were implemented using the capabilities of NI LabVIEW software environment.

Research methods and materials

Recently, in the study of the dynamics of complex structures such as medical-biological systems, in the clarification and analysis of the mechanisms of the activity of living organisms, attention is paid to the issues of adequate processing of these processes in the phase space, along with the analysis methods in the time and frequency domains.

Various approaches to studying the behavior of biological systems in phase space can give rise to additional diagnostic signs that are not repeated by other methods of analysis and complement them. From a given scalar s(t) ECG signal in the time domain, the phase is in coordinates s(t),(s(t))˙ (where s(t),and (s(t))˙ are the instantaneous value and derivative of ECG signal, respectively) the transition to the vector representation allows to effectively restore the useful signal distorted by excitations, to divide s(t) into separate R-R intervals and perform the selection of non-typical cycles. One of the advantages of the phase portraits of ECG signal is that during the description of ECG in $s(t), \dot{s(t)}$phase coordinates, its traditional diagnostic signs are more prominent than in the time domain [2]. During the change of diagnostic signs, the characteristic changes of the shapes of ECG phase portraits are described in Figure 1 [3]. If the shape of QRS complex remains unchanged and P, T teeth are positive, the phase portrait of ECG signal has a characteristic graphic image consisting of three rings belonging to P, T teeth and QRS complex (Fig. 1, *a*). During the pathology of tooth Q (if it is wide and deep), the graphic image turns completely (Fig. 1, *b*). The flatness (Fig. 1, *c*), negativity (Fig. 1, *d*), being extremely high (Fig. 1, *e*) or asymmetry (Fig. 1, *f*) of tooth T cause adequate changes in the sizes and orientations of the corresponding

rings in the phase portrait. S-T segment downward shift during depression (Fig. 1, *g*) or upward shift during elevation (Fig. 1, *h*) cause changes in the corresponding fragment in the phase portrait. In order to increase the reliability of ECG diagnostics, it is recommended to use the following [3] additional diagnostic features of phase portrait of ECG signal:
-orientation angle α_{QRS} of the averaged phase trajectory;
-scatter parameter σ_{QRS} of phase trajectory points;
-symmetry parameter β_T of repolarization fragment of the averaged phase trajectory with respect to $\dot{s} = 0$ axis.

Orientation angle αQRS is determined by the direction of the straight line connecting two characteristic points: the point of intersection q0 of the outer line of the trajectory corresponding to QRS complex with itself and the point qm of the averaged phase trajectory located at the maximum distance from this point. It was determined by model researches that the statistical dependence between αQRS angle and the amplitudes of Q and S teeth can be described by the following regression (0,986):

$$\alpha_{QRS} = 200{,}85e^{-0{,}7928\frac{Q}{S}} \qquad (1)$$

σQRS scattering parameter of phase trajectory points is determined as deviations of phase trajectories of the observed signal s(t) according to the reference cycle (Fig. 2). The variability of the amplitudes of QRS complexes corresponding to different cycles leads to a change in σQRS scattering parameter, and with the increase in the parameter characterizing the variability of their amplitudes, σ_{QRS} parameter also increases.

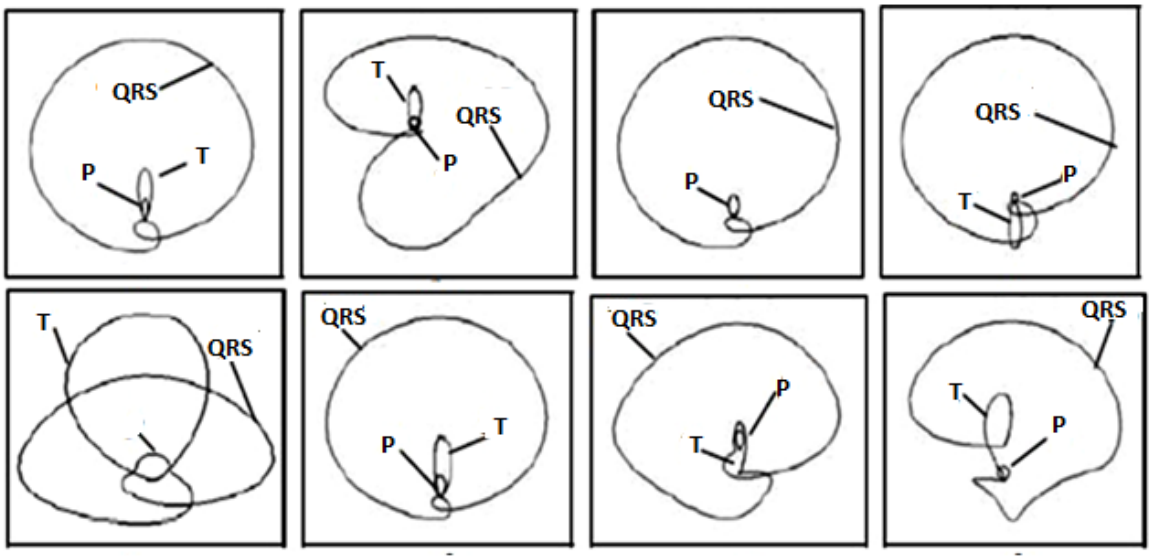


Figure 1. Characteristic changes of the shapes of phase portraits of ECG during the change of diagnostic signs [3]: a- phase portrait while maintaining the shape of the QRS complex and positive teeth P, T; b- with Q wave pathology; c- T wave flatness; d- negativity of the T wave; e - excessively high T; f - T wave asymmetry T; g- Downward displacement of the S-T segment in depression; h- Shift segment S-T up.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

Symmetry parameter βT is determined as the ratio of maximum velocities in the ascending and descending arms of phase trajectory fragment corresponding to tooth T: when tooth T is positive, $\beta_T = \frac{D_2}{D_1}$, and when tooth T is negative $\beta_T = \frac{D_1}{D_2}$. Statistical dependence between symmetry parameter βT and parameter ηT defined as the ratio of the parameters characterizing the symmetry of phase trajectory fragment corresponding to tooth T, can be described by the following upper function with a high coefficient of determination (0,993):

$\beta_T = 1{,}0082\eta_T^{-0{,}4248}$

In order to obtain phase portraits of real ECG signals, electrocardiographic data of healthy and various heart disease patients were taken from open internet resources - international databases [5, 6].

Comparative analysis of the main technological methods of constructing algorithms for the detection of QRS complexes in ECG signals was considered in numerous researches at different times, for example, in [7-10]. Examples of these methods include filter technologies, differentiation technologies, wavelet transformations, algorithms from the field of artificial neural networks, genetic algorithms, and also heuristic methods based on non-linear transformations of ECG elements. Currently known algorithms of ECG signal processing and analysis for real-time detection of QRS complexes in the literature can be summarized as follows: analog-to-digital conversion of ECG, low-frequency filter (LFF), high-frequency filter (HFF), derivative operator, non-linear converter , sliding window integrator, peak detector, search algorithm.

Results

Fig. 2 illustrates the block diagram of the program for processing informative parameters of ECG signal in the phase space in LabvieW environment. To check that the program is correctly built, the known signal (sine or cosine) is given to the input of the system with Simulate Signal virtual device (VD) and its derivative graph is checked (since the derivative of sine gives cosine). The signal which is studied and saved as a file is read by Read Biosignal VD, after being filtered with Filter VD, its derivative is found with Derivative (dX/dt) VD. The phase portrait of input ECG signal is constructed as the dependence of ds/dt on s(t) in two-dimensional XY coordinate system.

Fig. 3 presents ECG images and corresponding phase portraits of e0103.hea and 119.hea data files taken from Physio net international database. As it is seen from the figure, the phase portrait of patient with normal sinus rhythm (e0103.hea file, fig.3, a) is clearly different from the phase portrait of arrhythmia patient (file 119.hea, fig.3, b).

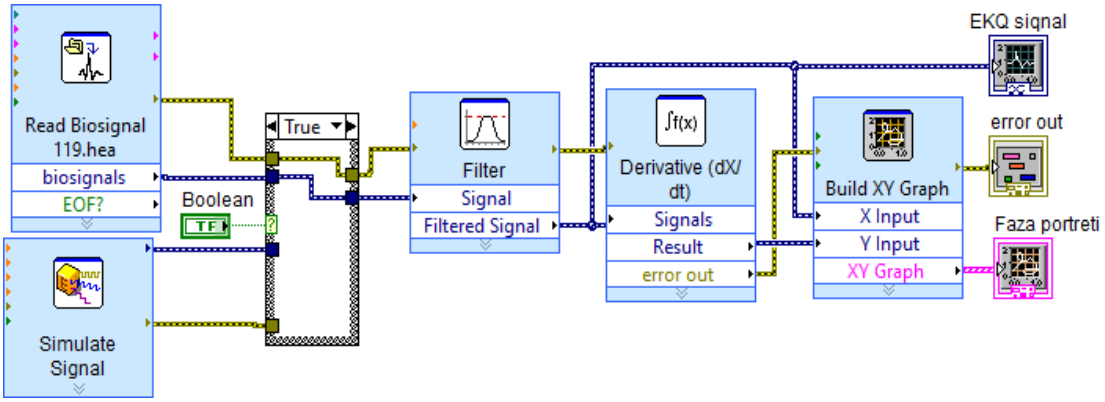


Figure 2. Block diagram of the ECG signal processing program in phase space in the LabVIEW environment.

The Front panel of the virtual system developed using the capabilities of LabVIEW environment to study Heart rate variability (URV) based on processing and analysis of ECG signals is depicted in Fig. 4. Statistical analysis of HRD was performed using the HRV Statistics VI included in the HRV Analysis palette of LabVIEW. To do this, first of all, a sequence of RR intervals- cardio-interval gram was obtained from the processed ECG signal, and then a statistical analysis of HRV was performed. To obtain a sequence of RR intervals in real time, a subroutine was developed - a virtual device that determines the localization of ECG signal peaks based on wavelet analysis. This is implemented using LabVIEW's WA Online Multiscale Peak Detection VI virtual appliance. The sequence of RR intervals was processed using HRV Statistics VI to obtain a histogram, scatter gram, fast Fourier transform, autoregressive spectrum, short-term Fourier transform and the corresponding informative parameters characterizing HRD: the average length and standard deviation of RR intervals, the mean value and standard deviation were determined heart rate, spectral parameters, etc.
The results obtained during the processing and analysis of ECG files taken from databases [5, 6], (the diagnostic features of which are known in advance) with both systems (the ECG signal analysis system in phase space and the HRD analysis system) implemented in the LabVIEW environment, confirm their adequacy.

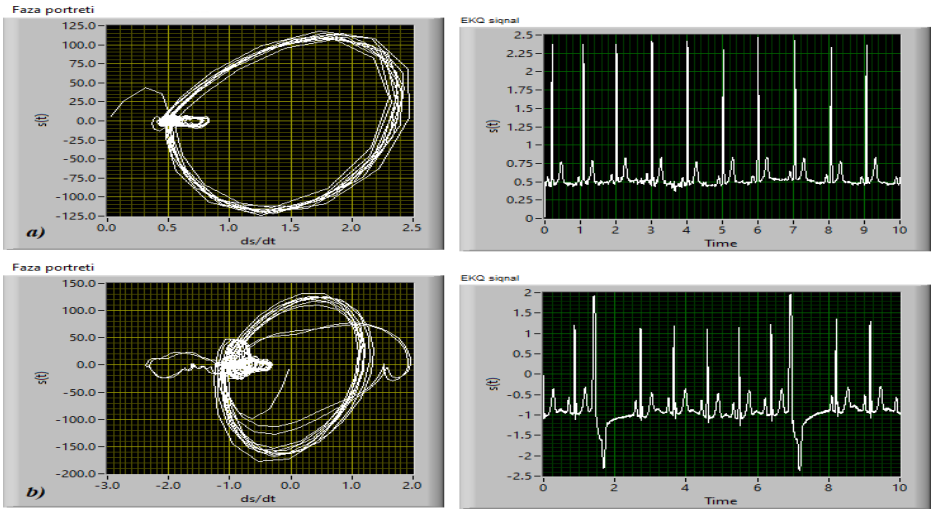


Figure 3. ECG images and corresponding phase portraits of data files e0103.hea and119.hea taken from Physio net international database.

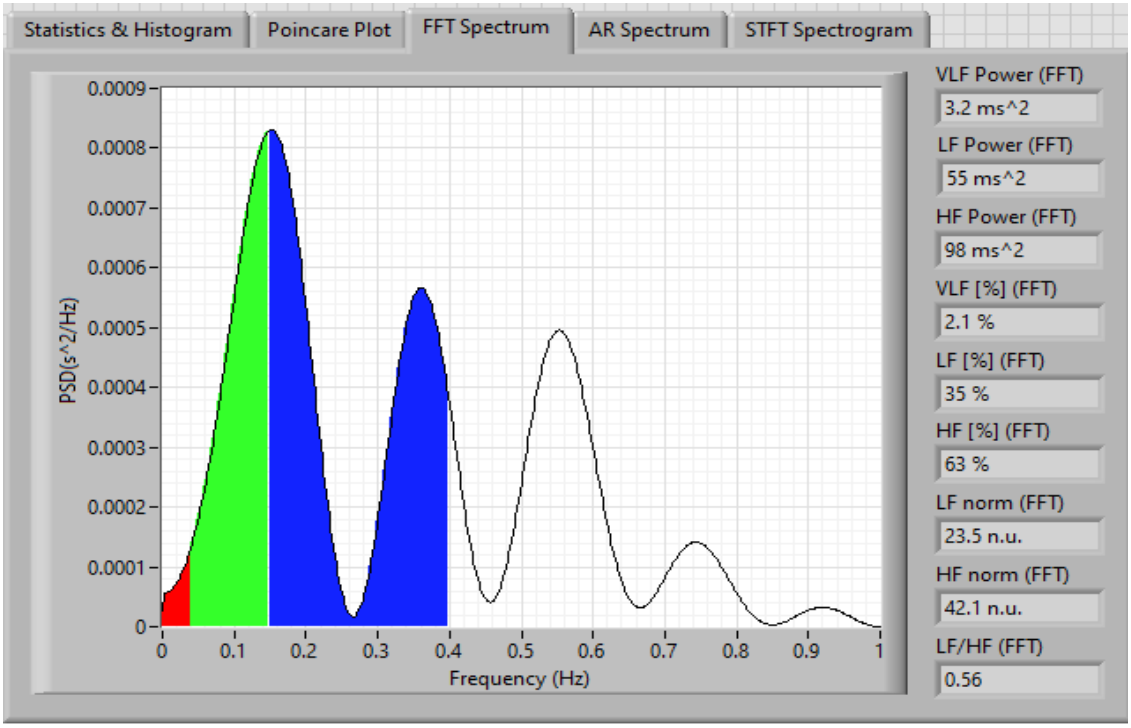


Figure 4. Front panel of the LabVIEW heart rate variability analysis program.

Conclusions

In the proposed system, the issues of processing ECG signal with classical methods and also in phase space have been considered, the comparison of these techniques have been implemented, characteristic variations of the shapes of ECG phase portraits corresponding to the change of diagnostic signs have been analyzed, and additional diagnostic signs determined on the base of phase portrait in order to increase the reliability of ECG diagnosis have been interpreted.

REFERENCES

1. Wang, Xin, Tapani Ahonen, and Jari Nurmi. "Applying CDMA technique to network-on-chip." IEEE transactions on very largescale integration (VLSI) systems 15.10 (2007): 1091-1100
2. L.S. Fainzilberg. New Possibilities of Phasography in Practical Medicine ISSN 1815-2066. Nauka innov. 2017,13(3): 41-56.
3. L.S. Fainzilberg. Computer diagnostics based on the phase portrait of electrocardiogram Kyiv, -“Osvita of Ukraine”, 2013, -192 p.
4. E.N. Minina, L.S. Fainzilberg. Phase portrait of a single-channel ECG in assessing the functional reserves of the cardiovascular system // Bulletin of new medical technologies – 2014 – T. 21, № 3 – p. 22-27.
5. V.G. Polosin. Construction of phase trajectories in the space of entropy- parametric potential for the study of dynamic characteristics of heart // Measurement.Monitoring. Control. – 2017. –№ 3 (21). – P. 124–132.

6. http://ecg.mit.edu/george/publications/mitdbembs-2001.pdf.
7. https://physionet.org/content/edb/1.0.0/]
8. G. D. Clifford Signal processing methods for heart rate vriability analysis / G. D. Clifford.PhD Thesis michaelmas Term., 2002.– 244 p.
9. Rangaiyan, R. M. Analysis of biomedical signals. Practical approach /R. M. Rangaiyan.– M.: Fizmatlit, 2007. – 440 p.
10. Luz E.J.S. et. al. ECG-based heartbeat classification for arrhythmia detection: A survey //Computer methods and programs in biomedicine. – 2016. – V. 127. – P. 144-164.
11. Khalaydzhi A.K., Muchnik1 I.B. Methods for classifying cardiac arrhythmias based on coding sequences of RR-intervals of the ECG signal. Proceedings of NSTU im. R.E. Alekseeva 2021. No. 1 (132), pp. 38-53.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

IMPLEMENTATION OF METHODS FOR DIGITAL TWIN AND GEOGRAPHICAL INFORMATION SYSTEMS

Ramiz Yusifov[1], Behram Ismailov[2]
[1,2] Azerbaijan State Oil and Industry University.

ABSTRACT

Business practices in areas like geographical information systems and environmental scanning are becoming more and more crucial, especially in light of the fierce competition in the technology sector. Organizations are less likely to hunt for information that they can act on right away than they are to experiment without trustworthy information, which results in organizational inattention. On the other hand, many companies are wasting money on initiatives that were either evaluated with insufficient data or that they were unable to absorb. In order to help enterprises design the best strategy for efficient environmental scanning and analysis, this study offers a new method based on environmental turbulence and aerial vehicles. Many businesses find it useful to measure the design of virtual models based on physical entities when creating their own virtual workshop models for scheduling and optimizing workshop production, but a single virtual workshop model cannot capture the interaction of physical and information objects necessary for intelligent manufacturing. To represent the fusion of virtual and real, however, and to therefore maximize the production of the workshop, the workshop for digital twins is an effective strategy. The digital twin system cooperative production unit is used as an example in this study to validate the suggested approach for building the digital twin workshop, which focuses on the definition and function of digital twin engines in a DT workshop.
Keywords: Environmental scanning, digitalization, digital twin, information technologies.

Introduction

Numerous businesses frequently use virtual workshop models in situations like workshop scheduling and simulation optimization. Applications that are frequently used are simulations of machining, assembly, logistics, and plant layout. Virtual simulation allows for the preview of each stage of the workshop's life cycle, the early detection of design flaws, and the minimization of design changes made during the building phase. However, the qualities of the interaction and merging between the real and virtual worlds necessary for intelligent manufacturing cannot be captured by the single virtual workshop model.

Geographic information systems (GIS) are basically an applied science, and while the GIS vendor society gives us the hardware and software with newer, better, and faster technological tools, it is the subject matter experts who use these tools that determine the state of the art. Field and district offices, engineering departments, logging divisions, and offices of tiny GIS entrepreneurs—all of whom use this technology in their line of work—remain the brains of the GIS. Even if many GIS have been successfully applied, it is clear that multidimensional and dynamic spatial phenomena cannot be accurately presented on two-dimensional maps with highly complicated contours and color schemes. Due to the massive data volumes, extremely rich semantics, and extremely diverse modeling and dispensation requirements, most GIS in use today were not built to serve multimedia data, and as a result, they have very little potential.[1]

This chapter examines a few GIS features, industry developments in general, and the technology involved in Digital Twins. Additionally, it outlines the benefits of using GIS through multimedia, which enables the development of its capabilities to convey geographic and other information. The primary GIS components are then displayed. The chapter also lists some of the most important fields in which multimedia GIS may be helpful.

A virtual depiction of the real world, including actual physical things, procedures, connections, and behaviours, is known as a "digital twin." GIS integrates a variety of digital models in a way that is unique and builds digital twins of the built and natural surroundings, as at picture 1. Through the integration of many types of data and systems, geospatial technology produces a single view that is accessible across the entire project life cycle. GIS improves data integration and capture, enables more accurate real-time visualization, offers sophisticated analysis and automates future forecasting, and permits information exchange and cooperation.

Picture 1: Example of Digital Twin of village as GIS

The concept of digital twin technology is one that is just starting to gain traction in business and, more recently, academics. Industry 4.0 has grown more quickly thanks to conceptual advances, especially in the manufacturing sector. The easiest way to summarize the Digital Twin, which is described in great length, is the seamless integration of data between a physical and virtual system in either direction. For artificial intelligence, the internet of things (IoT), and digital twins, the problems, applications, and enabling technologies are discussed.

Digital Twin

What Is A Digital Twin?

This section outlines the history of the digital twin. The study analyzes some of the misconceptions surrounding erroneously identified digital twins and provides clear definitions.

Since the early 2000s, formal concepts surrounding digital twins have been present. In spite of this, due to the constantly evolving criteria, it might have been able to describe digital twins earlier.

Grieves introduced the initial nomenclature in a presentation in 2003, and it was later described in a white paper, laying the groundwork for the advancement of digital twins.

A significant step in defining digital twins was taken in 2012 when the National Aeronautical Space Administration (NASA) published a study titled "The Digital Twin Paradigm for Future NASA and U.S. Air Force Vehicles." [2]

“A digital twin is a collection of virtual data that accurately depicts a possible or real physical creation at all scales, from the atomic to the geometrical.” [3]

"A digital twin is a model of a physical component or assembly created digitally utilizing service information and integrated simulations. The digital representation contains data that is gathered from various sources during the course of a product's life cycle. In order to improve decision-making, this data is continuously updated and visualized in a number of ways to forecast present and future situations in both design and operating environments." [4]
"A digital twin is a virtual representation of a physical system that is updated over the course of the original system's life cycle with information on its performance, upkeep, and health status." [5]

Digital Model

There cannot be an automated data flow between the physical model and the digital model for a digital model to be defined effectively. A computerized depiction of an actual or imagined physical thing is known as a digital model.
Digital models can include, but are not limited to, product designs and development plans for buildings. The crucial distinguishing characteristic is that there is no automated data transfer between the physical system and digital model. As a result, modifications made to the real thing after the digital model has been produced have no bearing on it.
Digital Shadow
A digital shadow is an image of an item that only moves in one direction between the physical and digital worlds. Instead than vice versa, a change in the physical object's state causes a change in the digital object.

Digital Twin

Theofm "Digital Twin" refers to the reference when data is transferred seamlessly back and forth between an existing physical entity and a digital object. Any modification to the physical thing causes an automatic modification of the digital entity, and vice versa.
These three definitions make it easier to spot the typical misunderstandings that appear in the literature. There are a number of misconceptions, albeit they are not confined to just these particular examples. One of the fallacies is that digital twins must be a precise 3D replica of a physical object. However, some people believe that a digital twin is simply a 3D replica.
Digital twin applications
The applications of digital twins are the subject of the following section of this review. The potential uses for digital twin technology will be examined first, followed by a discussion of the industries, problems, and domains. At the moment, the phrase and idea of a "Digital Twin" are spreading throughout academia, and developments in the Internet of Things (IoT) and artificial intelligence (AI) are making this expansion possible. With certain healthcare-related applications of Digital Twin technology found, smart cities and manufacturing are currently the main areas of study.

Smart Cities

Due to the fast advancements in connectivity made possible by the Internet of Things, Digital Twins are increasingly being used and have the potential to be extremely useful in smart cities.
The more connected communities become as a result of the development of smart cities, the more frequently digital twins are used. In addition, the more information we collect from IoT sensors

integrated into a city's essential services will open the door for research targeted at developing sophisticated AI algorithms.

For many different types of future-proofing, the capacity of services and infrastructures within a smart city to have sensors and be monitored by IoT devices is extremely valuable.

It can be used to support continuous creation of additional smart cities as well as planning and development of the current smart cities. Planning has advantages, but there are also advantages in the field of energy conservation. This information offers a valuable window into how our utilities are utilized and delivered. Utilizing digital twin technology is a potential advancement for smart cities. By allowing Digital Twins to learn from the environment by analyzing changes in the data acquired, it can enable growth by enabling the creation of a living testbed within a virtual twin that can accomplish two goals.

Data analytics and monitoring can be done using the obtained information. The potential for Digital Twins is expanding as smart city development increases connectivity and the amount of usable data.

Manufacturing

The industrial industry has been suggested as the next potential use for digital twins. In order to save time and money, which is a primary driving factor and motivation for any manufacturing, manufacturers are continuously looking for a means to track and monitor goods. This is why Digital Twins appear to be having the most impact in this context. Similar to how connection is one of the main factors driving the use of digital twins in manufacturing with the emergence of smart cities. The current expansion is consistent with the idea of Industry 4.0, often known as the fourth industrial revolution, which uses device connection to make the idea of a digital twin a reality for production operations.[6]

The Digital Twin has the capacity to provide real-time input from the manufacturing line as well as machine performance status. It enables the producer to anticipate problems earlier. Utilizing digital twins improves device connectivity and input, which boosts dependability and performance. As a result of the machine's ability to store massive volumes of data required for performance and prediction analysis, AI algorithms combined with Digital Twins offer the potential for improved accuracy. In a manufacturing environment, the Digital Twin has the potential to be a very useful tool since it creates a testing environment and a system that reacts to real-time data.

The automobile sector is where digital twins are also used, maybe most famously by Tesla. The capacity to create a digital twin of an engine or auto component can be useful for data analytics and simulation. AI increases testing accuracy by using data analytics on real-time vehicle data to forecast component performance in the present and the future.

Another business that offers a variety of Digital Twin applications is the building sector. A Digital Twin may be used during the planning phase of a building or structure. The technology can be used to create smart city structures and buildings as well as a continuous real-time monitoring and forecast tool. When anticipating and maintaining buildings and structures, the utilization of the Digital Twin and data analytics may lead to increased accuracy because any modifications made electronically are subsequently applied physically. Construction teams can simulate more precisely because to the Digital Twin's ability to apply algorithms in real-time before the physical building even exists.

Real-time simulation as opposed to low detailed static blueprint models is one common objective that has emerged so far in the realm of digital twins. The employment of these models has a purpose, but the predictability and learnability are constrained because they do not use real-time parameters. The Digital Twin can use machine and deep learning techniques while also learning and monitoring simultaneously.

Methods for digital twin and GIS

Although it can seem overwhelming to start creating a digital twin, it can be divided into three steps:

1. Design
2. Operation
3. Augmentation

Design

The creation of a digital twin consists of two key components: In order to connect the physical asset within its digital twin and enable the real-time flow of data from IoT devices as well as integration with operational and transactional information from other corporate systems, you must first choose the enabling technology you need. It is important to be clear about the kind of device you need, the modeling software required to produce a 3D model of the asset, and who will have access to the data stored in the Digital Twin or be able to take control of the physical asset using it.

In order to reduce the dangers involved with identifying the devices on your network, secure IoT device management is essential. It offers the tools necessary to deploy, configure, monitor, and manage each device after authentication. You can achieve this rapidly and securely at scale with an identity-driven IoT platform. This brings up the second design component. You must comprehend the kind of information needed throughout the asset's life cycle, where that information is housed, and how to access and use it. Information must be organized in a reusable manner so that it may be quickly and efficiently transmitted between systems. An identity-driven IoT platform may automate the safe connections between these individuals, systems, and objects by managing the identities of each component involved in the digital twin and offering messaging services.

Operation

You must choose the role that your digital doppelganger will play. Is it just for asset monitoring? Do you desire control and modification of the asset by the twin? Do you wish to make the asset's data accessible to advanced analytics so they can help with preventative maintenance? Or do you wish to do simulations using the twin's data and models to aid in operational performance and product development?

If you utilize more complex devices that enable information processing to travel to the edge, the answers to these questions will define the types of devices you attach to the asset. It will also help you decide how to prepare your data for integration and management.

These features are more extensive the more complex the digital twin application. For instance, the majority of twins will seek to use analytics to enhance operational effectiveness and decision-making. To use sophisticated analytics, you must be able to manage how data is consumed, stored, prepared, and presented. You must ensure the quality of the data flowing from your IoT devices if you want to produce high-quality results. Each IoT device is examined for legal

authorization to accept and transport data. Using an identity-by-design strategy, these qualities are built into your digital twin from the beginning.

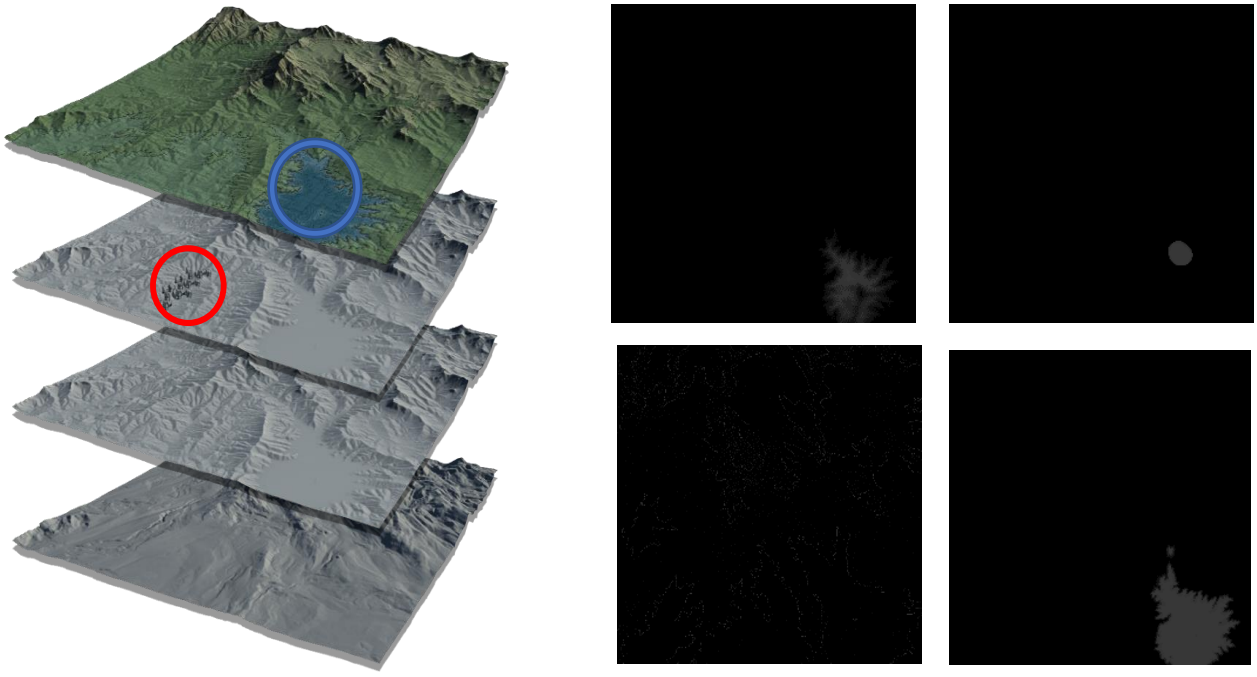
Augmentation

- The majority of digital twin implementations start off quietly, such as by monitoring the performance of one component inside an asset, but they develop with time. There are two aspects to this. The initial step is to arrange a number of smaller digital twins to offer a comprehensive view of a full equipment, asset, or business process. Second, businesses enhance an existing digital twin by including more intricate elements like simulations.
- You don't want to remove and replace in order to meet these shifting requirements; instead, you want to stack the functionality within the digital twin. You must be able to securely scale up functionality while maintaining performance in order to handle the increased data that has to be gathered and managed.

Digital twin System

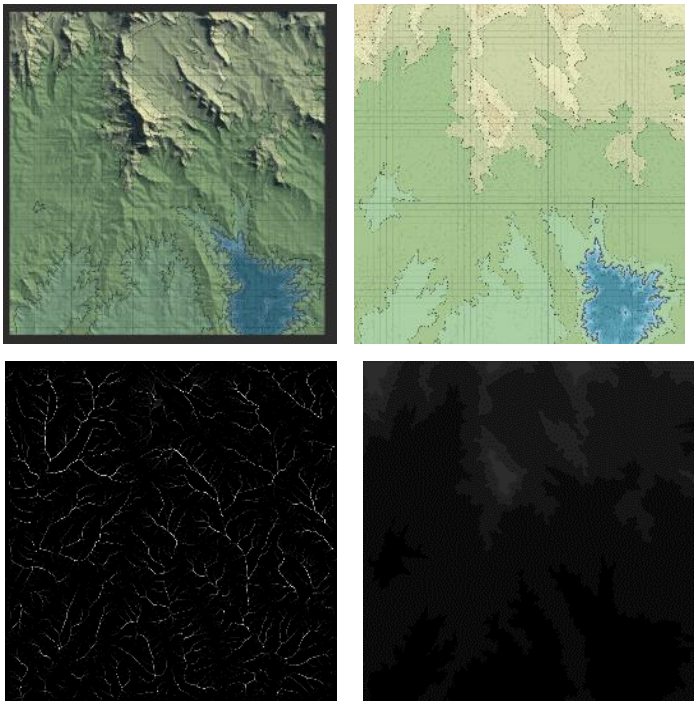
This section primarily validates the implementation interface of the digital twin workshop system proposed above, which is based on the DT cooperation production unit, and the digital twin intelligent manufacturing unit is realized by constructing a digital twin engine.
This paper builds and implements the digital twin engine of the intelligent manufacturing unit based on the proposed digital twin engine concept and architecture in order to realize the digital twin of the intelligent manufacturing unit.

Picure 2. Depicts the main construction of GIS based DT software.



Picture 2: Example of Digital Twin Systems based on GIS (from top to bottom: Cartography layer, Building Recognition layer, Water and Shore layer, Mountain Erosion layer)

This article realizes the visual operation of the virtual layer in the digital twin workshop based on Unity and QuadSpinner Gaea, providing the virtual layer roaming and information acquisition functions, to improve the visualization effect and interactivity.



Picture 3. Possible layers of Digital Twin Systems based on GIS.

Conclusion

The interaction and integration of physical and virtual models is more strongly stressed by digital twin technology, a topic of emphasis for many academics both domestically and internationally. The actual application of digital twins is still far from being fully developed, despite the notion receiving a lot of attention. In order to implement the digital twin workshop's architecture and function as its driving and service centre, this article suggests the idea of a digital twin engine. With such induction method the digital twin workshop's foundational implementation was completed, but additional study is required to improve the ability to offer intelligent services for digital twins.

REFERENCES

1. M. Grieves, “Digital Twin: Manufacturing Excellence through Virtual Factory Replication,” white Paper, NASA, 2014.
2. Y. Zheng, S. Yang, and H. Cheng, “An application framework of digital twin and its case study,” Journal of Ambient Intelligence and Humanized Computing, vol. 10, pp. 1141–1153, June 2018.

3. R. Vrabic, J. A. Erkoyuncu, P. Butala, and R. Roy, “Digital twins: Under- ˇ standing the added value of integrated models for through-life engineering services,” Procedia Manufacturing, vol. 16, pp. 139–146, 2018.
4. Madni, C. Madni, and S. Lucero, “Leveraging Digital Twin Technology in Model-Based Systems Engineering,” Systems, vol. 7, p. 7, Jan. 2019.
5. Fuller, Z. Fan, C. Day, C. Barlow “Digital Twin: Enabling Technologies, Challenges and Open Research” vol 2, 3-4, 2020
6. Z. Zhang, J. Lu, L. Xia, S. Wang, H. Zhang, R. Zhao “Digital twin system design for dual-manipulator cooperation unit” [2020]
7. Sun Huibin, Yan Jianxing, Wei Xiaohong, Chang Zhiyong.Assembly Technology of Digital Twin Driven Aero Engine .China Mechanical Engineering: [2019-12-07].
8. Qu Ting, Zhang Kai, Luo Hao, et al. Dynamic production-logistic linkage mechanism, system and case driven by Internet of Things. Journal of Mechanical Engineering, 2015, 51 (20): 36-44.D. Dan, Y.Q. Zhang, “Research on Definition of Network Survivability,” Journal of Computer Research and Development, 2006.
9. Thomas H.-J. Uhlemann, Christian Lehmann, et al. The Digital Twin: Realizingş
10. The Cyber-Physical Production System for Industry 4.0 . Procedia Cirp, 2017,

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

QUALITY ASSURANCE DURING TRANSPORTATION IN RAILWAY VEHICLES

Jala Jafarova[1], Sabina Aliyeva[2]
[1]Maqistr, Azerbaijan state oil and Industry University, [1]jalejafarova25@gmail.com
[2]Teacher at Azerbaijan state oil and Industry University, [2]s.aliyeva@yandex.ru

ABSTRACT

Regional cooperation in rail transport can help participating countries diversify their trade patterns. Improved rail transport can also help attract foreign direct investment, increase participation in global production networks and the scale of related trade in manufactured goods, and diversify exports. Improved rail infrastructure will increase global competitiveness and spur economic development. In addition, improved rail infrastructure will help regional cooperation and integration through improved connectivity between people, goods and services. The operation is carried out by a railway company, providing transport between train stations or freight customer facilities. Power is provided by locomotives which either draw electric power from a railway electrification system or produce their own power, usually by diesel engines or, historically, steam engines. Most tracks are accompanied by a signalling system. Railways are a safe land transport system when compared to other forms of transport. Railway transport is capable of high levels of passenger and cargo utilisation and energy efficiency but is often less flexible and more capital-intensive than road transport, when lower traffic levels are considered. Railways are a climate-smart and efficient way to move people and freight.
Keywords: railway, transport, improvement, transportation, transit, passenger, development, delivery, traffic, technology, vehicles.

Introduction

The continuity of the country's long-term economic growth is directly related to the mobility of production factors, in particular, the “labor” factor, the accessibility of transport services for the population, the dynamic expansion of consumer demand for passenger transportation. The relevance of the study of the features of passenger and customer service on the railway is due to the fact that all countries of the world are covered by the railway network, which ensures the availability of the vast majority of transport. The total length of Railways in our country is 2120 km.

Railway transport, which plays a special role in ensuring traffic mobility in our country, has unique resources that meet the challenges of sustainable and environmentally friendly development, high potential for interaction with other modes of transport, greater accessibility through the integration of the urban, suburban and intercity transport railway system. It is relevant to develop an economically justified management system for the organization of passenger transportation, to develop a range of services with other types of passenger transport, to improve service and to increase the range of products offered to passengers. Competitiveness of transport services in the railway sector largely reflects the quality of transport services, which in turn is formed by the implementation of the following key indicators of the industry: train speed, cargo delivery time, cargo safety, the degree of satisfaction with the transport of goods of various volumes, the timeliness of technological operations, the regularity and rhythm of keeping the

cargo moving according to the established plan of delivery of manufactured products, the complexity of transport services, the level of transport and logical services provided, etc. The values of the presented performance indicators of the railway transportation system (RTS), which fully form the quality of transport services, largely depend on the level of performance indicators of operational work presented.

Rail transport has emerged as one of the most dependable modes of transport in terms of safety. Trains are fast and the least affected by usual weather turbulences like rain or fog, compared to other transport mechanisms. Rail transport is better organised than any other medium of transport. It has fixed routes and schedules. Its services are more certain, uniform and regular compared to other modes of transport. Rail transport originated from human hauled contraptions in ancient Greece. Now it has evolved into a modern, complex and sophisticated system used both in urban and cross-country (and continent) networks over long distances.

Railway as a passenger transportation service

Every day, thousands of people make long- distance, local and suburban trips that require regular and high-quality service. The range of services provided by the company to passengers, on the one hand, creates favorable conditions and prerequisites for work, business, recreation, education, treatment, etc., which ultimately affects the productivity of employees working in various sectors of the Republic. The economy raises their cultural level and the quality of life of the population. On the other hand, railway transport increases its profitability by increasing the range of services provided to the population, attracting additional customers, providing services to them.

The level of demand for transport services in a competitive environment is determined, first of all, by the quality of Service. To achieve the desired effect, it is necessary to solve a number of tasks to improve the level of transport services provided to passengers. The transport service is the result of the activities of the transport service provider to meet the needs of the passenger, consignor and recipient for transportation in accordance with the established norms and requirements. To the population, the goods themselves are not sold by means of transport, but the service is sold. American marketing specialist F. According to Kotlyar, a service is any event that one side can offer to another. The quality of transport services is precisely the speed, timing and reliability of timely delivery, the degree of safety, the safety of goods and passengers, the tariff cost, the presence of a large number of related services, etc.- is. A service is an action that benefits or helps another. Service and transportation service is the result of the activities of the transport service provider: enterprises, organizations, institutions or entrepreneurs to meet the needs of the population during the period of their desire or during the trip (transportation). The consumption of services gradually begins to prevail over the consumption of material goods.

World statistics show that over the past 25 years, the share of services in the gross national product of developed countries has increased from 54 to 65%, and in developing countries 40 to 50%. In these countries, the civil service often becomes an independent sector of the economy, bringing 20-30% of the total profit to the state treasury. In the future, passenger transportation services in railway transport should become a fundamental basis for increasing transport profitability and attracting additional customers.

At present, transport is the main link in increasing revenues in railway transport, and services before and after the trip should “support”, “strengthen” harmlessness, create more favorable conditions for the movement of passengers, bring additional income to the carrier.

Rail transport is also known as train transport. It is a means of transport, on vehicles which run on tracks. It is one of the most important, commonly used and very cost effective modes of commuting and goods carriage over long, as well as, short distances. Since this system runs on metal rails and wheels, it has an inherent benefit of lesser frictional resistance which helps attach more load in terms of wagons or carriages. This system is known as a train. Usually, trains are powered by an engine locomotive running on electricity or on diesel. Complex signaling systems are utilised if there are multiple route networks. Rail transport is also one of the fastest modes of land transport.

World experience in the organization of passenger transportation on the basis of railway transport

The forms and methods of organizing combined passenger transportation may have specific features in individual countries. They willbe identified, first of all, by the following cases:

a) what type of transport can take over the function of consolidating the passenger transport market;
b) presence of a transport integrator company;
c) opportunities for the passenger company to launch its services in the relevant modes of transport;
d) technological and institutional conditionsfor building a network in the passenger transportation market.

The organization of combined transportation by railway companies is an opportunity to increase the demand for transportation services and form new profit centers, and for other participants in the transportation process-to accelerate the turnover of transport assets, reduce costs and increase economic efficiency.

The regulation and liberalization of the railway and air transport markets in the United States and Europe spanned a decade (1987-1997), and the reduction of barriers to access to transport infrastructure and liberalization of access to transport infrastructure had effects such as increased competition as a result of new market participants, diversification of assets, the creation of alliances. For example, the most significant socio-economic impact noted for the air transport market was the development of the route network and the increase in the connectivity of settlements, a decrease in costs/prices and an increase in the availability of air. Reforms for railway transport resulted in the emergence of new private carrier companies, while the railway infrastructure - networks, bridges, tunnels, stations and terminals-remained under state control.

For example, Net, a 100% state-owned non-profit organization in the UK, runs the entire railway infrastructure, the intensity of which is 80% higher than the EU average. The main function of net DKK is to provide a safe and reliable railway infrastructure, which is achieved through strategic investments in the creation of the network, long-term planning in terms of the implementation of common standards for production processes and specialized services, the assessment of network capacity bottlenecks. According to the recommendations given on the basis of the comprehensive study" improving the profitability of Railways", the largest passenger and freight train operators and net DKK, the carrier group (RDG) Railway, have established the governing body responsible for coordinating and directing intersectoral initiatives. The group includes all passenger and freight trains. The railway companies, including net DKK and HS2 (high-speed network), provide a horizontal interface between both passenger and freight carriers, government and research institutions.

The China Railways Association serves as a link between Central, regional and local government structures in railway transport. It is directly connected with the Ministry of Railways and is headed by two state commissions - the commission for planning and economic development. The association was entrusted with the functions of managing regional railway bureaus, local railway systems and relevant administrations of various provinces, municipalities and autonomous regions. The association is responsible for the exchange of experience in the construction and management of local railways, construction standards for local railways, coordination of joint construction, organization of Joint Transportation.

The current stage of the organization of passenger traffic is characterized by the development of hybrid mobility based on the high connectivity of the route network of international, regional, suburban and intra-city lines. The passenger transport industry must adapt to the new mobility landscape.

Rising incomes and populations in developing and emerging economies, where cities are growing exponentially, are set to lead to strong demand for more efficient, faster and cleaner transportation transport, but the need for speed and flexibility tend to favour car ownership and air travel.

Rising incomes also drive demand growth in freight, where higher incomes, have sharply increased demand for rapid delivery of higher value and lighter goods. The rail sector has important advantages to exploit in competing for business, but this will require additional strategic investments in rail infrastructure, further efforts to improve commercial competitiveness, and technological innovation. Global demand for transport is growing fast. Given present trends, passenger and freight activity will more than double by 2050. Such growth is a token of social and economic progress, but it carries with it greater energy demand and increased CO2 emissions and atmospheric pollutants. A greater reliance on rail has the potential to cut that growth. In a world becoming ever more urbanised, rail travel is well matched to urban needs. High-speed rail can serve as an alternative to short-distance air travel, and conventional and freight rail can complement other transport modes to provide efficient mobility.

Rail transit Vehicle BogieTechnology

The bogie technology is the fundamental component of rail transit vehicles, related to the running and load bearing. It provides the support to the body of vehicles, to ensure the smooth, steady and safe running of vehicles. The bogie consists of foundation brake, springs, drive and swing bolster, and existing different forms as uniaxial, biaxial and multi-axial forms. Most bogies of rail transit vehicles are in biaxial form. Currently, the bogies of rail transit vehicles have changed from biaxial form to the uniaxial link bogies, with shorter and wider body of vehicle structure. For this kind of vehicles, its running radial direction can be adjusted, and its bogie has used the modular design technology, with better development and application.

Apart from the basic properties, bogies for locomotives, railcars, passenger coaches and freight wagons, as well as underground and suburban vehicles are, however, designed differently. Only in this way can all the requirements for speed and comfort, load carrying capacity and axle load, safety against derailment and smooth running be achieved. There are an almost incalculable number of different designs of bogies. On closer consideration it also appears that many road-rail vehicles and even maglev vehicles run on special bogies.

Railway bogies generally run on two or more wheelsets. There are rare cases of single axle and so-called loose wheel bogies, which of course require a special mechanical activation for running in curves. Four and more axle bogies are generally formed from groups of two or three axle

frames because of the length produced by normal wheel diameters. They are in turn carried in a common likewise rotatable bridge frame. Such designs can be found, in particular, under track maintenance machines and heavy load transport wagons or crane vehicles. The additional bridge frame avoids problems when running in curves, just as the maximum permissible axle load enables the assembly space to be more uniformly loaded. With extremely small wheel bogies, as are fitted under low floor wagons, for car transporting wagons a four or five axle bogie design is possible, without the total wheelbase becoming too large. If the bogie has more than two axles then the flanges of the wheel discs between the end axles are reduced or are dispensed completely as they are not important for the track guidance.

Directions for improving thequality of passenger services.

In order to improve the quality of services provided to passengers, a large number ofinnovations should be applied, i.e.

1. The company's mission must be accepted:”we improve the quality of life by making your journey as safe, affordable and comfortable as possible."
2. Professional Code of ethics ofPassenger Transport Conductor to be prepared;
3. A number of additional servicesshould appear on trains:

a) Luggage compartments;
b) Traveling by car;
c) Booking hotels;
d) Promotions (special rates);
e) Creation of a service" shower onthe train";
f) Multimodal transport;
g) WiFi service;

4. Railway stations, suburban ticketoffices, as well as intercity ticket offices should be modernized;
5. Issuance of travel documents;
6. The level of staff training shouldbe improved through training andexperience;
7. It should offer comfortable travelconditions on long-distance trains for passengers with disabilities. There shouldbe wagons with special coupes, whichshould provide everything to make it easier for people with health problems totravel;
8. When buying a ticket, luxury carsmust have a service of pre-ordering their food before departing from the train formation station;
9. New generation electric trains should be put into operation forcommuting commuter passengers;

The company must make every effort to ensure that the number of people wishing to travel by train is steadily growing. Taking into account all the above, we can safely say that the development of passenger transportation, as well as the services provided in railway transport, is at a high level.

Safety System Supervision

As it has employed widely in rail vehicletransportation widely over the world, the safety issue is the most concerned one. In the newest international standard specifications, the lifetime of software and hardware of programmable, electric and electronic system has been determined, which provided the reference for the evaluation of rail transportation safety. Therefore, in our

country, the professional criteria and standards must be proposed in refer to the safety criteria in European countries and combined withthe reality of domestic rail transit vehicles.

Charging Technology in Application of Rail Transit Vehicles

Currently Canada has started the research and application of wireless charging in rail transit vehicles with existing infrastructure, to ensure the energy required in operation. For example, put the wireless charging cushion under the road, in charging the bus, electric bus and rail transit vehicles. The research hotspot is how to charge the cars in running. As railway transportation has its fixed running route and operation mode, and the wireless charging cushion will provide the satisfactory charging, through the connection of charging port with the cushion via the magnetic induction.

World Bank

Railways are a climate-smart and efficient way to move people and freight. Railways promote economic growth while cutting greenhouse gas emissions. They are a clean and compact way to move millions of passengers and millions of tons of goods across countries and continents.

Yet railways constitute a shrinking share of transport in many developing countries, where railway service is often uncompetitive and poorly integrated with other forms of transport. Slow speed, high prices, and lack of reliability mean that potential users choose other transport options.

To make rail more efficient, and useful to both urban dwellers commuting to work and factory managers moving freight, the World Bank supports developing country governments in tackling three key challenges:

- Reforms in the way railroads are organized and financed, including better governance and more competition, which will provide better service at lower prices.
- Integrating railways into a country's transportation network. This often requires both new investments in terminals and a new way of thinking about how railroads mesh with roads, ports and businesses in general.
- Research into rail's impact on poverty. With a better understanding of rail's potential to address poverty, transport ministries and urban planners can make more informed decisions on policies and investments.

Conclusions

1. Current approach to increasing the demand for passenger transportation by rail by developing the railway route network, improving the equipment of railway stations, improving the quality of services, expanding the range of services offered - all this stimulates their consumption by a large number of customers.
2. The requirements of the "green economy", which are especially important today,when the need for a strategic organizational decision in the context of resource constraints, should be critically comprehended in the light of new economic trends arising from digital technologies.
3. When traveling on trains in our time, you can see sensitive and polite conductors,as well as constant quality control by the train chief and other officials. A necessary condition for the development of passenger transport is the organization of network interaction of market participants on the basis of digital technologies toensure uninterrupted mobility of the population through the unifying role of railway transport.

REFERENCES

1. E.M. Hajizade. Railway transport systemof Azerbaijan: infrastructure provisionand transit potential.
2. G.V. Bubnova. Freight marketing management models (Marshrut Publ., Moscow, 2003)
3. Bubnova G.V., Frolovichev A.I. Conceptof transport company management // Economics of railways. - 2018. - No.9.- pp.29-38.
4. Weil P. Digital transformation of business: Changing the business model for the **organization of a new generation.
5. Peter Weil, Stephanie Werner; Translated from English - M.: Alpina Publisher, 2019. - 257 p.
6. Grinev A.A., Evreenova N.Yu. Multimodal transportation: Lecture notes. -M: MIIT. - 2013. - p.8.
7. Efimova G.N. Specifics and problems ofservice on railways // Modern problems of service and tourism. No. 1, 2010 – 51-53c.

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 24 ISSUE 03 2023

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

WAYS OF APPLYING THE QUALITY MANAGEMENT SYSTEM IN ENTERPRISES

Gunay Hasanova[1] Nuriyya Ramaldanova[2]
[1,2]Undergraduate "İntrument Engineering" Department, [1,2]Azerbaijan State Oil and Industry University.
[1]hasanovagunay.hp@gmail.com; [2]nura.saga2000@gmail.com

ABSTRACT

Achieving institutional quality is one of the main goals of today's enterprise. This requires the development of policies, regulations and practices that cover each institutional element with a single quality view, their translation into written documents, and the implementation of institutional assessments and audits in accordance with the written documents. The study aims to identify quality and quality management approaches, the development of the ISO 9001 Quality Management Standard and the necessary documentation and document management practices within this framework. Control and evaluation of the system is also carried out through documents, which are the source of corporate information. The results of our research are considered significant in terms of revealing the importance of document management practices in quality management models that are fundamental to modern enterprises. The ISO 9001 Standard is not difficult and contains general requirements. It can be applied in any sector, be it large or small scale. It represents a powerful management system when properly understood and properly applied. The ISO 9001 Standard is completely dedicated to organizations to establish a Quality Management System. What needs to be done is not to create a "standard" Quality Management System, but to create a Quality Management System that meets the requirements of the standard.
Keywords: ISO 9001:2000, quality management system, enterprise, international standards, quality, etc.

Introduction

The main characteristic feature of the modern economy of Azerbaijan is that enterprises and industries specializing in the production of consumer goods and the provision of various services are a priority. The socio-economic situation of modern Azerbaijan determines the relevance of ensuring a stable pace of economic development of the state. The process of rapid integration of Azerbaijan into the world economy has begun. Large local financial and industrial groups enter foreign markets both by purchasing local enterprises and by creating their own.

The effectiveness of quality management systems (SSS) established in accordance with the requirements of the international standard ISO 9001 version 2000 depends on the understanding and implementation of the eight principles of quality management formulated in the ISO.

9000:2000 standard. The most important of them is the fifth principle - a systematic approach to management. With a systematic approach, there is a need for an integrated KIS that meets the requirements of all stakeholders. Therefore, work on the integration of SIS in various organizations, including industrial enterprises of Azerbaijan, has problems on this path are identified, ways to prevent or minimize them are proposed. The introduction of a quality system is a long and laborious process that requires significantmaterial and labor costs. However, along with the introduction of the quality system itself, it is necessary to ensure its proper functioning,

which is mainly focused on internal quality audit and a system of corrective and preventive measures, recently begun to develop actively.
Based on the analysis of the application of ISO series international quality standards in specific enterprises, the main.

Stages of establishing a quality management system

Stage 1. Management decision the manager must decide on starting the project, notify the company's employees, and also create the prerequisites for the speedy implementation of all other stages. It is also necessary to formulate the goals of establishing a quality management system, to highlight at the top the processes that need to be controlled and the criteria for assessing their quality. Then the objectives of the system should be established in the document called "Quality Policy", which also describes the principles for achieving them. This document is the basis in the system of regulatory documents of the quality management system of the enterprise [3].

Stage 2. Personnel training employees of the enterprise must study the theory of quality management, ISO 9000 series standards, master the theory of the process approach, as well as the basic requirements for the implementation of the KIS. Training in using the system can be carried out both with the help of consultants and independently if the company has an employee with experience in building the system.

Stage 3. Formation of an implementation program. The implementation of the quality management system (SIS) should be considered as a complex and long-term project (from one and a half to two years). Therefore, it is necessary to compile a program that includes:

- description of the stages of execution;
- list of responsible persons for each stage of the project.
- budgeting for the implementation of a quality management system.
- Procedure for assessing the implementation of the SIS.

After drawing up the program, one can proceed to the direct formulation of the quality management system

Stage 4. Description and optimization of business processes. The basis of the quality management system is the process approach. First of all, it is necessary to describe business processes, which management considers the most important for a quality management system. For example, for a manufacturing enterprise, this would be the production and sale of the product, as well as the process of Service and procurement. The described business processes should be optimized, that is, all inconsistencies and duplicate processes with the requirements of the standard should be eliminated, and new processes should be prepared in accordance with the rules of the standard.

Stage 5. Preparation of regulatory documents. At this stage, regulatory documents, rules and procedures are formed that ensure the functioning of the quality management system. The basis for them is usually a set of documents available at the enterprise, which are modified and supplemented in accordance with the requirements of the standard.
First, a document called" quality instruction "is prepared on the basis of" Quality Policy". It contains the main provisions governing assurance procedures, procedure for conducting QMS document flow, description of the procedure for handling complaints, etc. The next level of documentation is called "documented procedures on the system". Six procedures must be carried out in accordance with the ISO 9001 Standard [1]:

- document management;
- Data (Records) Management;

- Quality Management System Audit Management;
- management of products that do not meet standards (defect identification process and their neutralization procedure);
- management of non-compliance measures;
- management of measures to prevent the occurrence of nonconformities.

The documentation of the next level describes the rules for effective planning, implementation and management of processes. Such documents include methods of work, job descriptions of employees, schemes of movementof processes.

Stage 6. Testing of the quality management system and internal audit. After all regulatory documents are prepared, pilot operation of the system begins. Within the framework of the new system, processes can be launched in stages, for example, First control over the procurement process, then production, etc. applicable. At the beginning of the operation, they are performed often (perhaps once a week), then less often (once a month or even a quarter). For the purposes of internal audit, it is necessary to note quantitative qualitative indicators, for example, the degree of refusal, the degree of customer satisfaction, the degree of return, etc. To determine the value of such indicators, similar indicators of industry leaders are usually used. Internal audits should identify discrepancies between the current work and the requirements ofthe standard.

Stage 7. Certification of the quality management system. To certify the KIS, it is necessary to submit an application to the certification body (see the box“who and how can certify the KIS”). First, a number of documents must be submitted to the certification body:

- application for certification;
- all documents (“Quality Policy”, “qualitymanual”, table of organizational structure of the company, documented procedures and otherdeveloped documents of the quality managementsystem);
- list of the main consumers and suppliers of the enterprise.

Specialists of the certification body conduct an examination of the submitted documents within a month. The review may include a visit of the certification body to the facility for testing the quality system in operation.Based on the results of the audit, a protocol is drawn up in which all discrepancies between the quality management system and the requirements of ISO 9001 are recorded.

Principles of Quality Management System [2]:

1. Orientation to the consumer. Thisis an understanding of the needs of the target audience, compliance with their requirements, the ability to exceed their expectations;
2. Leadership of leaders. Creation of general goals and activities of the organization. The ability to create andmaintain an internal environment in which employees will be motivated toachieve the goals of the organization;
3. Staff participation. To reveal the skills of employees and use them for the benefit of the organization. Involvement in work forms loyalty, which contributes to innovation, a creative approach to work, a sense of responsibility amongemployees;
4. Process approach. The resources and activities of the company must be managed as a process. This helps to reduce costs and shorten the turnover time, the final results are improved and become more predictable;
5. Systematic approach to management. It allows you to concentrateyour efforts on key processes, combine and chain processes that will best achievethe results you want;
6. Continuous improvement of the company's performance;

7. Improving approaches to decision making. When decision-making is based on the analysis of data and data;
8. Improve relationships with suppliers;

Studying the experience of application and functioning of quality management systems in enterprises in Azerbaijan

An analysis of the production activities of a machine-building enterprise carried out within the framework of a quality management system allows you to identify various problem situations. The study of the problem situation in the field of quality at machine-building enterprises should be carried out in the context of the creation, implementation and improvement of the SIS. The problems of creating quality management systems should be solved both at the level of individual enterprises and at the state level, which forms the basis of national economic programs. To solve the problems of increasing the quality and competitiveness of domestic machine-building products, it is necessary to direct the efforts of federal and local governments, scientific and technical associations and organizations to change the previously existing mechanisms for managing the scientific and technological development of an organization within the framework of quality management systems operating in the Regions [1].

Currently, this problem is being solved by the Standardization Institute and the Azerbaijan Accreditation Committee. At the level of individual enterprises, many quality management systems have been created and are being created "in shape and likeness", which implies the active use of "analog systems" used in other enterprises. In these cases, it is necessary to talk about the low efficiency of such systems, which is characterized by a gradual change in the structure and properties of its individual elements. For enterprises producing science-intensive products, this approach is not effective. This is due to organizational, technical, technological, social and other features. For example, for a small manufacturing enterprise, this is the degree of documentation and detailing of documents, this is a lack of clarity in the distribution of functions and the interaction of departments and services [4, p.69].

The activities of the KIS at enterprises cannot be effective without a single Quality Management Information System. It should also be noted that at enterprises producing consumer products, the tasks of assessing customer satisfaction are difficult. Despite the significant success of machine-building enterprises in the implementation of foreign certification systems, it should be noted that the process of introducing quality systems, voluntary certification of production is slow. The difficult economic situation, the lack of interest of enterprises themselves have their effect. Today, it is extremely necessary to create a system of economic measures that motivate enterprises to produce high-quality and competitive products. It is necessary to provide manufacturers with the opportunity to spend part of the profit obtained by increasing production volumes on financing work on improving the technical level and quality of products, certification of products and quality management systems, development of after-sales services [6].

The experience of the development and implementation of KIS at Enterprises has shown that often this work does not lead to the achievement of the expected indicators, and even more so to efficiency in production activities. Although, it should be noted that the quality management system at the enterprise is a mechanism that guarantees an increase in the organizational and technical level of Production Management, an improvement in the quality of the created products, an increase in their competitiveness. Therefore, there is a need for a constant study of the functioning of the quality management system, which forms an objective basis for the

development of measures aimed at improving the work of both the system itself and the enterprise as a whole.

Difficulties in implementing a quality management system.

The implementation of the KIS is a complex project for any company, the successful implementation of which requires accurate knowledge and compliance with all laws and documents. There are certain difficulties in a project of this magnitude [5]:

- non-acceptance of the strategic decision on the establishment of the system by individual employees and managers;
- strong organizational structure, functional management;
- internal barriers between departments, lack of understanding of the overall goals of the organization, a gap of trust between personnel ofdifferent levels;
- violation of the balance of responsibilityand authority;
- low level of production culture;
- lack of clearly formed vision, mission, common ideology, philosophy, development principles for the whole company;
- processes are not described, basic processes are not defined, quantitative and qualitative criteria are not defined and measured;
- quality is understood not as the quality of processes, resources, management decisions, but only as the quality of products;
- lack of customer satisfaction measurement and marketing system. A true tool for improving performance, ISO 9001 will help the company overcome these difficulties, which brings the company to a fundamentally new level of development.

Conclusion

At the modern stage of development of Azerbaijan's integration into the world market economy, common problems began to arise before enterprises of various forms of ownership and fields of activity. And these problems are associated, first of all, with improving the quality and competitiveness of domestic products, which is impossible without the introduction and functioning of international quality systems atenterprises.

The competitiveness of products is a complex characteristic that can be changed and therefore controlled. Product quality is an integral part of competitiveness, and the latter component can be influenced through Quality Management. Understanding the main problems solved with the help of quality management, as well as the requirements of the modern market, prompts manufacturers and suppliers of products, goods and services to implement Quality Systems. During the analysis of the dynamics of foreign trade turnover and industrial production in Azerbaijan over the past few years, a significant increase in imports and a steady increase in production with the introduction of ISO series international quality standards have been announced the main enterprises that provide this growth.

Research and development work in the field of building an integrated KIS aimed at Total Quality is currently at the initial stage of its development. We are currently not aware of any incidents involving a fully integrated and certified management system. Management integration is still ongoing, with the addition of autonomous systems to each other and consistent certification of their compliance with current international andnational standards.

REFERENCES

1. T. HuseynovA. ” Economics of the enterprise": textbook. Baku-2005
2. N.R. ” Fundamentals of standardization": textbook. Baku: Elm, 2003
3. S.Y. and b. "Current situation in the application of international standards in Azerbaijan": scientific works of AzTU, 2007, I edition
4. V.V. Miroshnikov, T.V. School. Principles of building integrated quality management systems // Bulletin of the Military Register. - 2004. - No. 12. - S.23-35.
5. "From quality management to quality management and business". St. Petersburg, October 4-6, 2005
6. Alekseev V.P. What is quality (review) // Standards and quality. - 2002.- No. 3.-S. 99-102.

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023
ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

BIG DATA ANALYSIS IN REHABILITATION TREATMENT

[1]Aynur Jabiyeva, [2]Farid Nagdaliyev
[1]PhD, associate professor, Aynur.Jabiyeva@outlook.com
[2]Master student, farid.naghdaiyev@affa.az
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

High productivity recent advances in technology of athletes complex of diseases more exactly achieve modeling for system of biology as a holistic science occur to come out reason has been Close will come personalized of medicine appear that it will come out predicts. Healthcare in their systems level personalized medicine Conducting Omics enterprises with regions is limited and personalized medicine high and down profitable countries between healthcare in their systems increasing the abyss expand can A series factors traditional from medicine personalized medicine transition slow: profitable high of productivity information creation; hybrid education and multidisciplinary teams; of information storage and processing; of information integration and interpretation ; individual and global economic relevance. This review personalized medicine global transition speed up for big of information analysis and forward strategies on important of developments update provided is doing.
Keywords: Big data, Omics, Personalized medicine, High-throughput technologies, Cloud computing, High -dimensionality

Introduction

Great to omics (genomics, transcriptomics, proteomics, epigenomics, metagenomics, metabolomics, nutriomics etc.) entry revolutionized biology and biological mechanisms more good done deduction for system of biology to the creation reason it happened System biology interdisciplinary from fields coming data unit in the form (more traditional reductionism instead of holism) integration by doing complex biological reciprocal the connection modeling aims. Factors the mixture to the end point leading alone entities who review from holding different as, systems biology relies on experimental and computational approaches to provide mechanistic insights to an endpoint.

Traditional observation epidemiology and either biology alone not, completely clarify multifaceted heterogeneous disorders and this, this kind of diseases for all prevention and treatment searches live limits [2, 3]. Broad on the picture acceptance is done that biological systems done to fall for many dimensio ns the same at the time consider should be taken [4].

Systematic approaches to action brings advanced biology and medicine [5, 6]. Normal and abnormal phenotypes for deterministic of networks usage proactive to storage opportunity given by is thought of Individual health, that is predictive, preventive, personalized and participant medicine (P4 and either more many so to speak, personalized medicine) [1] .

Many of them in rehabilitation of personalization appear that it will come out predicts near in the future medicine, however scientific of the public and of the media what he thought up to quickly appear coming out probability there is no [7]. Growing two level healthcare to the system parallel as global level, similar two layered transition more also delay who knows omic of information creation and analysis with our ability connected

phenomenon observation is being T echnological to progress although in rehabilitation medical omic of information management making (storage and calculation resources) are expensive as remains . It means that that is personalized medicine more rich with countries be restricted can [8]. This omics data to create and comment make in our ability increasing with space opposite is being.

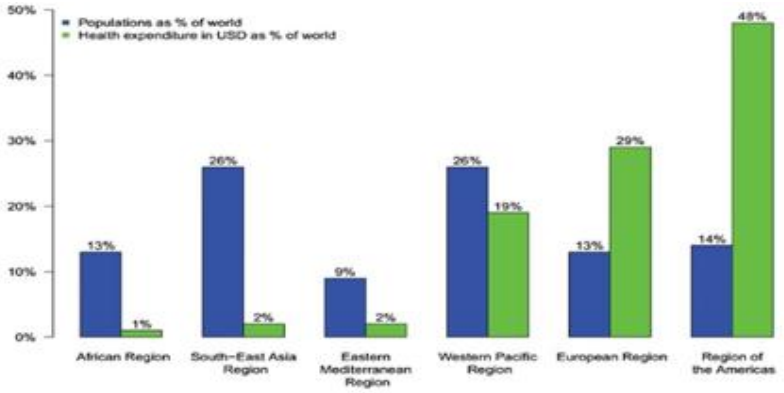


Fig. 1 Distributions of populations and global health expenditure according to WHO

High in technologies in athletes and soldiers medical in rehabilitation advances with our our ability between the abyss remove to lift urgent need there is Omics data integration done , analysis is done and comment is done [10-12] . This review personalized medicine direction socio-economic and scientific in progress increasing spaces coverage is doing.

Study the problem.

The world 84% of the population recovery needs, however to healthcare separated global expenses of mistakes only 12 % organize does [13]. Geographical regions on of people distribution with global healthcare expenses between big there is a difference (Fig 1). From 1995 to 2006 up to of healthcare internal from sources state by financing global 100% increase in scale case, down and medium profitable countries most of them the same at the time of financing decrease with faced [14]. Development in doing which is life in countries (for example, Covid 19). for soldiers for danger creator, however easily prevention buy who knows and either treatment to be who knows one how many disease yet too is spreading. Personalized medicine this differences will increase even more and one many down and medium profitable countries personalized medical out of hand to give can [15-17]. The international rehabilitation committee should devote significant efforts to strengthen the health systems of military personnel, especially athletes.

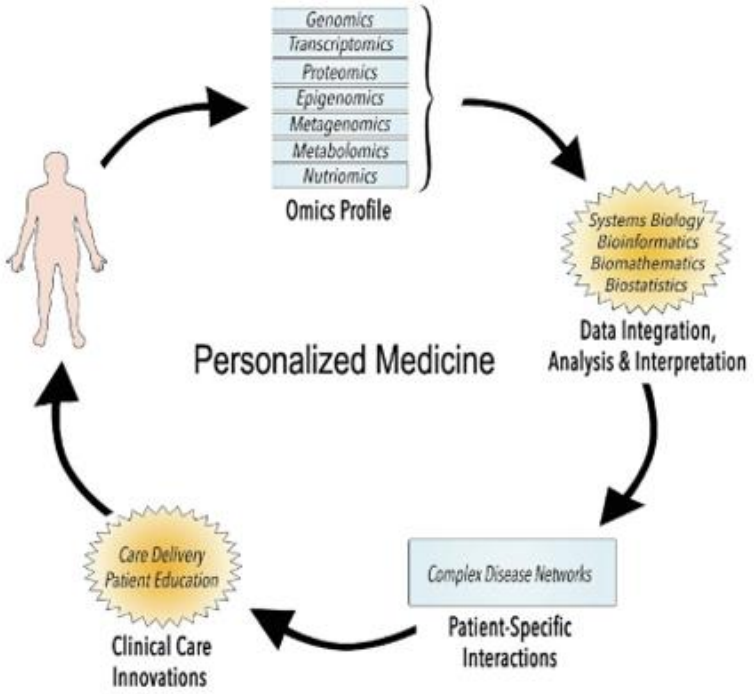


Fig. 2 A basic framework of personalized medicine. The integration of omics profiles permit accurate modeling of complex diseases and opens windows of opportunities for innovative clinical applications to subsequently benefit the patient

System medicine, system of biology application human diseases [18], advanced omics tools and analyst tools, advanced digital technologies (high calculation performance and storage resources) and high qualified multidisciplinary teams clinicians , epidemiologists , biologists , computer scientists, statisticians and mathematicians) security and to privacy to investments addition support they should be. Technology rapidly development does and new developments data more efficient use is doing Some of them technological to the plateau various for reasons (reliability, profitability) that he knows they predict, however this predictions date with trends not confirmed. New technological development in science always the head to give can [20]. With that so in omics studies of expenses of most of information from creation more many of information from the analysis that it will come out about there is a consensus [9].

The future of the disease the beginning and either special to treatments-interventions the answer for personalized tests of omics networks as economic value big in size unknown as remains. Many little research personalized of assessment economic aspect in itself concentrated a n d tests was conducted. These tests clinical in use which is and either development did development stage of those, genetic from the tests consists of Food and Medicine Administration tags , display built clinical benefit which is tests and conditions the examiner tests high with death and either high with health related with costs done comes. To investments and politics decisions management make for personalized of tests economic evaluation need. They are personalized medicine transition speed up for important initially is a condition. Ago addition, economic of information included which is one how many personalized of tests relatively economical which is revealed was done, however their only one little part to expenses savings did , this is more good your health definitely more down

with costs related that it is not shows [21]. Summary, personalized medicine transition with with athletes connected expenses uncertain as remains , however personalized medicine high and down profitable countries between healthcare in their systems economic inequality expand further can.

This is stability social and political the supports danger under puts and all in the world microgrants oriented more wide attention the need emphasizes [22].

1,000 USD microgrants relatively small although the World Bank certain which he did whom poverty at the limit from 1.25 USD / day down which is persons yearly income quite a lot exceeds. These grants recipient are they sports? efforts expand for to knowledge based on innovations to associate and together production in doing long one road pass they can Funding agencies through given type 1 micro grants personalized medicine new discovery models with to associate for small to laboratories and local to scientists support be can [23]. Science observatories and either soldiers financing mechanisms through financed type 2 microgrants similar burden which is fields new innovations (i.e therapeutic, diagnostic) to share for global healthcare of diplomacy development make it easy can [23]. Down and medium profitable countries knowledge and of innovation in promotion local to scientists common support need.

Science Peace Corpus for global science interdisciplinary programs down and medium profitable countries research and developments for else one prospective catalyst is an agent. Current Peace Corps program, scientific studies for Resistant knowledge flow whom service make for of the world various regions voluntary work (minimum 6 weeks and with 2 up to) intended holds. Small and either great scientists life sciences, medicine, surgery and psychiatry topics coverage to do they can This program two is directional because it is both to the rich , both too to the poor the concept of "health". Clarify and personalized medical various environments integration make for service is doing Down and medium profitable countries developed life style behind the rest of people of the majority where he lives place that it is consider intellectually individuals for with prizes open opportunity to create need.

If pandemic during the period military in the field people each other benefit to give for collective on the picture movement if they have to , institutional diversity done to fall there is a need. Personalized of medicine various applications of the world diversity cope with to come for many level personalized healthcare to their systems one many on the scale permission to give and of this instead of resource management compromise go will know alone high level healthcare from the system run away for intended be caught can. This is both too cooperation for security factor whom both science and too ethics for inside each other regulation to their systems need creates [29,30]. Transparency and accountability to all scientists, practitioners , athletes , ethics, sociologists and to politicians application should be done. Personalized to medicine Resistant transition the head if he gives, not at all who accountability from the struggle behind should not stay .

Omics data in the last decade integration make and comment make in the field increasing regression observation has been done [9]. Biotechnology companies by supported Man Genome From the project arising new technologies and knowledge of ^{the} 21st century to the early omics revolution reason it happened [31]. High transmission ability which is of technologies use doing, we now short duration during to the DNA of individuals (genomic), over time of genes transcription to RNA (transcriptomics), DNA methylation and specific protein to their profiles output opportunity whole number that gives measurement take away

we know . Tissues and cells (epigenomics and proteomics), metabolites (metabolomics), others type omics to the information included happens [32]. Even traditional as training the past experts by evaluated and evaluated histopathological and radiological pictures now calculation to quantities (i.e imaging exposed to informatics remains [10, 33]. Investments to their income based on business models, available with technologies in comparison increasing profitable with prices omic of information creation speed up for continue who did technological to developments boost gave. As a result, omics platforms and individual omics profiles enough up to appropriate at a price will be is expected and of information creation, most at least medium and high profitable countries the majority laboratories for use is done [34].

First omics data for big there were expectations of the disease the beginning and development main mechanisms, as well as of the disease prediction, prevention purchase and treatment for new strategies about discussions was conducted [1]. Idea, omics profiles disease to networks based on to the topic special care convert was (Fig 2).

Omecs to their profiles increasing need although complex relationships limited as remains.

Individual of medicine hybrid to education needs , data problems solution ways already available although and Google, Apple, Amazon and Like Facebook companies by enough up to homogeneous big of data (ie user data) [37] solution making for acceptance if done in , omics data heterogeneous nature new present a problem is doing of data integration and comment out to hold for main biological of concepts and analysis of algorithms enough up to done to fall demand who did problems [38] , working for the scientist 1) main problem 2)data analysis methods 3) explorations to carry and result to remove for various calculation platforms advantages and its shortcomings done the fall it is important. Biology in the field experience cause and effect to contextualize and reciprocal connection signals identification and comment management make for ground creates.

Omics data and biological reciprocal effects to remove for various of approaches usage modeling experience demand is doing finally, the computer programming skills explorations management make and relevant as omic information analysis make for need. Scientific calculations for most good experiences through reliable and Resistant computer to the codes need have [41] . Scientists approx 90 % program of provision in preparation by itself they learn Their each in one of assignments automation of code review holding , units checking , to version control and of the problem tracking whom main experiences not to be can [42, 43]. Computer scientists, mathematicians, statisticians, biologists, and clinicians between many different scientific to the source according to yet too subjects between obstacles is available. Personalized medicine transition for most modern science, essentially it is integrative and will come researchers traditional as divided of subjects in the interface to grow and to teach for in universities innovative to strategies urgent there is a need.

Sportsman and of the military level increasing of knowledge modern of societies in development to be the main factor though, one owns the individual he can knowledge and experience of wealth up limit there is [45]. It is multidisciplinary individual with training as well as university research financing of agencies initiatives and governments system biology and personalized with medicine related interface in their subjects various scientific from the source which is researchers to combine encouragement is done. Health Studies Institute biomedical of research in financing different from a discipline (eg genetics) to a multidisciplinary one expert to the panels to pass correct direction thrown away is a step .

Education and multifaceted research activities connecting Steno Center in Denmark in the future interdisciplinary research institutions creation and in Azerbaijan personalized medicine institutions become will know smart initiative forward drove.

Omics of information management making and processing

Scientific specialists by bioinformatics, biomathematics and to biostatistics big investments should be placed. Personalized medicine transition speed up for classic research laboratories enough up to does not have opportunities.

Omics of information management making and storage calculation resources, in the laboratory placed servers program of provision configuration and usage for informatics support investment demand is doing This kind of of servers construction and storage it is expensive. of Omics data processing for various work of streams dynamic requirements the answer does not give and this, or extreme more than , or sub- optimal to the servers brought takes out Omic of information creation and processing between gap remove raise for prospective of technologies one cloud calculations [46,47]. This is through the Internet virtual resource whom numerous from the full potential of computers use who did adaptive memory and calculation service [48]. Currently attention Ohm of information high productive processing and analysis for cloud-based instrument of sets and workflow platforms preparation directed.

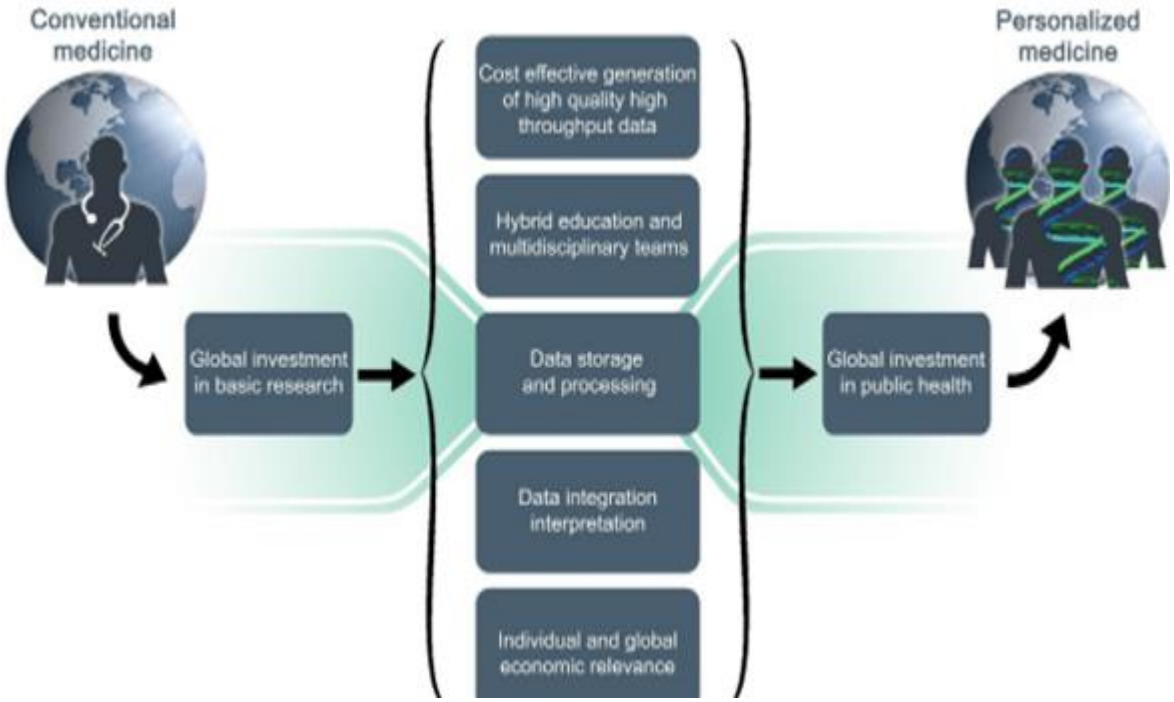
Omics data clinical benefit review impervious before research platform's reliability should be viewed. Image 3 individuals of medicine to the application help to do will know cloud based frame description is doing Personalized to medicine transition during omics of information integration and interpretation for yet too more many programming to your efforts there is a need. Regular as to update who knows complex flexible programs encouragement who did potential down flow applications information while being created always does not appear.

Omics of information integrative methods

Finally, omics of information integration through biological of systems description various subcomponents between cause and effect relationships to remove and description make for relevant math and statistics methodologies demand does[40]. Omics of information integration biostatistics and in biomathematics both difficult , both too is an opportunity that this also omics refiles decreasing expenses with increasing is reality. Thousands of measurement analysis calculation complexity one since, of correlations real and meaningful biological reciprocal connection whom removal unimportant not Errors biological to systems non-linear reciprocal effects and numerous of factors together effects include signals by accident to separate makes it difficult.

Biological to fully clarify networks for both calculations, both too experimental to methodologies need there is with that so, experimental from analyses different as, calculation models biological in terms of management which is to variables based on and Omic of information characteristic traps has.

Omic of information analysis for else one strategy, maximum information who keeps one data to the collection numerous information types of integration intended holds. This omics data complexity alone high sized information of the set to the analysis up to reduces Omic of information integration for else A problem is meaningful comment to be done who knows correlation in hand is to do.



Omics data quality high productivity platforms between change can.
Complex of diseases in modeling network approaches of the disease progress the map provided to do can and your health proactive in storage big role play can. Complex reciprocal connection signals all reproducibility and checking personalized of medicine in search of it is important. this omic of research adaptation help make and research of the results correct repetition provided make for how (data about information) scientific whom to metadata increasing the need emphasizes. Metadata check list and publishing metadata samples existed. Metadata both too integrative sciences for open innovations whom service to do can and discovery and translation models high and more importantly down-level diversification make for valuable be can and medium profitable countries. In general, stability proof whom numerous information sets on inspections demand is being and theoretical in terms of justified new of methods available those who exceeds Appropriate biological networks appointment make for both description , both too mechanical models with caution to work demand is doing Omics data to the future integration who did and comment who did program guarantee currently private in the sector competition leading by companies (Anaxomics, LifeMap).

The result

Omics data tall of data sports and war in the industry big mixture in itself concentrates here new associations certain make for current our ability big data in the context of more big information at the expense of done comes Omic of information their analysis development to make and high productivity technologies most good on the picture use make for bioinformatics , biomathematics and biostatistics fields big investments should be placed. New generation many talented from scientists and multidisciplinary research from groups exactly complex disease models to build and

effective personalized prevention , diagnosis and treatment strategies permission to give demand is being Omics information integration make and reciprocal activity to show our ability personalized medicine in transition important restrictive is a factor . of these limitations remove removal clinical of omics tools under conditions country on the scale application strengthen can Next scale economies, own in turn, two level personalized of drugs increasing his shadow def making it inconvenient to countries personalized medicine output in hand to do can medicine.

REFERENCES

1. Hood L, Flores M. A personal view on systems medicine and the emergence of proactive P4 medicine: predictive, preventive, personalized and participatory. New Biotechnol. 2012;29(6):613–24.
2. Khoury MJ, Gwinn ML, Glasgow RE, Kramer BS. A population approach to precision medicine. Am J Prev Med. 2012;42(6):639–45.
3. Taubes G. Epidemiology faces its limits. Science. 1995;269(5221):164–9.
4. Loos RJ, Schadt EE. This I believe: gaining new insights through integrating “old” data. Front Genet. 2012;3:137.
5. Schadt EE, Bjorkegren JL. NEW: network-enabled wisdom in biology, medicine, and health care. Sci Transl Med. 2012;4(115):115.
6. Schadt EE. Molecular networks as sensors and drivers of common human diseases. Nature. 2009;461(7261):218–23.
7. Tremblay-Servier M. Personalized medicine: the medicine of tomorrow. Foreword. Metab Clin Exp. 2013;62 Suppl 1
8. Hardy BJ, Seguin B, Goodsaid F, Jimenez-Sanchez G, Singer PA, Daar AS. The next steps for genomic medicine: challenges and opportunities for the developing world. Nat Rev Genet. 2008;9 Suppl 1:S23–7.
9. Mardis ER. The $1,000 genome, the $100,000 analysis? Genome Medicine. 2010;2(11).
10. Yuan Y, Failmezger H, Rueda OM, Ali HR, Graf S, Chin SF, et al. Quantitative image analysis of cellular heterogeneity in breast tumors complements genomic profiling. Sci Transl Med. 2012;4(157):157ra43.Kumar V, Gu Y, Basu S, Berglund A, Eschrich SA, Schabath MB, et al. Radiomics: the process and the challenges. Magn Reson Imaging. 2012;30(9):1234–48.
11. Brugmann A, Eld M, Lelkaitis G, Nielsen S, Grunkin M, Hansen JD, et al. Digital image analysis of membrane connectivity is a robust measure of HER2 immunostains. Breast Cancer Res Treat. 2012;132(1):41–9.
12. Gottret P, Schieber G. Health transitions, disease burdens, and health expenditure patterns. Health Financing Revisited: A Practitioner’s Guide: The International Bank for Reconstruction and Development. 2006. p. 23–39.
13. Lu C, Schneider MT, Gubbins P, Leach-Kemon K, Jamison D, Murray CJ. Public financing of health in developing countries: a cross-national systematic analysis. Lancet. 2010;375(9723):1375–87.
14. Li A, Meyre D. Jumping on the Train of Personalized Medicine: A Primer for Non-Geneticist Clinicians: Part 2. Fundamental Concepts in Genetic Epidemiology. Curr Psychiatr Rev. 2014;10(4):101–17.

15. Li A, Meyre D. Jumping on the Train of Personalized Medicine A Primer for Non-Geneticist Clinicians Part 1. Fundamental Concepts in Molecular Genetics. Curr Psychiatr Rev. 2014;10(4):91–100.
16. Li A, Meyre D. Jumping on the Train of Personalized Medicine A Primer for Non-Geneticist Clinicians Part 3. Clinical Applications in the Personalized Medicine Area. Curr Psychiatr Rev. 2014;10(4):118–30.
17. Hood L. Systems Biology and P4 Medicine: Past, Present, and Future. Rambam Maimonides Med J. 2013;4(2).
18. Vecchio G, Fenech M, Pompa PP, Voelcker NH. Lab-on-a-Chip-Based High- Throughput Screening of the Genotoxicity of Engineered Nanomaterials. Small (Weinheim an der Bergstrasse, Germany). 2014.
19. Schadt EE. The changing privacy landscape in the era of big data. Mol Syst Biol. 2012;8:612.
20. Phillips KA, Ann Sakowski J, Trosman J, Douglas MP, Liang SY, Neumann P. The economic value of personalized medicine tests: what we know and what we need to know. Genet Med. 2014;16(3):251–7.
21. Hekim N, Coskun Y, Sinav A, Abou-Zeid AH, Agirbasli M, Akintola SO, et al. Translating biotechnology to knowledge-based innovation, peace, and development? Deploy a Science Peace Corps–an open letter to world leaders. Omics. 2014;18(7):415–20.
22. Ozdemir V, Badr KF, Dove ES, Endrenyi L, Geraci CJ, Hotez PJ, et al.
23. Crowd-funded micro-grants for genomics and “big data”: an actionable idea connecting small (artisan) science, infrastructure science, and citizen philanthropy. Omics. 2013;17(4):161–72.
24. Dove ES, Ozdemir V. All the post-genomic world is a stage: the actors and narrators required for translating pharmacogenomics into public health. Per Med. 2013;10(3):213–6.
25. Mbuagbaw L, van der Kop ML, Lester RT, Thirumurthy H, Pop-Eleches C, Ye C, et al. Mobile phone text messages for improving adherence to antiretroviral therapy (ART): an individual patient data meta-analysis of randomised trials. BMJ Open. 2013;3(12), e003950.
26. Hardin G. The Tragedy of the Commons. Science. 1968;162(3859):1243–8.
27. Ostrom E. Coping with Tragedies of the Commons. Ann Rev Politic Sci. 1999;2(1):493–535.
28. Ostrom E. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press; 1990.
29. De Vries R. How can we help? From “sociology in” to “sociology of” bioethics. J Law Med Ethics. 2004;32(2):279–92. 2.
30. Dove ES, Ozdemir V. The epiknowledge of socially responsible innovation. EMBO Rep. 2014;15(5):462–3.
31. Finishing the euchromatic sequence of the human genome. Nature. 2004;431(7011):931–45.
32. McDermott JE, Wang J, Mitchell H, Webb-Robertson BJ, Hafen R, Ramey J, et al. Challenges in Biomarker Discovery: Combining Expert Insights with Statistical Analysis of Complex Omics Data. Expert Opin Med Diagn. 2013;7(1):51.

33. Kristensen VN, Lingjaerde OC, Russnes HG, Vollan HK, Frigessi A, Borresen-Dale AL. Principles and methods of integrative genomic analyses in cancer. Nat Rev Cancer. 2014;14(5):299–313.
34. Shendure J, Lieberman AE. The expanding scope of DNA sequencing. Nat Biotechnol. 2012;30(11):1084–94.
35. Pal A, McCarthy MI. The genetics of type 2 diabetes and its clinical relevance. Clin Genet. 2013;83(4):297–306.
36. Scholz MB, Lo CC, Chain PS. Next generation sequencing and bioinformatic bottlenecks: the current state of metagenomic data analysis. Curr Opin Biotechnol. 2012;23(1):9–15.
37. Berger B, Peng J, Singh M. Computational solutions for omics data. Nat Rev Genet. 2013;14(5):333–46.
38. Gomez-Cabrero D, Abugessaisa I, Maier D, Teschendorff A, Merkenschlager M, Gisel A et al. Data integration in the era of omics: current and future challenges. BMC Syst Biol. 2014;8(Suppl 2).
39. McShane LM, Cavenagh MM, Lively TG, Eberhard DA, Bigbee WL, Williams PM et al. Criteria for the use of omics-based predictors in clinical trials: explanation and elaboration. BMC Med. 2013;11(1).
40. Brown NJ, MacDonald DA, Samanta MP, Friedman HL, Coyne JC. A critical reanalysis of the relationship between genomics and well-being. Proc Natl Acad Sci U S A. 2014;111(35):12705–9.
41. Wilson G, Aruliah DA, Brown CT, Chue Hong NP, Davis M, Guy RT et al. Best Practices for Scientific Computing. PLoS Biol. 2014;12(1).
42. Hannay JE, MacLeod C, Singer J, Langtangen HP, Pfahl D, Wilson G, editors. How Do Scientists Develop and Use Scientific Software? Washington, DC, USA: IEEE Computer Society; 2009.
43. Prabhu P, Jablin TB, Raman A, Zhang Y, Huang J, Kim H, et al. editors. A Survey of the Practice of Computational Science. New York, NY, USA: ACM; 2011.
44. Marshall E. Human genome 10th anniversary. Waiting for the revolution. Science. 2011;331(6017):526–9.
45. Cesario A, Auffray C, Russo P, Hood L. P4 Medicine Needs P4 Education. Curr Pharm Des. 2014;20(38):6071–2.
46. Schatz MC, Langmead B, Salzberg SL. Cloud computing and the DNA data race. Nat Biotech. 2010;28(7):691–3.
47. Schadt EE, Linderman MD, Sorenson J, Lee L, Nolan GP. Cloud and heterogeneous computing solutions exist today for the emerging big data problems in biology. Nat Rev Genet. 2011;12(3):224.
48. Armbrust M, Fox A, Griffith R, Joseph AD, Katz R, Konwinski A, et al. A View of Cloud Computing. Commun ACM. 2010;53(4):50–8.
49. Marx V. Biology: The big challenges of big data. Nature. 2013;498(7453):255–60.
50. Hiltemann S, Mei H, de Hollander M, Palli I, van der Spek P, Jenster G, et al. CGtag: complete genomics toolkit and annotation in a cloud-based Galaxy. GigaScience. 2014.
51. Liu B, Madduri RK, Sotomayor B, Chard K, Lacinski L, Dave UJ, et al. Cloud- based bioinformatics workflow platform for large-scale next-generation sequencing analyses. J Biomed Inform. 2014;49:119–33.

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023
ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

MATHEMATICAL MODELING OF THE OPERATION OF AUDIO FREQUENCY (NO JUNCTION) AND JUNCTION RAIL CIRCUITS

Bayramov A.R.[1], Bekirova L.R.[2]
[1]"Azerbaijan Railways JSC, Department of Infrastructure, Signaling and Communication service, bayramov-aladin@mail.ru
[2]Doctor of technical sciences, associate professor Department of "Instrument Engineering" Azerbaijan State Oil and Industry University, lala_bekirova@mail.ru

ABSTRACT

Rail circuits are the basic elements of modern railway automation and telemechanics systems, performing the functions of track sensors and telemechanical channels. It is shown that the calculation of their operating boundary conditions becomes more complicated with the application of junctionless audio frequency rail circuits. The analysis of track circuits consists of studying the changes in their operation in various modes when the circuit parameters are changed. During the analysis, the optimal values of the parameters of the circuit elements and the frequency of the power source are determined for the given operating conditions. An analysis of the factors affecting the operating currents and voltages of such rail circuit schemes has been carried out. When analyzing and calculating a track circuit, it is assumed that the track line and equipment elements are linear, that is, their parameters do not depend on the flowing currents. To simplify the calculations, the track circuit is represented by the corresponding mathematical model (equivalent circuit) for each mode. Depending on the type of equivalent circuit used, four-pole and multi-pole models are distinguished. At the same time, the analysis and reporting of jointed rail circuits are carried out. Based on their results, the directions that allow for more accurate modeling of the operating modes of the circuits of the non-joint audio frequency rail circuits have been determined.
Keywords: Rail circuits, train traffic safety, audio frequency (no junction) track circuits, junction rail circuits, signaling system, track sensors, mathematical model, remote conditioning monitoring.

Introduction

To increase the efficiency of cargo transportation in railway transport, it is necessary to constantly improve complex technical equipment and buildings. The modernization of railway automation and telemechanics systems are no exception, as one of its main tasks is to ensure the safety and reliability of train movement on roads and stations. The rapid development of the microelectronics and microcontroller element base helps, in particular, to retrofit the general automation and telemechanics systems of railways and the systems of rail circuits in railways. Virtually all main and low-speed railways, as well as metropolitan railways, are equipped with rail circuits that transmit information to the traffic (trains) and monitor the condition of the road [1-6].

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

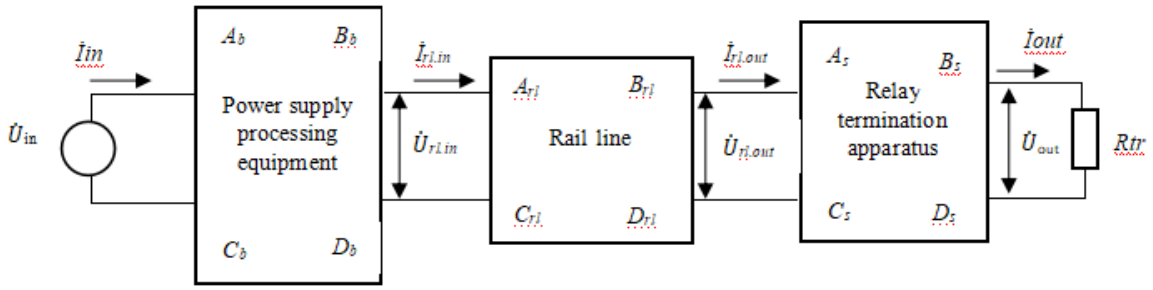


Figure 1. The general switching scheme of the rail circuit.

The difficulty in the operation of rail circuits is that they have to work in several modes (normal, shunt, and control) and under conditions of the significant influence of various external factors-ambient temperature, humidity, pollution of ballast, and a large amount of interference [7]. Currently, various types of rail circuits are used on railways and metros. The vast majority of rail circuits in use are junction rail circuits. At the same time, newly built rail circuits are junctionless rail circuits that are not bounded by insulating junctions, which found their application with the development of audio frequency rail circuits.

Tone frequency rail circuits have economic, technical, and operational advantages. The use of the signal current in the frequency ranges of 420-780 Hs and 4.5-5.5 Hs (with 8 and 12 Hs frequency modulation) allows for an increase in the ability of the rail circuit to be protected from the effects of drag current obstacles. The practically required power is reduced when using a modern element base.

Tone-frequency rail circuits have advantages as well as disadvantages. The use of high-frequency signal currents causes these rail circuits to be designed with a reduced length. The length of articulated rail circuits can vary from 1200 to 2600 meters, and the length of articulated rail circuits can vary from 300 to 1000 meters.

Accordingly, the abundance of railway automation and telemechanics equipment in such rail circuits leads to an increase in major repair costs in areas equipped with auto-blocking devices. The increase in the total volume of electronic devices required for the operation of electronic auto-locking complicates the calculations of operating modes during the application and operation of audio frequency rail circuits. Calculation of the range of required operating current and voltage under the boundary conditions of tone-frequency rail circuits is an integral part of safety and reliability functionality. The initial equations for the mathematical analysis of performance criteria for linear circuits of junction rail circuits are based on the theory of linear passive quadrupole networks. The elements of the hardware (transformers, resistors, connecting cables, etc.) that make up the feed and relay ends of rail circuits are presented in the form of four-pole networks characterized by parameters A, B, C, and D (Figure 1).

According to the equivalent circuit of the rail circuit (see Fig. 1), the input and output currents and voltages are related by the following expressions: [8]

$$\begin{cases} \dot{U}_{in} = A\dot{U}_{out} + B\dot{I}_{out} \\ \dot{I}_{in} = C\dot{U}_{out} + D\dot{I}_{out}, \\ \dot{U}_{out} = \dot{I}_{out} * R_{tr} \end{cases} \quad (1)$$

Where A, B, C, and D are the feed ends, the rail line and the relay end are the coefficients of the rail circuit quadrupole obtained by multiplying the quadrupoles. The input-Zin and output-Zout resistances of quadrupoles can be calculated using the known parameters A, B, C, and D. The parameters of the general matrix of the equivalent four-pole network are found and the coefficients of the four-pole rail line are determined, taking into account the worst conditions for signal transmission (minimum insulation resistance and maximum rail resistance):

$$\begin{pmatrix} A_0 & B_0 \\ C_0 & D_0 \end{pmatrix} = \begin{pmatrix} A_b & B_b \\ C_b & D_b \end{pmatrix} * \begin{pmatrix} A_{rx} & B_{rx} \\ C_{rx} & D_{rx} \end{pmatrix} * \begin{pmatrix} A_s & B_s \\ C_s & D_s \end{pmatrix} \quad (2)$$

When calculating the performance of junctionless tone frequency rail circuits, it is necessary to take into account the leakage of the signal current into the adjacent and parallel rail circuits. This situation significantly complicates the working scheme of the audio frequency rail circuit in different modes and makes it necessary to take into account the parameters of adjacent and neighboring rail circuit equipment in the calculations (Figure 3).

Quadripoles of adjacent and adjacent rail circuits can be represented in the form of recalculated input resistances connected in parallel to the considered audio frequency rail circuit equipment. In this case, the considered input resistance is a cascade connection of the quadrupole of the next rail line with the input resistance of the feed and relay terminals of the adjacent rail circuits (Figure 4). Zin, Neighbor. The equivalent resistance RD is calculated from left to right in the scheme according to the multiplication factor of the quadrupole (see Figure 4).

$$Z_{in.rl.2(n-1)} = \frac{A_{in.rl2(n-1)} Z_{dal.2y} + B_{in.rl2(n-1)}}{C_{in.rl2(n-1)} Z_{dal.2y} + D_{in.rl2(n-1)}}, \quad (3)$$

Where the:

$$\begin{pmatrix} A_{in.rl(n-1)} & B_{in.rl2(n-1)} \\ C_{in.rl2(n-1)} & D_{in.rl2(n-1)} \end{pmatrix} = \begin{pmatrix} A_{rl2(n-1)} & B_{rl2(n-1)} \\ C_{rl2(n-1)} & D_{rl2(n-1)} \end{pmatrix} \begin{pmatrix} 1 & 0 \\ \frac{1}{Z_{r.2(n-1)}} & 1 \end{pmatrix}$$

The signal frequency of the considered rail circuit RT2(n-1) of the relay terminal is determined by the following formula: RL2(n-1) connected in series and resistance Zr.2(n-1) at the signal frequency of the considered rail circuit RT2(n-1) of the relay terminal.

$$Z_{r.2(n-1)} = \frac{A_{k(n-1)} Z_{out.2(n-1)} + B_{k(n-1)}}{C_{k(n-1)} Z_{out.(n-1)} + D_{k(n-1)}}$$

Zdal.2n is the wave resistance of the rail line at the signal frequency of the considered rail circuit; Zout.2(n-1) is the output resistance of the track receiver of the rail circuit connected to the relay terminal RL2(n-1) at the signal frequency of the considered rail circuit, similar to Zout.22 (see Fig. 2). The input resistance of the next cascade (see Figure 4. from right to left) is determined by the equivalent resistance Zin.neighborTC

$$Z_{in.rl.2(n-1)} = \frac{A_{in.rl2(n-2)} Z_{in.rl.2(n-1)} + B_{in.rl2(n-2)}}{C_{in.rl2(n-2)} Z_{in.rl.2(n-1)} + D_{in.rl2(n-2)}},$$

Where the:

$$\begin{pmatrix} A_{in.rl.2(n-2)} & B_{in.rl.2(n-2)} \\ C_{in.rl2(n-2)} & D_{in.rl.2(n-2)} \end{pmatrix} = \begin{pmatrix} A_{rl.2(n-2)} & B_{rl.2(n-2)} \\ C_{rl2(n-2)} & D_{rl.2(n-2)} \end{pmatrix} \begin{pmatrix} 1 & 0 \\ \frac{1}{Z_{in.rec.2(n-2)}} & 1 \end{pmatrix}$$

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

The signal frequency of the rail circuit is determined by the coefficient of the quadrupole, RT2(n-2) arranged without series connection and considering the resistance Zin.y.2(n-2) of the supply terminal ST2 (n-2).

$$Z_{in.rl.2(n-2)} = \frac{A_{y.2(n-2)} Z_{out.FPM.2(n-2)} + B_{y.2(n-2)}}{C_{y.2(n-2)} Z_{out.FPM.2(n-2)} + D_{y.2(n-2)}},$$

RL2(n-2) is a resistance connected to the feed end similar to Zout.FPM.22 (see Fig. 2). Zout.FPM.2(n-2) is the output resistance of the road filter at the feed end of the signal frequency of the considered rail circuit.

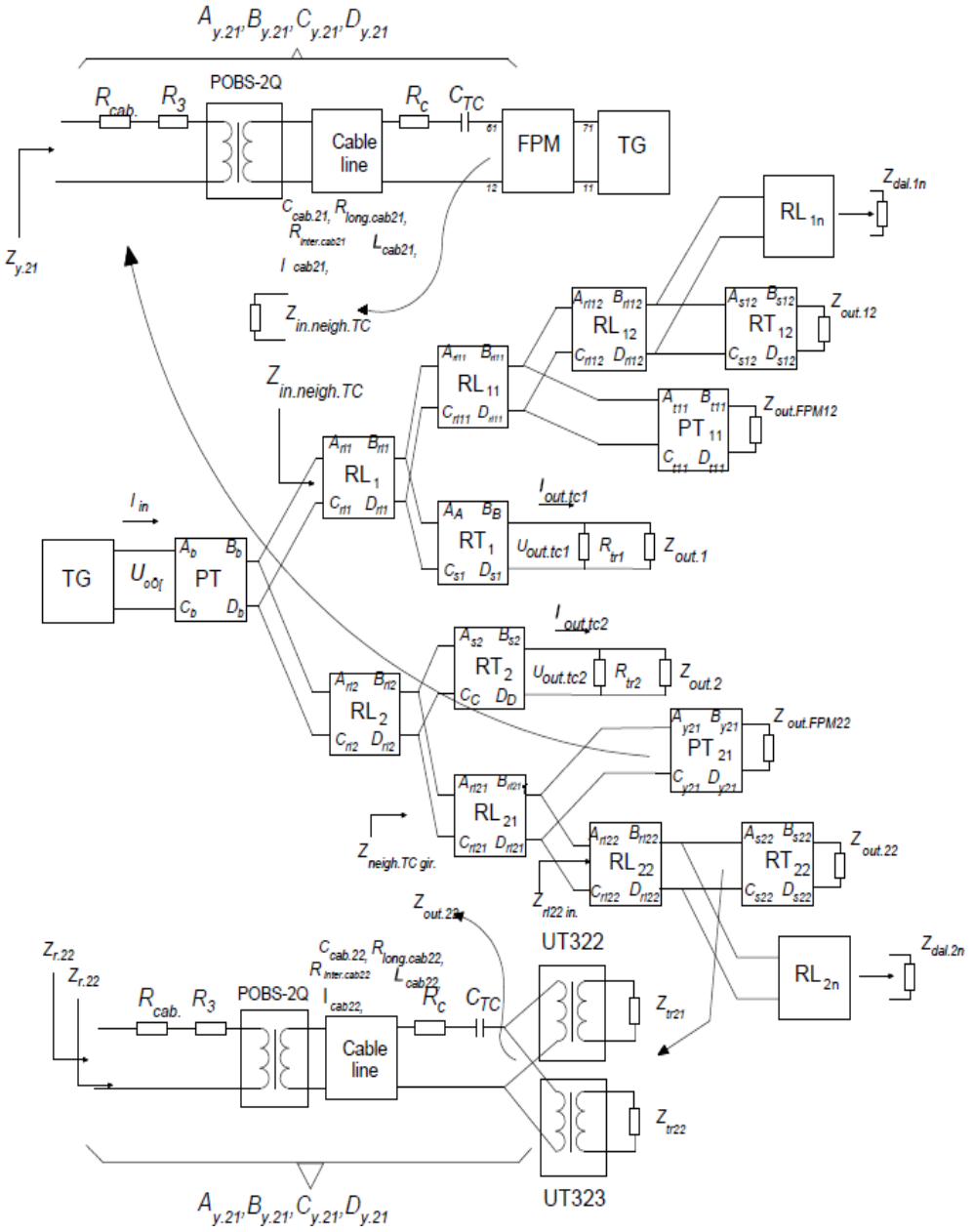


Figure 2: Equivalent circuit of the investigated audio frequency rail circuit.
TG – trackgenerator, PT, PT11, PT21 – four-pole feed end device, RL1, RL11, RL12, RL1n, RL2, RL21, RL22, RL2n – four-pole rail circuit on the rail line, RT1, RT12, RT2, RT22 – four-pole relay end device, Zoutput 1, Zoutput 12, Zoutput 2, Zoutput 22 – the equivalent input resistance of the track receivers of the adjacent track circuit at the frequency of the considered audio frequency rail circuit, Rtr1, Rtr2 – the resistance of the track receivers of the audio frequency rail circuit.

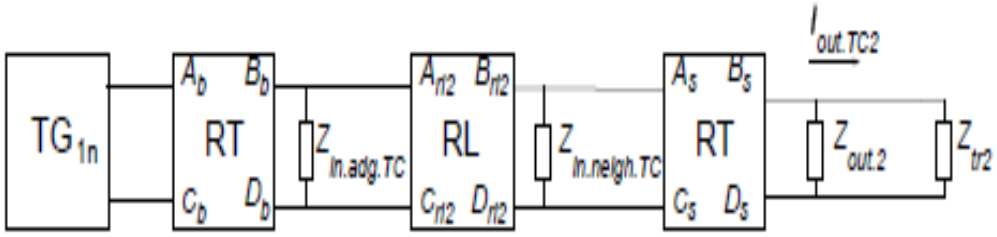


Figure 3. The layout of the tone frequency rail circuit in normal operation.
TG–road generator, QS–power termination device, RL–rail line, RT–relay termination device, Zin.bit.TC - adjacent rail circuit input resistance, Zin.neigh.TC - adjacent rail circuit input

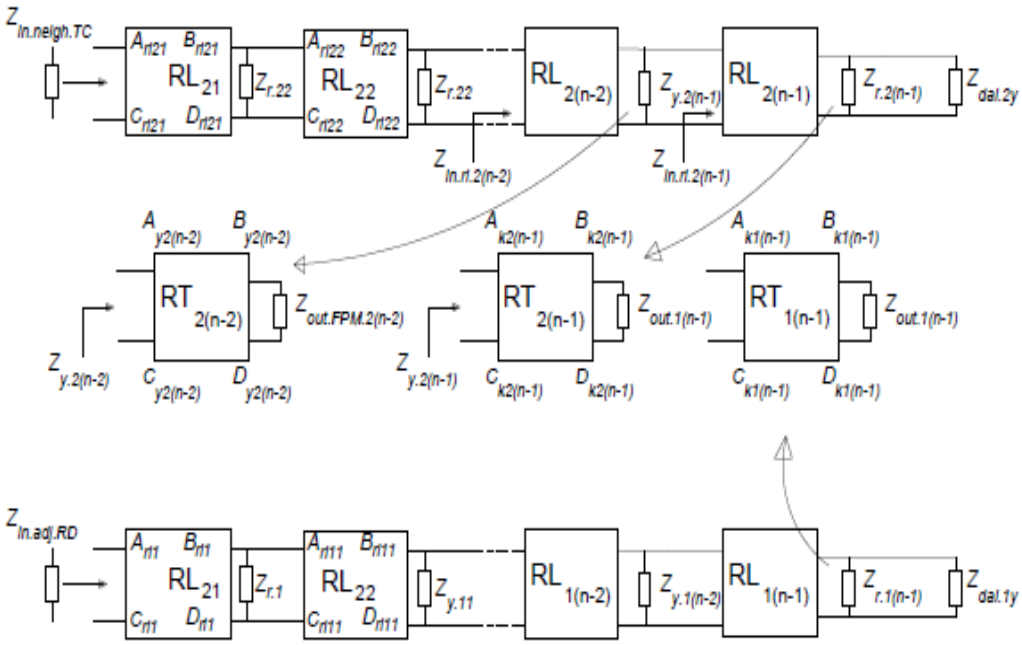


Figure 4. Equivalent circuit of input resistances of adjacent and adjacent rail circuits

In addition, a step-by-step calculation is made up to the input resistance Zin.neigh.TC using similar expressions. Moreover, the number of cascades of quadrupoles connected to the rail line and the input resistances of the feed and relay ends of the adjacent tone frequency rail circuits are determined primarily from the conditions of the length and ballast resistance of these tone frequency rail circuits.

Thus, if only the input resistance of the rail connection is taken into account (without the input resistances of the feed and relay terminals), then the parallel of the equipment connected to the neighboring rail circuit with a ballast resistance of 0.5 Ohm*km and at a distance of 1–1.3 km from the

feed end of the rail circuit with the considered audio frequency resistance should be taken into account (Fig. 5a). If the ballast resistance is 50 ohm*km, this distance will increase several times (Fig. 5b). However, since the number of equipment connected to the feed and relay ends increases due to the number of adjacent audio frequency rail circuits, this will lead to shunting of the input resistance of the equipment that is part of the rail line.

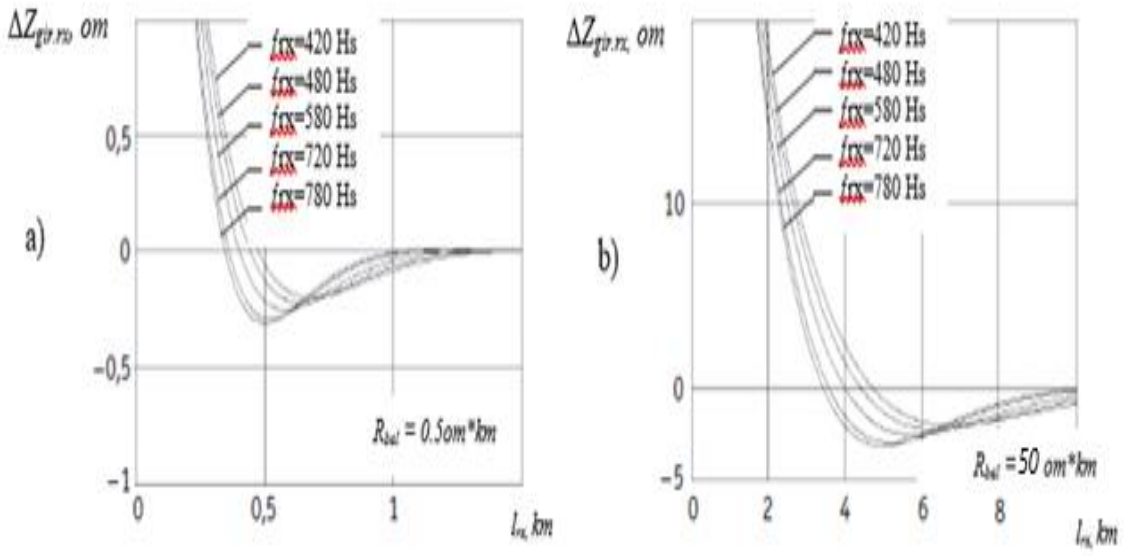


Figure 5. Dependence of the short-circuit and no-load modes of the rail line on the frequency and length of the 3rd generation of the audio frequency rail circuit on the difference in resistances: a-Rbal = 0.5 ohm*km, b-Rbal = 0.5 ohm*km

Conclusion

The performed analyses show that in further and more accurate modeling of the operation modes of the audio frequency rail circuit, it is necessary to take into account the resistances of neighboring and adjacent rail circuits as agreed in equations (3) and (4) in Figure 4. In this case, the number of n number of adjacent rail circuits is considered from the parameters of their elements (length of connected cables, the resistance of connected wires, characteristics of

transformers, etc.), especially the nonlinear input resistance of adjacent rail circuits corresponding to the audio frequencies of the considered audio frequency rail circuits ZSubtract. It depends on the input resistance of the FPM and track receivers (for example, Zout.22, see Fig. 2). Thus, for a more accurate simulation of the operating modes of tone-frequency rail circuits, it is necessary to investigate the nonlinear resistance of the input elements of the feed and relay terminals of neighboring and adjacent rail circuits in the leakage of the signal current at the frequency of the simulated tone-frequency rail circuits.

REFERENCES

1. Railway automation and telemechanics systems. Yu. A. Kravtsov, V. L. Nesterov, G. F. Lekuta, and others. Transport, M., 1996. 400.
2. N. E. Fedorov. Modern auto-locking systems with audio rail chains 132 pages, Samara: ам, 2004.
3. Kulik P. D., Ivakin N. S., Udovikov A. A. audio rail chains in -systems: construction, regulation, maintenance, search and elimination of malfunctions, improvement of operational reliability. Kiev: "Manufactura", 2004. 288 с.
4. Sisin V. A., Hnitko R. Automatic crossing signaling device optimization // Transport of the Urals. 2011. No. 3 (30).. 40-43. ISSN 1815-9400.
5. Sisin V. A., Hnitko R. V., Tilk I. G. Investigation of the electromagnetic compatibility of rail circuits with relay end switching with power supply interference and prospectiveтовоо состава // Vestnik UrGUPS. 2013. No. 2 (18).. 34-44. ISSN 2079-0392.
6. Bryleev A. M., Shishlyakov A. V., Kravtsov Yu. A. Rail chain theory, calculation, device, and operation. M. : Transport, 1978. 425 p.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

IMPROVEMENT OF THE METHODOLOGY FOR EVALUATING THE CARRIER FREQUENCY OF THE SIGNAL DURING DATA TRANSMISSION IN TELECOMMUNICATION CONTROL AND DISTANCE LEARNING SYSTEMS

[1]Nahlah M.A.M Najm, [2]Nada Adnan Taher, [3]Oleksandr Valchenko, [4]Oleksandr Turovsky.
[1]Assistant Lecturer of Department Computer Techniques Engineering, nahlahalammary@gmail.com
[2]Lecturer of Department Computer Techniques Engineering, mehaamra@gmail.com
[1,2]Al Rafidain University College, Iraq,
[3]Department of Civil and Industrial Safety, Candidate of Technical Sciences, Associate Professor, avalchenko60@gmail.com
[4]Department of Information Security, Doctor of Technical Sciences, Professor, s19641011@ukr.net
[3,4]National Aviation University, Ukraine.

ABSTRACT

Effectiveness of the application of telecommunications systems is directly influenced by the effectiveness of the functioning of each component and device of its design.
The article directly examines the issue of improving the carrier frequency estimation methodology for data transmission in telecommunication management and distance learning systems. The essence of the solution lies in proposals for improving the efficiency of frequency estimation at the input signal synchronization stage, which is presented on the example of a satellite telecommunication control system and distance learning. Namely, the analysis of modern satellite telecommunications systems was carried out and the features that affect the effectiveness of carrier frequency estimation and input signal synchronization were determined. The main inconsistencies are the low energy of the input signal receiving channel, significant signal frequency uncertainty, and the presence of "neighboring channels" receiving the input signal. It was determined that satellite communication systems during data transmission work in the mode with multi-station access in the variant of operation with frequency division of channels, which can receive data packets in the mode of multiple access or when providing a data reception channel on demand. At the same time, the operation of telecommunications systems can proceed both in continuous and in batch modes of receiving the input signal. It is considered that coherent processing of the input signal is carried out in demodulators of satellite telecommunications and interference-resistant coding is used.
To solve the task of estimating the carrier frequency of the input signal in coherent demodulators of modern satellite telecommunications, considering the above-defined inconsistencies and features, the article proposes a methodical approach. The essence of this approach is to determine the potential boundary of variances of the obtained estimates of the carrier frequency and to develop algorithms for estimating the carrier frequency of the input signal separately for continuous and batch modes of input data transmission based on the fast Fourier transform.
Keywords: Frequency, signal, uncertainty, carrier, estimation.

Introduction

Problems of signal transmission in modern satellite systems are determined by certain features of both the construction of the system itself and the problems of signal reception and transmission [1,2,3].

The best results can be obtained by a joint assessment of unknown signal parameters. However, in practice, such an assessment is possible only by considering the values of the channel energy and the magnitude of frequency uncertainty.

This, in turn, can lead to the use of a process in which the assessment of the shift of the carrier frequency of the signal received relative to the nominal value is carried out before other synchronization procedures are included, namely: phase synchronization and clock synchronization [3,5,6,7].

The complexity of the task of estimating the carrier frequency in the satellite channel is exacerbated by the possible presence of additional artificial and natural disturbances and radio space noise.

Especially when these factors are close to the main signal type of modulation and singing measured data rate. Also crucial in the implementation of the algorithm for estimating the carrier frequency is the mode of transmission of useful data [3,6,7].

A number of works are devoted to the definition of the main features of modern satellite systems in the direction of increasing the efficiency of useful data transmission and directly to the issues of estimating the carrier frequency of the input signal.

In [2], the main content of increasing the efficiency of modern satellite communication systems is justified by increasing the signal power through the data transmission channel.

In [4], the author proposes to use low-orbit satellite systems, which somewhat devalues the shortcomings of geostationary systems. However, the issue of conducting a general analysis of the process of carrier frequency estimation in geostationary satellite systems is not presented in the paper.

In [8], the results of the study of multi-symbol differentiated detection of signals of different coding with phase shift in the presence of random frequency changes and additive white Gaussian noise are presented. It is determined that the distortion of the transmitted signals due to the attenuation of the amplitude and the introduction of a variable phase time to the information symbols can be caused by a change in frequency. To eliminate this distortion, a scheme of double differential phase shift coding PSK (DDPSK) and the following multi-character differentiated phase shift detection in the presence of frequency shift is proposed. But the article does not estimate the frequency uncertainty and does not consider the possible modes of transmission of useful data.

The authors of [9] propose a joint assessment of the synchronization and shift of the carrier frequency and the detection of data using a filter of signals ranked by importance in the channels of additive white Gaussian noise. In this paper, we propose a weighted Bayesian Kramer Rao-boundary (WBCRB) for joint determination of time and carrier frequency shift, which takes into account the previous distribution of estimation parameters and is the exact lower limit for all considered signal-to-noise ratio (SNR). The issue of taking into account artificial and natural obstacles is not taken into account in this paper.

The work [10] combines the algorithm for estimating the frequency shift (FS) with the method of estimating phase noise. The estimation of phase noise is derived from the calculated coefficients of discrete-cosine transformation. A number of implementations of the proposed algorithm are

analyzed. However, the modes of transmission of useful data and the impact of various obstacles on them are not considered.

Methodology for evaluating the carrier frequency of the signal.

Thus, a preliminary analysis of the process of functioning of modern satellite telecommunications and the development of a methodological approach to estimating the carrier frequency in them, taking into account the result of the above analysis is an urgent scientific problem to which this article is devoted.

Analysis of the energy values of the satellite communication channel requires the implementation of coherent signal processing against the background of the use of noise-tolerant coding. The noise-tolerant coding system is one of the main parts of the satellite modem.

Most systems use methods of high-precision coding with decoding by the Viterbo algorithm, as well as cascading codes and other methods [6,11-14]

Also widespread are turbo codes and codes with low density of parity checks [11].

Based on the low energy of the input signal of the satellite channel, satellite telecommunications systems mainly use phase modulation [1,2].

The most used three types of phase modulation: FM-2, FM-4 and FM-8. Most ground stations of satellite communication systems operate in the bands 6 or 14 GHz for transmission and 4 or 11 GHz for reception [3,15,16]. The simplest satellite communication channel includes two satellite earth stations and a space communication station located on board the satellite. Note that there is at least one signal frequency conversion in this channel. This conversion is carried out in the on-board device for transmitting the signal of the communication satellite [1,2,15].

The presence of this transformation due to the internal instability of the reference generator-frequency converter of the on-board repeater of the communication satellite leads to accidental and non-stationary displacement of the carrier oscillation of the signal relative to the nominal value [15]. This causes the frequency uncertainty of the signal.

The general frequency range in which the satellite repeater operates is divided into several subbands (width 27 ... 36, 72 ... 120 MHz). In the specified ranges, the signal is amplified by a separate trunk path. The "trunk" signal system, in turn, can transmit the signals of several satellite earth stations. Thus, the satellite repeater provides communication between a large number of subscribers. This organization of access to practically independent earth stations in the general communication system, as well as the rapid establishment of connections between arbitrary stations and multi-station access are widely used in satellite telecommunications [5,15,16].

There are several different ways in which many users can send information via satellite. Currently, two types of multi-station access are widely used in satellite telecommunications [12,13]:

– multi-station access with frequency division multiplexing.

– multi-station access with temporary division of channels.

In the first case, network subscribers are separated by the carrier frequency, in the second subscribers have a common frequency resource, but separated in time of use of the common frequency path.

On the basis of these methods of channel division, as a rule, satellite telecommunications are built with the provision of a channel on demand. At the beginning of the communication session, in a certain way, the signals are switched at the respective satellite communication stations, the subscriber is allocated a frequency channel or a temporary position. In such communication

networks it is possible to refuse to establish communication due to the busyness of all channels of the system.

Quite simple in construction and under the condition of low cost of the equipment, as well as extensive experience in research and operation of frequency division systems, obtained during the development and operation of early communication systems, led to the fact that that the vast majority of satellite telecommunications are currently used multi-station access with frequency division multiplexing. Satellite telecommunications with channels on demand, operating with frequency division multiplexing, operate at relatively low information rates.

The relative simplicity and low cost of equipment, as well as extensive experience in the development and operation of frequency division systems, gained during the development and operation of early communication systems, have led to the fact that the vast majority of satellite telecommunications are currently used multi-station access with frequency division multiplexing. Satellite telecommunications with channel on demand, operating with frequency division multiplexing, operate at relatively low information rates.

As a result, in such systems it is possible to use relatively cheap satellite terminals with a small aperture class VSAT (very small aperture terminal) [12].

Narrowband channels are used in multi-station access with temporary division of channels systems. Therefore, the initial shift in the frequency of the carrier oscillation of the signal can be comparable to the bandwidth of the channel [15,16].

The structure of satellite telecommunications with frequency division multiplexing indicates another fundamental feature of the receiving channel - the presence of additional interfering effects, namely the so-called "neighboring channels" - signals with the same type of modulation and the same transmission rate as the main information channel. Since the uncertainty of the carrier oscillation frequency of the signal can be comparable to the data rate in the communication channel, a significant part of the spectrum of the "neighboring channel" can fall within the search range of the demodulator on the carrier frequency [11,16].

For satellite telecommunications with multi-station access with temporary division of channels, a control channel is required, the function of which includes the allocation of a free frequency resource to the subscriber. This channel is not symmetrical. The common channel from the central station to the peripheral stations of the network operates in continuous mode For the control information of each peripheral station of the network in this common channel is allocated its own temporary position. Signals from peripheral stations to the central station of the network are transmitted in packet mode at random times, occupying one fixed frequency channel. As a result, signals from many users cannot be separated in the receiver during simultaneous transmission [4,5].

Such channels use random access methods. When multiple network users try to transmit packets at the same time, the packets overlap over time (overlapping.) The overlap conflict must be resolved by using some channel protocols to retransmit the packets. In satellite telecommunications, the most widespread protocol is ALOHA [4,16].

This control channel is usually called a common alarm channel [4,15].

In order to analyze the carrier frequency estimation process, we determine the allowable variance of the carrier frequency estimation and analyze the known methods for estimating the carrier frequency of the phase-modulated signal (FM signal).

It should also be noted that in [1,2,15,16] the main attention is paid to the problem of information packet detection, and the algorithm for estimating the carrier frequency of the phase modulated signal is described insufficiently.

The coherence of signal processing in the demodulator causes extremely strict requirements for the accuracy of estimating the phase of the carrier oscillation in the corresponding loop of the demodulator with phase-automatic frequency tuning [3,5].

Because of this, the band bandwidth B_C should not normally exceed thousandths of the clock frequency of the received signal - about 10^{-3} 1 / T [17,18].

The values B_C are usually selected for reasons of compromise between the level of energy loss of the demodulator in a given range of signal-to-noise ratio per bit of information and the timing of the synchronization of the phase synchronization loop.

The smaller B_C the lower the level of energy loss of the demodulator, the longer the entry into synchronization. The value of the loop band is selected so that the additional energy loss of the demodulator does not exceed 0.1 dB.

Based on these considerations, the size of the loop is usually chosen in values $B_C \approx 3 * 10^{-3} 1/T$.

And for reliable entry of the auto tuning system into synchronization, the value of the variance of the estimation of the carrier frequency of the FM signal δ_C^2 should not exceed B_C.

That is, the value δ_C^2 should not be greater than 10^{-5} 1 / T 2 [5,7].

In the future, we assume that for the variance of the FM signal carrier frequency estimation at low signal-to-noise ratios per bit of information (from 0 to 12 dB) the following requirement must be met [5]:

$$\delta_C^2 T^2 \leq 5 * 10^{-6}. \qquad (1)$$

Given that the assessment of the carrier frequency in continuous mode and batch mode is carried out in fundamentally different ways, it is advisable to consider the evaluation methods in continuous and batch modes separately.

It is known that satellite information transmission systems work, including in modes with random access of signal packets [16].

That is, for them it is important to synchronize coherent phase demodulators operating in batch mode.

The synchronization methods for this case, described in some works, are intended for demodulators of communication systems that work with temporary channel allocation. The main disadvantage of these works is that we consider relatively small in relation to the bandwidth of the transmitted signal displacement of the carrier oscillation, while in real modern communication systems, these displacements can be correlated with the clock frequency of the received signal [5,17].

To synchronize coherent phase demodulators operating in packet mode, we assume that to synchronize the packet demodulator on the carrier frequency at the beginning of the preamble is transmitted a segment of the harmonic signal.

The complex envelope of the received signal can be given as [5,7]:

$$z(t) = e^{j(2\pi\nu+\varphi)} + \nu(t), \qquad (2)$$

where ν – the carrier frequency offset relative to the nominal value.

$w(t)$ – complex additive Gaussian noise.

Note that coherent reception gives an advantage of noise immunity up to 1 dB for one-way phase-difference modulation when used in modern satellite communication systems of multiple modulation, when the number of signal positions reaches 512 signal variants, the gain can be 5 – 7 dB.

Thus, it is promising to consider for this case coherent methods of reception.

The problem of determining the carrier frequency of the received signal is solved by analyzing the frequency of the maximum in the spectrum of a fragment of a sinusoidal signal against the background of additive Gaussian noise resulting from (2).

Currently, there are many methods for estimating the frequency of sinusoids. The work [17] is quite indicative.

It is known that the smallest estimation variance is determined by the Cramer – Rao boundary [5]. It seems that from all the variety of frequency estimation methods, one should choose those that provide an estimation variance that coincides with the minimum marginal estimation variance (MHD estimation) or close to it.

The analysis of effective estimates provided by different methods of estimating the frequency of a sinusoidal signal against the background of additive white noise provides a variance of the estimate that asymptomatically coincides with the Cramer – Rao boundary with increasing signal-to-noise ratio.

The estimate of the maximum similarity (MP - estimate) of the frequency of the sinusoidal signal is determined by the expression [3,5,17]:

$$\nu = arg\left\{ \max_{\nu} \{I(\nu)\} \right\}, \qquad (3)$$

where

$$I(\nu) = \left| \sum_{n} z(t_n)^* e^{-j2\pi\nu t_n} \right|$$

$t_n = nT_s$;

$n = 1,2...,N$;

t_s – the period following the calculation of the complex bending signal received;

NT_s – observation interval.

In fact $I(\nu)$, it is the Fourier transform module of the signal that is captured in the observation interval.

The value $I(\nu)$ is called the periodogram of the received signal.

Thus, finding the MP - estimation of the frequency of the sinusoidal signal is reduced to finding the maximum of the function $I(\nu)$ in the range of frequency uncertainty of the received signal. Given that the satellite communication signal is characterized by significant frequency uncertainty, finding the maximum from expression (3) requires significant computational problems.

Because of this, it seems appropriate to analyze the problems of implementing "fast" methods of finding the maximum.

Currently, the most widely used two approaches to finding the maximum of the periodogram of the signal.

The first approach is based on the use of auto-correlation analysis methods, the second - on the use of discrete Fourier transform algorithms.

The advantage of the first approach is a relatively simple calculation procedure. However, at low signal-to-noise ratios, methods based on a discrete Fourier transform are more efficient.

The procedure for finding the maximum of a periodogram based on a discrete Fourier transform includes [7,17]:

Calculation of fast Fourier transform (FFT) N_f and finding the maximum:

$$m_f = arg\, \max_k \{|Ik|\},$$

$$I_k = \frac{1}{N_f} \sum_{n=0}^{N_f - 1} z(t_n) * \exp\left(- \frac{j2\pi nk}{N_f} \right).$$

Where

Finding the maximum $I(\nu)$ closest to km_f, determining $\overline{\nu}$ such that

$$\overline{\nu} = arg\left\{ \max_{\nu} \{I(\nu)\} \right\}$$

The above procedure is actually a two-step.

The first stage procedure is usually accepted as a rough evaluation procedure. Its accuracy is limited by FFT [5,7].

To implement the second stage, you can use a number of methods, which are defined as methods of interpolation of calculations of the Fourier transform of the received signal. These methods are characterized by sufficient computational simplicity. However, the variance of the frequency estimation provided by interpolation methods at low signal-to-noise ratios loses the Kramer – Rao boundary.

Therefore, to implement the estimation algorithm with the highest efficiency as a procedure of the second stage, it is advisable to use the methods of finding the maximum, which are also implemented on the basis of Fourier transform [7].

A common disadvantage of the known evaluation procedures based on the use of FFT is that their implementation requires the initial accumulation of data for the subsequent implementation of the calculation algorithm.

This provides an additional delay in the implementation of the evaluation procedure.

In batch mode, the additional delay is a significant disadvantage, as the limited length of the preamble of the packet imposes strict restrictions on the long duration of the processing procedure. Of interest are estimation methods based on recurrent computational procedures that combine the processing and accumulation of the received signal.

However, the variance of estimates that provide these methods, as shown in [7,16,17], significantly loses the Cramer – Rao boundary.

Currently, there are a number of methods for estimating the frequency of a sinusoidal signal, which is based on recurrent procedures. Such as Pisarenko method, MUSIK method, auto regression method [5,17].

Given the satellite channel (high frequency uncertainty, low energy, the presence of interfering actions in the form of Gaussian noise and interference such as "neighboring channel") and the need for coherent signal processing to date is a pressing problem of digital phase demodulator synchronization.

In the implementation of synchronization procedures in the satellite channel, the determining factor is the synchronization of the carrier frequency. The task of developing an algorithm for estimating the carrier frequency of the FM signal in coherent demodulators of modern satellite communication systems is of great importance.

The task of the study is essentially to develop an evaluation algorithm that takes into account the properties of the satellite communication channel, and to conduct a study of the effectiveness of the proposed solutions.

Directions for improvement of carrier frequency assessment methodology

Thus, as the main methodological approach to improve the process of estimating the carrier frequency of satellite telecommunications is proposed:

1. Develop an algorithm for analyzing the carrier frequency of an FM signal for coherent demodulators of satellite communication systems, which would provide optimal or close to optimal estimation.

This requires:

- to determine the potential boundaries of variances of the obtained estimates;
- to develop an algorithm for analyzing the carrier frequencies of the FM signal, taking into account the specifics of the satellite communication channel;
- to develop implementation evaluation procedures based on FFT, while for the packet demodulator to offer such a procedure for analyzing the carrier frequency of the received signal, which would provide, on the one hand, simplicity of hardware implementation, and on the other hand - optimal asymptotic estimation.

2. Investigate the effectiveness of analyzing obtained using the proposed procedures for analyzing the carrier frequency of the FM signal, by computer simulation.

This requires:

- to develop simulation models of signals and interference, taking into account the specifics of the satellite communication channel, including the presence of "neighboring channels";
- to construct dependences of the received variances of estimations on a signal / noise ratio on a bit of the information and to compare the received variances with potential borders;
- in the process of modeling to determine the minimum required length of the observation interval, which would provide the required evaluation efficiency (fulfillment of condition (1)).

3. Show the feasibility of the proposed algorithms and their effectiveness in existing satellite telecommunications systems.

This requires:

- to show the hardware implementation of the developed procedures for estimating the carrier frequency of the FM signal on the basis of modern digital signal processors and thus show the feasibility of the developed procedures in real time;
- to conduct bench tests of the proposed evaluation algorithms;
- to conduct field tests of equipment using the proposed algorithms for analyzing the carrier frequency of the FM signal in the existing satellite communication system.

Conclusions

The paper deals with the issue of improving the carrier frequency estimation methodology for data transmission in satellite telecommunication control systems and distance learning. The essence of which consists in taking into account the peculiarities of telecommunication functioning during the transmission of data packets and substantiating the development of an algorithm and based on it, a methodology for estimating the carrier frequency of a phase-modulated input signal by a coherent demodulator of satellite telecommunications of control and remote learning.

1. Low energy of the channel, significant frequency uncertainty of the signal, and the presence of "neighboring channels" are defined as features of functioning for the considered modern satellite telecommunications systems.
2. Multiple access and operation, both in continuous and batch modes, are required for satellite telecommunication systems of control and remote learning with multi-station access, using the "frequency division of channels - provision of a channel on demand" mode.
3. To increase the effectiveness of satellite telecommunication control systems and remote learning, coherent processing of the input signal in the demodulator and the use of powerful interference-resistant coding are used at the current stage, which involves the estimation of the carrier frequency with high requirements for its accuracy.
4. The process of increasing the efficiency of carrier frequency estimation of a phase-modulated input signal by a satellite telecommunications coherent demodulator requires the development of an appropriate carrier frequency estimation algorithm that would provide optimal or near-optimal estimates separately for continuous and packet data transmission modes.

REFERENCES

1. K.I. Kukk, Satellite communications: past, present, future. Moskow: Goryachaya liniya (2015) 262.
2. Kryilov A.M. Satellite communication and broadcasting systems. State and development prospects. Moskow: Radio and communication. (2014) 182.
3. P. Kootsookos Fast, Accurate Frequency. IEEE Signal Processing Magazine. Vol. 24, № 3. (2007). 123-125.
4. A.S Dovgopoly, S.O. Ponomarenko, V.V. Tverdohlibov, O.O. Beloborodov, Improvement of satellite navigation systems of weapons and military equipment under conditions of intentional interference. Weapons and military equipment. No 1(17) (2018) 67–71.
5. O. L. Turovsky, O. V. Drobik, Procedure for evaluation of the supporting frequency signal of the satellite communication system in continuous mode. Radio Electronics, Computer Science, Control. (2) (2021) 28–38. https://doi.org/10.15588/1607-3274-2021-2-3.
6. Barabash Oleg, Laptiev Oleksandr, Tkachev Volodymyr, Maystrov Oleksii, Krasikov Oleksandr, Polovinkin Igor. The Indirect method of obtaining Estimates of the Parameters of Radio Signals of covert means of obtaining Information. International Journal of Emerging Trends in Engineering Research (IJETER) Vol. 8 No. 8 (August 2020) 4133 – 4139.
7. O. L. Turovsky, Algorithm for estimating the carrier frequency of a phase-modulated signal of a satellite communication system when transmitting data in a continuous mode

using the fast Fourier transform function. Zviazok, No2(144) (2020) 55-61. DOI:10.31673/2412-9070.2020.025560

8. A.M. Rabiei, N.C. Beaulieu, Frequency offset invariant multiple symbol differential detection of MPSK. IEEE Trans. Commun. No 59(3) (2011) 652–657.
9. A.A. Nasir, S Durrani, R.A. Kennedy, Particle filters for joint timing and carrier estimation: Improved resampling guidelines and weighted bayesian cramer–rao bounds. IEEE Trans. Commun. No 60(5) (2012) 1407–1419.
10. J. Bhatti, N. Noels, M. Moeneclaey, Low–complexity frequency offset and phase noise estimation for burst–mode digital transmission in Proc. IEEE PIMRC. Toronto. 11-14 September 2011. 1662–1669.
11. Oleg Barabash, Oleksandr Laptiev, Oksana Kovtun, Olga Leshchenko, Kseniia Dukhnovska, Anatoliy Biehun. The Method dynavic TF-IDF. International Journal of Emerging Trends in Engineering Research (IJETER), Volume 8. No. 9, September 2020.pp 5713-5718. https://doi.org/10.30534/ijeter/2020/130892020
12. Serhii Yevseiev, Roman Korolyov, Andrii Tkachov, Oleksandr Laptiev, Ivan Opirskyy, Olha Soloviova. Modification of the algorithm (OFM) S-box, which provides increasing crypto resistance in the post-quantum period. International Journal of Advanced Trends in Computer Science and Engineering (IJATCSE) Volume 9. No. 5, September-Oktober 2020, 8725-8729.
13. Oleksandr Laptiev, Oleh Stefurak, Igor Polovinkin, Oleg Barabash, Savchenko Vitalii, Olena Zelikovska. The method of improving the signal detection quality by accounting for interference. 2020 IEEE 2nd International Conference on Advanced Trends in Information Theory (IEEE ATIT 2020) Conference Proceedings Kyiv, Ukraine, November 25-27, 172 –176.
14. Oleksandr Laptiev, Vitalii Savchenko, Andrii Pravdyvyi, Ivan Ablazov, Rostyslav Lisnevskyi, Oleksandr Kolos, Viktor Hudyma. Method of Detecting Radio Signals using Means of Covert by Obtaining Information on the basis of Random Signals Model. International Journal of Communication Networks and Information Security (IJCNIS), Vol. 13 No. 1 (2021) 48-54.
15. Intelsat. Intelsat Earth Standarts (ISS) Perfomance characteristics for broadband VSAT (BVSAT) digital carriers // Document IESS–313 (Rev.A) approval date: 08 August 2000.
16. I.V. Gorbatiy Systems for Remote Sensing of the Earth from Space: Monograph / I.V. Gorbatiy. Lviv: SPOLOM, (2011) 612.
17. L.N. Lee, A. Shenoy, Digital processor–based programmable BPSK(QPSK) offset–QPSK modems. Comsat Technical Review. No 2 (vol. 19) (1998) 57-64.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

QUALITY CONTROL IN FOOD LABORATORIES ON MICROPLASTICS

Gunay Damirova[1], Laman Maharramova[2]
[1,2]Azerbaijan State Oil and Industrial University,
[1]Teacher "Instrument Engineering" Department, demirovagunay19@gmail.com,
[2]Undergraduate "İnstrument Engineering" Department, lamanmaharramova18@gmail.com

ABSTRACT

Microplastics are small particles of any kind of plastic, not exceeding 5 mm. Microplastic is one of the main problems today. Because these small particles not only pollute the environment, but also get into living organisms, animals and, worst of all, into the human body as a result of natural circulation in nature. Thereby contribute to the formation of various diseases in the human body. Because of the size of microplastic we do not notice how it enters our body. But they can be detected by laboratory tests. To date, unfortunately, accredited food laboratories quality control passes without detecting microplastic particles. In our opinion, this is the main problem. We consume microplastics in food and water every day without even noticing it. This article describes research carried out in various countries of the world and shows in what products was found microplastics. And also how to find and measure microplastics in the laboratory. This, in turn, may be useful to reduce the amount of microplastics in the human body. In conclusion, we propose to strengthen the development of new reference materials, to develop new standards for microplastics and to implement microplastic detection devices in the quality control system of food laboratories, to report the size of microplastic particles detected in the samples. We also recommend the further development and standardization of analytical methods to assess, analyze, and quantify its presence in food quality control. And quality control by implementing microplastic screening and detection methods in accredited food laboratories.
Keywords: Microplastic, pollution, accreditation, quality control.

Introduction

Nowadays, this term refers to small particles of any type of plastic, not exceeding 5 mm in size - it's about the size of a grain of rice. In addition to visible fragments of plastic (found, for example, on the sea beach), microplastics are microscopic particles that, among other things, form during the washing of clothes made of synthetic materials or are contained in household products - in toothpaste, shower gels, glitter and more.

To make it clearer, imagine a handful of beads: small, plastic, multi-colored. If you scatter it around the room, then most likely you will not collect all the beads, they will remain in the cracks, behind the furniture. So it is with microplastics - it cannot be separated from water, soil, air. Microplastics are primary and secondary. To make it clearer, imagine a handful of beads: small, plastic, colorful. If you scatter it around the room, you're not likely to collect all the beads, they will remain in the cracks, behind the furniture. It is the same with microplastic - it is impossible to separate it from water, soil and air.

Microplastics are primary and secondary. Primary microplastics are added to cosmetics, toothpaste, and household chemicals. It can act as a stabilizer, viscosity regulator, emulsifier or antistatic. Microplastic granules are also used for their abrasive effect or simply for beauty purposes, such as in cosmetics with glitter.

In addition, microplastic fibers are separated from synthetic clothing during washing. They end up in rivers and then in the seas and oceans via sewers. Another source of primary microplastics is car tires. They wash off the pavement and release microplastic particles into the air. Microplastics are also released when certain types of pavement and paint used to mark lanes are worn.
Secondary microplastics are formed when plastic objects (bags, cups, disposable dishes, tubes and fishing nets) break down into small pieces when exposed to heat, air, water and salt.

The problem of microplasticity and its detection and control.
The problem of environmental pollution with microplastics has become relevant right now, because before that its amount did not cause concern. Now it has accumulated and caused invisible but dangerous pollution. Microplastic pollutes our habitat, its final stop is the organisms of humans, animals, fish, birds, insects. Scientists are still cautious about the actual harm of microplastics for people. there are many laboratory studies on the properties of microplastics, which allow us to talk about its potential danger.
In accredited food laboratories, quality control today passes without detection of microplastic particles. In our opinion, this is the main problem. Listed below are the products in which microplastics have been detected. But first we want to talk about how microplastics affect the human body.
-Firstly, microplastic is a fine hard abrasive, its action is similar to a scrub, therefore, in contact with the soft tissues of the body, it can damage them.
-Secondly, microplastic is an excellent artificial adsorbent, it absorbs various substances with which it comes into contact. For example, it absorbs toxic pollutants from the water in which it floats: polychlorinated biphenyls (PCBs) and pesticides. When exposed to the body, these substances leach from the particles and enter the organs, which can cause a reaction from the immune and reproductive systems. But science still doesn't know how dangerous this is for humans, what doses of toxins accumulate in us and how it affects health.
Because of the size of microplastics, we don't notice how they get into our bodies. But it can be detected in laboratory tests. We tell you where we have already found microplastic.

Microplastics in food
It is extremely relevant to study the presence of microscopic particles of plastics (microplastics) in food products, their size and quantity. In the presented work for the first time, the presence in some vegetable oils of micro and nano-objects with characteristics similar to plastic was determined by the method of Dynamic Laser Light Scattering using the analyzer of nanoparticles "Zetatrac". The distribution of these particles into fractions, their specific surface area and zeta potential were determined. The content of micro- and nano-particles identified as plastic in vegetable oils was calculated. It ranges from 2.5 to 9 billion per liter of food product. It has been suggested that a possible reason for the presence of such particles in this type of food is that they can be extracted from slowly deteriorating plastic containers. The value of the zeta potential calculated by the device based on the particle motion data is in the region of 20 to 30 mV. This means that the microparticles in the suspension are stable and not prone to coagulation. Thus, self-cleaning from them is not possible.

Seafood

Seafood makes up approximately 17% of the total amount of animal protein consumed in the world. fish and shellfish of commercial importance, both wild and farmed, contain microplastics. In Europe, seafood consumers are estimated to ingest an average of 11,000 microplastics per year in countries where large quantities of shellfish are eaten. .(11) It has also recently been suggested that the average person may ingest approximately 5g of plastic each week, based on normal food and drink consumption, with shellfish accounting for 0.5g of total weekly consumption.
-Seafood in which the entire body is eaten (e.g., bivalve mollusks) is a serious concern (17)), as any remaining contents in the gastrointestinal (GI) tract will also be ingested. In 2008, eco-toxicologist Mark Brown of the University of New South Wales in Sydney conducted an experiment with mussels. He treated them with seawater containing microplastics, then placed them in a clean environment and monitored the movement of the particles.
At first they accumulated in the intestines, after 3 days they entered the bloodstream and remained there for more than 48 days. After 12 days, the amount of microplastic debris began to decrease. But only the larger elements were eliminated, the smallest plastic remained and had great potential for further accumulation.

Tea

Microplastics are not only found in the food we eat, but also in the beverages we drink. Tea, for example, contains microplastics. This is because tea bags are thermo-welded using polypropylene plastic so that the tea bags do not break. During the study, the lab took out the tea and placed the empty tea bags in water heated to 95°C (203°F) as if they were brewing tea.Fig.1.
They found that one plastic tea bag emitted about 11.6 billion microplastic and 3.1 billion smaller nano-plastic particles into the hot water. The particles are completely invisible to the naked eye.

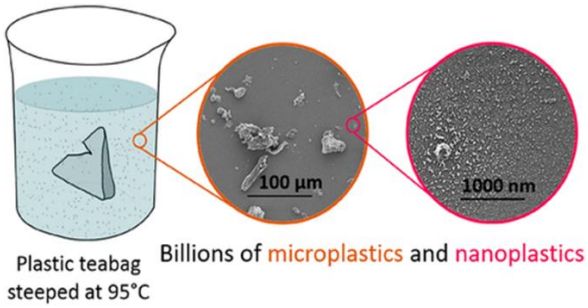


Figure 1. Microplastics in plastic teabag

Rice

A 2021 study found that microplastics are found in packaged rice . Fig.2. Whether the rice was packaged in paper or plastic, the type of packaging did not matter. And, alarmingly, precooked rice (such as microwaveable rice packets) contains four times as much plastic.

Figure 2: Microplastic in rice

Water

Analysis of tap water around the world showed that 83% of the samples had microplastic particles. Fig.3.The highest percentage was in tap water in the United States, the lowest in Europe. 90% of bottled water, according to one study, contained microplastics.

An analysis of 259 bottles purchased from 19 different stores in 9 countries found that only 17 of them contained clean water. All of the others contained fragments of plastic, and concentrations of contaminating particles were twice as high as the same figure.

According to the researchers from the State University of New York (USA), on average, every liter of bottled water they bought in America, China, Brazil, India, Indonesia, Mexico, Lebanon, Kenya and Thailand contained 325 plastic particles. And more often than not, they were fragments of polypropylene, which is used to make bottle caps. Among the brands studied were such international brands.

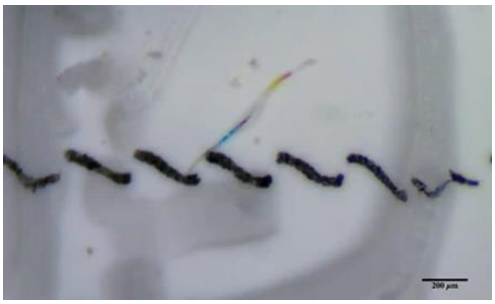


Figure 3: Microplastic in water

Todays Quality control laboratories do not detect microplasticsş

In accredited food laboratories quality control today passes without detection of microplastic particles.

For example, when controlling the quality of water. We took the water as this water is directly consumed by a person and can affect his health and well-being, to control its composition are taken seriously. To check compliance with water quality requirements are responsible for the sanitary-epidemiological services, which conduct research in laboratories under their jurisdiction. So during the control are tested according to standards, drinking water is assessed by four indicators:

- organoleptic;
- chemical;
- bacteriological;

- toxicological.

But unfortunately, the toxicological subsection does not check the amount and presence of microplastics, although the largest amount of this substance is in the water.

What harm does microplastic do to the body?

1. Destroy hormones

At least 15 chemicals used to make plastic packaging are endocrine disruptors. They are similar in structure to hormones such as estrogen, testosterone and insulin, mimicking them and disrupting their natural functions. This leads to adverse health effects and increases the risk of chronic disease.

There are studies proving that bisphenol A plays a role in infertility in both men and women, as well as in the development of polycystic ovaries. Bisphenol A is used to make plastic beverage bottles, including baby bottles.

2. Increase the risk of chronic diseases

Prolonged exposure to microplastics contributes to the development of type 2 diabetes, heart disease, and inflammation. Some scientists even believe that microplastics are as destructive to the body as improper nutrition.

3. Decreased immunity.

The gut plays an important role in immunity - up to 80% of the body's immune cells are in the gut. Increased inflammation caused by microplasticity leads to a deterioration of the gut and, as a result, a weakened immune system.

Analysis and measurement of microplastics

Quality control, detection, analysis and quantification of microplastics in food is a priority.

Current detection methods for microplastic particles in water include the visual method (the visual method with the naked eye and the visual method of the microscope), Fourier infrared spectroscopy, Raman spectroscopy, and thermal pyrolysis analysis. Analysis of microplastic particles in water usually involves sampling, filtering, cleaning, identification, etc.The visual method is widely used due to its convenience and low cost, and it can determine physical properties such as size, color and shape of microplastic particles.

Spectroscopic methods, including Fourier transform infrared spectroscopy and Raman spectroscopy, can determine the chemical composition of a sample, and the accuracy is relatively high. Thermal pyrolysis analysis such as Pyrolysis-GC/MS and TGA-MS were used for microplastic analysis. The samples are first thermally decomposed and the resulting products are sent to a mass spectrometer for analysis.

Studies focusing on drinking water are rare, and studies have mainly used micro-Fourier

Transform Infrared Spectroscopy (μ-FT-IR). The main limitation of this technique is its inability to detect particles smaller than 20 μm. However, micro-Raman spectroscopy is capable of detecting much smaller particle sizes. For example, AIM - 9000 infrared microscopes can be used to conduct qualitative and mapping analyzes of microplastics collected in the filter. Even the smallest samples can be measured with great sensitivity.

Conclusions

We are very affected by this topic because the food sector is the sector where microplastics have the most negative impact and can cause harm to human health. To control food quality and

combat microplastic food contamination, suppliers, manufacturers and researchers continually rely on reliable and accurate characterization tools and techniques to help identify microplastics. This helps them recognize the source of microplastic contamination in food and reduce risks to human health. Quality control, detection and analysis of microplastics in food and their impact on the food chain and our bodies is becoming an increasingly important issue for environmental and food laboratories around the world.

Microplastic particles can be potential carriers of contaminants and there are legally binding EU or national maximum levels for contaminants. If these maximum levels are exceeded, such foodstuffs and food products cannot reach the market. However, regular tests by state authorities responsible for food quality control and studies by the food industry for traces of microplastics in food do not show high levels. The focus is on the level of microplastic particles in the marine environment, the effects of microplastics on marine animals and how microplastics get into seafood. However, microplastic particles are also found in foods other than seafood, and quality control work is needed to analyze and reduce the amount of microplastic particles in these foods.

Exposure to microplastics through food is very high. One of the most global problems today is the detection of microplastic particles in food and in our bodies and the study of their effects on humans. Identifying microplastics is only one step in the fight against environmental pollution.

At this stage, a huge burden falls on food laboratories and quality control .

In laboratories, analytical methods are used to detect and measure microplastics in food samples. And standard samples are needed for validation of those analytical methods. Certified reference materials are used to calibrate measuring devices that determine microplastic particles and for quality control purposes. There is a great need for the preparation of reference materials in the field of microplastics. It is particularly difficult to prepare reference materials for microplastic particles found environmental samples. Because such microplastic particles irregularly shaped, fragmented and oxidized. Work is being done in this direction ,at the moment, but very slowly.

Our proposal is to propose to strengthen the development of new standard samples, to develop new standards for microplastics and to introduce microplastics detection devices into the quality control system of food laboratories.

Accredited food laboratories should be required to detect microplastic particles in tested foods. To do this, food laboratories should have microplastic particle detection devices, analyzers, microscopes, etc. By sending food samples to laboratories and detecting microplastic particles in them, it is possible to prevent these products from reaching the market. This, in turn, can be useful in reducing the amount of microplastics in the human body.

A report should be made on the size of microplastic particles found in the samples. This report should be used for risk assessment. In the future, it should be a best practice to provide detailed information on the size of all microplastic particles detected, e.g. as supplementary data or at least upon request.

Regarding microplastics, we also recommend further development and standardization of analytical methods to assess, analyze and quantify their presence during quality control in food.

REFERENCES

1. D. G. Kotsifaki, C. Ripken and S. N. Chormaic, "Detection and analysis of microplastics in the subtropical ocean of Okinawa using micro-Raman Optical Tweezers," 2021

International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), 2021, pp. 158-162, doi: 10.1109/MetroSea52177.2021.9611590.

2. N. M. Razali and N. N. H. Saris, "Simulation of Optical Planar Waveguide Sensor for Microplastics Detection in Water," 2022 International Conference on Numerical Simulation of Optoelectronic Devices (NUSOD), 2022, pp. 201-202, doi: 10.1109/NUSOD54938.2022.9894821.
3. E. W. Ningrum and M. P. Patria, "Microplastics and Mercury Detection on Anchovy from Alor and Balikpapan Harbors, Indonesia," 2019 IEEE R10 Humanitarian Technology Conference (R10-HTC)(47129), 2019, pp. 254-257, doi: 10.1109/R10-HTC47129.2019.9042436.
4. T. Kaviarasan, P. Mishra, K. Dhineka, M. Sambandam, M. Begum and M. V. R. Murthy, "Microplastic contamination in commercially important fish and shellfish from coastal waters of the Bay of Bengal off Chennai, southeast coast of India," OCEANS 2022 - Chennai, 2022, pp. 1-5, doi: 10.1109/OCEANSChennai45887.2022.9775536.
5. F. Guerrini, L. Mari and R. Casagrandi, "Microplastic as a vector of chemical contamination in the marine environment: A coupled Lagrangian-Eulerian approach," Global Oceans 2020: Singapore – U.S. Gulf Coast, 2020, pp. 1-7, doi: 10.1109/IEEECONF38699.2020.9389405.
6. D. Pirone, V. Bianco, P. Memmolo, F. Merola and P. Ferraro, "A fractal analysis of the holographic diffraction patterns for detecting microplastics among diatoms," 2021 International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), 2021, pp. 173-177, doi: 10.1109/MetroSea52177.2021.9611578.
7. E. C. Edson and M. R. Patterson, "MantaRay: A novel autonomous sampling instrument for in situ measurements of environmental microplastic particle concentrations," OCEANS 2015 - MTS/IEEE Washington, 2015, pp. 1-6, doi: 10.23919/OCEANS.2015.7404541.
8. Lagunov and M. Abdurakhimov, "The problem of Microplastic Accumulation in the Arctic Ocean," 2021 IEEE Ocean Engineering Technology and Innovation Conference: Ocean Observation, Technology and Innovation in Support of Ocean Decade of Science (OETIC), 2021, pp. 30-34, doi: 10.1109/OETIC53770.2021.9733722.
9. N. Davaasuren et al., "Detecting Microplastics Pollution in World Oceans Using Sar Remote Sensing," IGARSS 2018 - 2018 IEEE International Geoscience and Remote Sensing Symposium, 2018, pp. 938-941, doi: 10.1109/IGARSS.2018.8517281.
10. A. Foti, L. Nalbone, M. G. Donato, O. M. Maragò, F. Giarratana and P. G. Gucciardi, "Detection of microplastics in a digested complex organic medium by Raman Tweezers," 2021 International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), 2021, pp. 224-228, doi: 10.1109/MetroSea52177.2021.9611592.
11. Z. Chaczko, P. Wajs-Chaczko, D. Tien and Y. Haidar, "Detection of Microplastics Using Machine Learning," 2019 International Conference on Machine Learning and Cybernetics (ICMLC), 2019, pp. 1-8, doi: 10.1109/ICMLC48188.2019.8949221.
    T. Mato and S. Noguchi, "Microplastic Collection With Ultra-High Magnetic Field Magnet by Magnetic Separation," in IEEE Transactions on Applied Superconductivity, vol. 32, no. 4, pp. 1-5, June 2022, Art no. 3700105,doi: 10.1109/TASC.2021.3135796.
12. M. Volgare et al., "“The effect of the detergent on microfibre release during the washing process of polyester textiles”," 2021 International Workshop on Metrology for the Sea;

Learning to Measure Sea Health Parameters (MetroSea), 2021, pp. 444-448, doi: 10.1109/MetroSea52177.2021.9611615.

13. Z. S. Mazhandu and E. Muzenda, "Global Plastic Waste Pollution Challenges and Management," 2019 7th International Renewable and Sustainable Energy Conference (IRSEC), 2019, pp. 1-8, doi: 10.1109/IRSEC48032.2019.9078268.
14. Y. Zhu, C. H. Yeung and E. Y. Lam, "Holographic Classifier: Deep Learning in Digital Holography for Automatic Micro-objects Classification," 2020 IEEE 18th International Conference on Industrial Informatics (INDIN), 2020, pp. 515-520, doi: 10.1109/INDIN45582.2020.9442146.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

IMPACT OF THE TECHNICAL REQUIREMENTS OF THE AZS ISO/IEC 17025-2020 STANDARD ON THE RESULTS OF MEASUREMENTS CARRIED OUT IN TESTING AND CALIBRATION LABORATORIES

Rashid Mammadov[1], Hikmet Askerov[2]
[1]Undergraduate, "İnstrument Engineering" Department, mamedovrashid05@gmail.com
[2]PhD, docent, "İnstrument Engineering" Department, hikmatasgarov@mail.ru
[1,2]Azerbaijan State Oil and Industry University,

ABSTRACT

For the adequacy of calibration/testing laboratories general conditions are defined in the AZS ISO/IEC 17025-2020 [1] standard, and the Azerbaijan Accreditation Center accreditation by (AZAK) audits in accordance with the conditions specified in this standard being carried out. The conditions to be complied with in the AZS ISO/IEC 17025-2020 standard are specified in the sections under the headings of "Management Conditions" and "Technical Conditions". In accreditation audits, the quality management system of laboratories, "Management Conditions"; calibration/testing activities are evaluated according to the requirements specified under "Technical Conditions". To be accredited for calibration/testing services a laboratory that wants to meet the conditions specified in the standard creates/maintains the quality management system (QMS) in line with in this context, it creates the quality management system documentation in which the QMS applications are defined. The laboratory's quality management system policies and quality policy The Quality Handbook, which contains the declaration, is the most important document of this documentation. During the accreditation process, these documents and those defined in these documents. The services/activities provided according to the practices are subject to audits. In this statement, by giving information about the technical conditions considered, mostly in the technical activities of laboratories an assessment of the observed nonconformities is done.

Introduction

Metrology means the science of measurement and measurement covers all activities related to Measurements made for calibration or testing purposes included in the Industrial Metrology category. The accuracy and reliability of the measurements can only be achieved if certain conditions are met. The method used, the device(s) used, the environment where the measurement is performed and the personnel performing the measurements form the main topics of the necessary technical conditions. Although industrial metrology applications are known as non-mandatory activities referred to as "Voluntary Area", routine standards in activities, quality management system applications, and measurement processes require control and inspection by independent organizations. This process is called accreditation. The ISO/IEC 17025 [2] standard is the basis for the accreditation of laboratories serving in calibration and testing areas is used as Laboratory accreditation activities in our country are carried out by AZAK based on AZS ISO/IEC 17025-2020 standard. Accreditation process, International Accreditation Cooperation Organization (ILAC), European Accreditation Association (EA) guide documents prepared by AZAK in this direction defined in the documents. The accreditation inspection of a laboratory is carried out in two stages. One of them, created by the laboratory within the scope of accreditation.

review of quality documents and quality records, and the other is related to the scope of services. It is the practical observation and evaluation of applications in the laboratory environment or in the field. Deviated from practices defined in KYS documentation and/or standards to be, not to perform activities is defined as "incompatibility". laboratory, the activities to be carried out after such a situation does not occur or the non-conformity is detected and defined the services provided in the quality handbook and quality documents it is necessary to give and maintain it.

The AZS ISO/IEC 17025-2020

The AZS ISO/IEC 17025-2020 standard consists of five main parts, except for the preface. “Scope”, “Referenced standards and documents” and “Terms and definitions” constitute the first three parts of the standard. The “Management conditions” and “Technical conditions” sections are the other two sections where the conditions that laboratories must meet are defined. The "management conditions" section includes the organizational structure, quality management system, creation/management of documentation and records, customer relations, purchases, internal audits, nonconformities, corrective actions, preventive actions, activities for continuous improvement, and the direction of the laboratory. It consists of 15 chapters related to the review. In this paper, the focus will be on technical conditions, since the content of management conditions is not targeted.

Technical conditions

The “Technical requirements” section consists of 10 sections that define the requirements for the factors affecting the accuracy and reliability of the calibration and testing services provided:

1. General
2. Staff
3. Settlement and environmental conditions
4. Test and calibration methods and method validation
5. Devices
6. Traceability of measurements
7. Sampling
8. Procedures applied to the test samples and the devices that come to the calibration
9. Assurance of the quality of test and calibration results
10. Reporting the results

In this part of the study, the standard

The important and critical requirements specified under the technical conditions are mentioned, and frequently encountered non-conformities are emphasized in line with the experiences gained from their audits. All technical activities

The requirements are defined in the AZS ISO/IEC 17025-2020 standard, but here the emphasis is placed on important issues.

Personnel

It is one of the most important requirements of the standard, which uses devices for calibration and testing services, makes measurements, calculates uncertainties, reports report

Evaluating the knowledge and skills, educational status, and training needs of the personnel, who prepares them and interprets the measurement results, when necessary, is to record and authorize them. In general, the nonconformities encountered in this area during the audits are listed below:

1. Failure to keep records of training programs and pieces of training, work experience and authorization,
Inability to access copies of diplomas or certificates received.
2. Authorization records do not contain the date of authorization and/or qualification verification
3. Insufficient experience, knowledge, and skills of the personnel for the scope of accreditation.
4. The effectiveness of the pieces of training received has not been evaluated.
5. The authorization criteria are not specified, the authorization process is not fully implemented despite being defined, and the authorization records are incomplete.
The competence of the staff is important and essential. From this point of view, although the training records of the personnel authorized within the scope of the audit are complete and sufficient,
It is essential to perform work in accordance with the calibration/test instructions in the applications made and to evaluate the adequacy of the knowledge and experience.

Facilities and environmental conditions
The infrastructure (energy sources, lighting, etc.) and environmental conditions of the laboratory should allow the activities to be carried out correctly and should not adversely affect the measurement results.
Documentation of the technical conditions related to the location and environmental conditions that may affect the calibration results for the indoor and outdoor spaces where the laboratory serves.
These are the requirements evaluated in this section. each other negatively
It is also considered within this scope to distinguish between areas where there are activities that may affect the entrances and to control the entrances. encountered
General nonconformities are listed below:
1. Failure to monitor environmental conditions and/or not keep records
2. Failure to ensure the calibration of the devices on which environmental records are monitored, within the calibration program
3. Calibration range and/or measurement uncertainty of environmental monitoring devices are not suitable for the monitored measurement parameter
4. Environmental conditions monitoring devices
the correction factors specified in the calibration certificates are not applied during the measurements.
5. Tolerances are not defined for the parameters that need to be monitored and/or not conforming to the ranges specified in the relevant standards or instructions
6. Failure to provide the necessary stability for the calibration/experimental environment conditions and continuing the calibration/experiment activities in such cases
In case the calibration/experimental activity is carried out according to an external standard, whether the standard contains a certain criterion for environmental conditions, if any, the environmental conditions of the laboratory should be determined.
it is necessary to meet this criterion and to document, monitor, and keep records of the environmental conditions provided. It is also necessary that the calibration/test results records and the data in the calibration certificates and test reports issued should be compatible.

Testing and Calibration Methods and Method Validation

The laboratory operates within the scope of accreditation; sampling, transportation, transportation, storage, preparation of materials to be tested/calibrated, if appropriate

Analysis of test/calibration data should use appropriate methods and instructions, including the measurement uncertainty budget. The methods and instructions applied should be such that they meet the needs of the customer. Deviations from test and calibration methods are only permissible when they are documented, technically accepted, verified, and accepted by the customer [1, 2].

All instructions, standards, manuals, and reference data about the work of the laboratory should be kept up to date. Common nonconformities encountered are listed below:

1. The documentation created is not prepared for calibration/tests within the entire scope of the application
2. The applied method is not defined in the instruction or is not defined in sufficient detail.
3. The external standards used are not up-to-date and accordingly the instructions used are not appropriate.
4. Missing data in the forms used for records (operator, reference standard used, date of measurement, etc.)
5. Failure to keep records of the software used and their validation
6. The calculation tables (Excel worksheets, etc.) used are not documented, verified, and protected against unintentional changes.
7. Failure to declare the model function in uncertainty budgets, lack of uncertainty components, Realistic determination of the value, not updating it, errors in the distribution functions
8. Inconsistency of the scope of accreditation and uncertainty budgets
9. The declared uncertainty for the measuring range in the scope is not valid for the entire measuring range.

Equipment

The laboratory should use suitable equipment that ensures the accuracy and uncertainty required for experiments and calibrations. Calibration and, if necessary, intermediate control programs should be established and implemented for devices that have an impact on the results. Calibration, maintenance, repair, etc. of devices. information should be recorded, and records kept. Practices should be defined to prevent defective or outdated devices from being used in experiments/calibrations.

Common nonconformities encountered are listed below:

1. Insufficient or insufficient devices required to carry out the activity
2. The absence of a regulation containing the calibration date information of the devices
3. The results of the calibration for the reference devices calibrated not defined acceptance criteria for evaluation
4. Failure to create records and/or not being preserved
5. It is defective or out of tolerance Failure to investigate the effect of the detected device on previous measurements in which it was used, Failure to apply the “Control of non-conforming work” procedure.

Metrological traceability

Testing, calibration or sampling all instruments used in experiments and/or calibrations, including instruments used for other measurements (e.g., ambient conditions) that have a significant impact

on the accuracy or validity of the results, must be calibrated prior to use. The laboratory should have a program and procedure established for the calibration of its instruments. Such a program includes the selection, use, calibration of measurement standards, reference standards used as measurement standards, and measurement and test devices used to perform tests and calibrations,
It should include a system for control and maintenance. Common nonconformities encountered are listed below:
1. Not determining the calibration periods for the reference and working standards used, not complying with the determined calibration periods
2. Failure to perform calibrations within the measuring range appropriate to the scope
3. Calibration validity period of the reference standards used has passed
4. Inappropriate transport and storage conditions for the reference standard/materials
5. Failure to make intermediate controls, not keeping records
6. Inadequate calibration periods, in cases where the period is determined to be longer than the period recommended by the manufacturer, there is insufficient data to evaluate the history of the device.

Sampling
If the laboratory takes samples of substances, materials or products for testing or calibration, it should have a sampling plan and procedures. The sample taken should sample the whole. Sample records should include details to identify the sampling procedure used, a description of the sample, environmental conditions, and the location where the sample was taken.
Sampling practice is generally done in the field of chemical metrology.

Procedures Applied to Test Samples and Devices Coming to Calibration
The laboratory should take all necessary precautions to prevent damage to the sample arriving for testing/calibration. In this context, it should establish procedures for the transport, admission to the laboratory, transport, preservation, storage, detention and delivery of samples. In addition, an identification system should be applied to prevent samples from mixing with each other. Abnormalities in the calibration/experiment process, deviations from standards or instructions should be recorded, and the customer should be consulted when necessary. Interviews with the customer should be recorded. Common nonconformities encountered are listed below:
1. Lack of proper identification in areas where samples are stored.
2. Lack of effective separation between incoming and outgoing samples.
3. Inappropriate marking of samples.
4. Failure to properly keep records showing the condition of the sample.
5. Not recording the conversations with the customer.

Assurance of Quality of Test and Calibration Results
The laboratory should establish control procedures to monitor and check the validity of the calibration/testing services it provides. Ensuring the accuracy and continuity of the results.
Reference material should be used, should participate in interlaboratory comparison or proficiency testing (IC/PT) programs, and
appropriate results should be obtained, experiments and calibrations should be repeated using the same or different methods, and the consistency of the results should be evaluated. The data obtained within the scope of quality assurance should be analyzed and determined to be outside

the defined criteria procedures should be established to find and eliminate the cause of nonconformity and prevent false results from being reported, and planned activities should be implemented.

Common nonconformities encountered are listed below:

1. Not keeping IC/PT records and not creating plans
2. To have never participated in the IC/PT program within the validity period of the accreditation certificate in the fields within the scope of accreditation.
3. Not to initiate corrective action in case of unsuccessful results in IC/PT comparisons.
4. Inadequate quality assurance activities in areas where IC/PT is not regulated.

Reporting the Results

The laboratory should make conclusions by using the data obtained after the calibration and test measurements and report them. Results should be accurate, clear, unbiased and in accordance with the test/calibration instructions and the requirements of the national/international standards used. Calibration certificates/test reports

The content and format must comply with the communiqués of the institution issuing the accreditation certificate and the conditions specified in the AZS ISO/IEC 17025-2020 standard. Delivery of laboratory certificates to the customer,

In the event of a change in the issued certificates, it should specify in its procedures what the action will be like. Common nonconformities encountered are listed below:

1. Calibration certificate format not defined in the documentation system.
2. Calibration results are not given in a resolution compatible with the uncertainty value.
3. The use of non-SI units in calibration certificates and/or the non-given conversion factor of these units to SI units.
4. In the calibration certificates, the change interval of the environmental conditions during the measurements is not given.
5. The number of pages and the total page numbers are not compatible.
6. In the calibration certificates, the units are not written in accordance with the rules specified in the SI brochure [3].
7. Failure to specify all environmental conditions affecting the measurements in the calibration certificates.
8. Failure to provide information about the level of reliability and coverage factor in certificates.

Benefits of AZS ISO/IEC 17025-2020

The benefits of laboratory accreditation quality management system AZS ISO/IEC 17025-2020, official recognition of laboratories with proven competencies in specific test areas, elimination or reduction of test repetitions and evaluations of laboratories, updating test laboratory standards and status, and testing results from accredited laboratories in the domestic market and internationally. acceptance in the markets, increase in the quality levels of the experiments, prestige and commercial superiority, preventing multiple audits by enabling the laboratory to pass a single inspection, discipline the continuity of quality and reliability, increase in reliability, increase in customer satisfaction, increase in the technical competence of personnel, improvement of resources, continuous improvement of equipment and equipment. maintenance and control can be summarized as the determination of the authority and responsibilities of the employees.

Accreditation areas; calibration laboratories, test laboratories, inspection bodies, certification bodies (product, quality systems, personnel, environmental management systems), and HACCP. AZS ISO\IEC 17025-2020 accreditation is for laboratories performing routine analysis. In this system, the procedure starts with the sample coming to the laboratories and only the content of the sample is responsible. At sample acceptance, the procedure starts with the sample being delivered to the laboratory.
It is aimed at the accuracy and reliability of the analyzes.
Procedures for accreditation of the laboratory
organized according to international criteria and has been standardized. Thanks to the common approach used for accreditation, reports, and certificates containing the results obtained by accredited laboratories are internationally accepted. This reduces the risk of slowing down product trade between countries with unnecessary test and analysis repetitions and reduces the costs of additional testing and analysis.

Conclusions

Calibration/testing laboratories comply with the conditions defined in the AZS ISO/IEC 17025-2020 standard, providing their services within the scope of accreditation.
carried out within the framework of a structured Quality Management System. The AZS ISO/IEC 17025-2020 standard defines the requirements to be fulfilled. There may be differences in the way institutions/organizations fulfill these requirements. Quality systems must be sustainable at a certain level of quality rather than being ideal is also necessary. Continuity of the quality management system, planned/unplanned internal audits carried out within the institution, and the institution issuing the accreditation certificate. It is monitored by the initial audit/surveillance audit or scope expansion audits by findings during the audit should be seen as an opportunity for the continuity and improvement of the quality management system. In this paper, possible findings that can be detected during technical inspections of laboratories are mentioned. Such findings are not based on interpretation and there is no relevant record or activity cause may occur. The detected findings are mostly due to the procedures, instructions, deviations defined in the quality management system documentation during implementation. The nonconformities mentioned it can be examined whether it is in existing quality management systems. If any, nonconformities should be eliminated with corrective actions to be taken.
Re-detection of the same nonconformity at different times is a result of the ineffectiveness of the corrective action taken.

REFERENCES

1. AZS İSO/İEC 17025-2020. ”Sınaq və kalibrlənmə laboratoriyalarının səlahiyyətliliyinə dair ümumi tələblər ,” AZSTAND Baku/Azerbaijan.
2. İSO/IEC 17025-2005. “General Requirements for the Competence of Testing and Calibration Laboratories,” ISO, Switzerland.
3. ILAC Policy for Participation in Proficiency Testing Activities. ILAC-P9:06/2014.
4. ILAC Policy on Metrological Traceability of Measurement Results ILAC-P10:07/2020.
5. Self-assessment model for testing and calibration laboratories based on ISO/IEC 17025:2017 requirements // Luciano Carlos Belezia and Maria Fatima Ludovico de Almeida 2021.

6. Implementation of PDCA Cycle in Calibration and Testing Laboratory Based on ISO/IEC 17025:2017 // M H Habibie and R H Kresiani 25-27 August 2020, Island, South Korea.
7. ISO/IEC 17025:2017 Lab Management System Effectiveness Verification by Using Quantitative Approach // Yousaf Ayub, Zahid Anwar , Zahid Abbas Shah Volume 10:4, 2021.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

RESEARCH NEW GENERATION ULTRASOUND TECHNOLOGIES IN BLOOD FLOW MONITORING

Laman Niftaliyeva
Undergraduate, "İnstrument Engineering" Department, lemannifteliyeva2499@gmail.com
Azerbaijan State Oil and Industrial University,

ABSTRACT

Currently, ultrasound machines are widely used in hospitals for the first diagnosis of various pathologies. There is also an ultrasound Doppler method to determine and monitor blood flow. Through this method, it is possible to get information about the general condition of the veins and whether there are any problems during the examination of the veins in the clinic. But, it does not have the ability to continuously monitor the condition of the veins. Continuous monitoring of blood flow rate will facilitate the work of doctors during post-operative monitoring or diagnosis of the patient's condition. At the same time, traditional ultrasound transducers may not be comfortable for post-operative examinations. In this article, a number of difficulties encountered during examinations conducted using a conventional ultrasound machine were investigated. At the same time, as a solution to these difficulties, one of the newest technologies of the modern era, the new generation ultrasound machine "USM patch", its main features and advantages were discussed. This device, based on the working principle of the Doppler effect, is suitable for continuous monitoring of the absolute speed of blood flow in the arteries of the deep layers. It is lightweight, small in size, and has the potential to increase the accuracy and quality of the examination.
Keywords: Blood Flow Sensor, movement of red blood cells, Doppler effect, ultrasound machine, Doppler ultrasound patch, biodegradable sensor, automatic.

Introduction

Recently, diseases of the cardiovascular system such as chronic heart failure, hypertension (high blood pressure), arrhythmia, etc., have become quite common. Also, some of those who suffer from this disease are young people. According to studies conducted in developed countries, the mortality rate of the population due to cardiological pathologies as well as related diseases is approximately 40–60%. For this reason, there is always a need for modern, automated devices and accurate methods to detect various pathologies and make a correct diagnosis of diseases quickly.
Blood flow monitoring provides a lot of information about the health of a person's cardiovascular system. Through these parameters, we get information about artery stenosis, hardening, occlusion, and many diseases [1]. Long-time, continuous monitoring of blood flow velocity may be valuable for early diagnosis of some vascular diseases. For example, an ischemic stroke occurs as a result of blockage of the vessels leading to the brain [2].
Blood is a special liquid consisting of red blood cells, white blood cells, and platelets. A person's blood volume makes up 7% of their body weight. The average density is about 1.054 g/cm³ [3]. An average adult has about 5 liters of blood. Blood supplies the body's organs and tissues with oxygen and nutrients. At the same time, it regulates body temperature. Our better understanding of human health is related to research on various methods of measuring blood flow. Measurement

of blood flow is vital and provides us with necessary information for diagnosing disorders of blood flow [4].

Venous blood flow was considerably slower, at 1.5–7.1 cm/sec, whereas arterial blood flow ranged from 4.9 to 19 cm/sec. Blood flow rates of 3.0–26 ml/min in arteries and 1.2–4.8 ml/min in veins are found when considering equivalent vessel sizes ranging from 800 micro m. to 1.8 mm.

Various techniques are used to monitor blood flow. For example, Doppler ultrasound, Positron Emission Tomography, Photoplethysmography, Laser Doppler, etc. Each of these methods differs according to the purposes of use and the parameters it sets [5].

Different technologies determine different parameters:

- Photoplethysmography (PPG) provides only an estimate of changes in blood volume;
- Thermal analysis provides only a relative time-average value of the flow rate.

However, these technologies are limited in their ability to measure depths of only a few millimeters.

The ultrasound Doppler is the only method that determines the parameters of the velocity of the blood flow and the changes occurring in the vessel in real time. The advantage of using ultrasound is that it is harmless to the body and has the ability to penetrate deeper [6].

There are different types of Doppler ultrasound flowmeters:

- Continuous wave (CW) Doppler ultrasonic flowmeter;
- Pulsed wave (PW) Doppler ultrasonic flowmeter;
- Ultrasound for measuring perfusion [5].

As mentioned, for early diagnosis of cardiovascular system diseases, it is important to determine the patient's blood circulation, blood flow rate, and whether there are blockages in the vessels that can cause a heart attack. Currently, for this purpose, there is a new generation "USM patch" that is used to determine and control blood flow. The "USM patch" is a device that can monitor blood flow in arteries and veins deep in the human body in real time, as well as automatically and continuously monitor blood pressure and heart activity. At the same time, it facilitates the early detection of cardiovascular problems [7].

The main features and advantages:

- Lightweight, flexible and simple to use;
- Easy placement on the chest or neck areas;
- High punctuality;
- It can non-invasively measure cardiovascular signals up to 14 centimeters deep in the human body;
- The ability to propagate the ultrasound beam at different angles.

Let's review the last feature again. The device has the ability to emit ultrasound waves at different angles, not only unidirectionally in the area where it is located. As a result, we get a wider range of information [8].

The ability to direct ultrasound waves at different angles is a first among devices developed using this type of sensor. Usually, sensors only monitor the structure below the area where they are located. However, we can check a wider area through the “USM patch”. This gives us ample opportunities for faster and correct diagnosis of various pathologies. During blood flow monitoring, an experienced doctor presses an ultrasound transducer against the patient's skin and moves it from one area to another until it is directly over a major blood vessel. But, the “USM

patch" is placed in the necessary area and signals are received. It is more suitable for use mainly in the neck area. The continuous wave (CW) Doppler patch is placed on the neck at an angle of about 60 degrees. The adhesive strip is important to keep the position and angle of the device stable during measurements. This increases the information content of the obtained results [7,9].
During routine ultrasound examinations, the correct contact of the transducer with the skin and the smoothness of that surface are the main conditions. But, ultrasound visualization on knees or moving surfaces becomes somewhat more difficult. These new generation devices are flexible, so they can be easily placed on an uneven skin surface. So, the receiving of signals from such surfaces becomes easier and more accurate. In addition, special gel is not used.

The device design and working principle

The CW Doppler ultrasound patch is a wearable, non-invasive device. The "USM patch" consists of a thin, flexible polymer layer that can adhere to the skin surface. This layer is also called an elastomer (a natural or synthetic polymer with elastic characteristics). It consists of millimeter-sized ultrasound transducers. This type of array is known as an ultrasonic phased array. This is a key part of the technology because it allows ultrasound waves to penetrate deeper and wider.
The Doppler ultrasound patch (USM patch) uses 2 main modes of operation. In the first mode, all transmitters can be synchronized to transmit ultrasound waves together, which creates a high-intensity ultrasound beam focused on a point 14 centimeters deep in the body. Another mode, can be programmed for asynchronous transmission, where the transmitters generate ultrasound beams that can be directed at different angles [9].
In Figure 1, we can see that the "USM patch" emits ultrasound waves in a wider range than a conventional ultrasound transmitter. At the same time, we can see the difference between the classic ultrasound transducer and the "USM patch" [10].

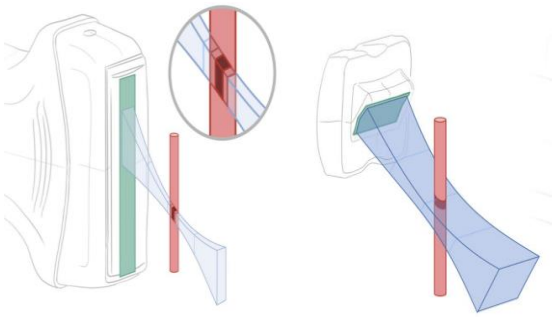


Figure 1. The difference between the USM patch and the range of the ultrasound wave emitted by the ultrasound transducer. (A) Classic ultrasound transducer. (B) "USM patch"

Modern technology allows us to control the ultrasound beam as we need. This also allows the device to have multiple applications, including the high-precision determination and monitoring of blood flow [9].
The general appearance of the device is shown in Figure 2.

Figure 2: The wireless Doppler ultrasound patch

Two types of continuous wave (CW) 4 MHz ultrasound transducers are used in the Doppler ultrasound patch device:

- One transducer incessantly transmits an ultrasound beam;
- Another transducer receives the disorderly echoes from the blood [10].

Transducers emit ultrasound waves that radiate from the surface of the skin to the depths of the body. Ultrasound waves penetrate a blood vessel and they encounter the movement of red blood cells flowing through the vein. The movement of red blood cells is determined by how the ultrasound waves echo. So, the difference between the frequency of the transmitted wave and the frequency of the received wave is calculated.

This process is commonly known as Doppler frequency shift or the Doppler effect. There may not always be a difference between frequencies. In the case of blood vessel blockages, the frequency of the transmitted and received wave is the same. This also helps us to detect pathologies [11].

This is the basic principle of blood flow monitoring with the "USM patch". And we can say that the working principle of the "USM patch" is based on the Doppler effect.

The Doppler shift can be measured by analysing the spectrum of the Doppler signal. The Doppler signal is a mixture of several single-frequency signals for the radiators with different speeds in the blood flow. Each of these has a specific frequency, amplitude, and phase. The first signal received must be demodulated to obtain a Doppler signal. Compared to low-frequency Doppler signals, they are removed from the output. This process is performed by high-pass filters. Low-frequency signals are usually received from slowly moving vessel walls etc.(Fig.3).

Then the spectral analysis of the signals is considered [12].

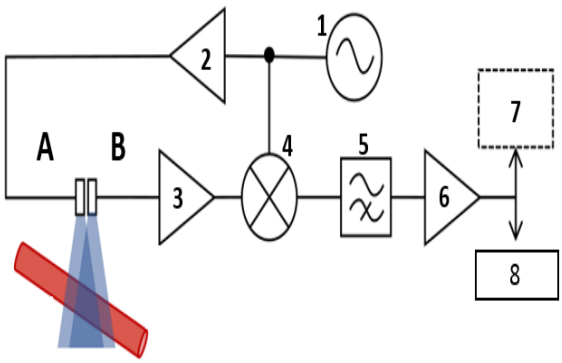


Figure 3: Diagram of the Doppler ultrasound patch system displaying the transmit and receive electronics paths. (1) Clock generator, (2) Transmit Amplifier, (3) Low-noise receiver, (4) Quadrature demodulator, (5) High pass filter, (6) Audio amplifier, (7) Speaker, (8) External audio capture, (A) Transmit element, (B) Receive element.

Sensors for Blood Flow monitoring

Blood flow monitoring provides important information on human health. Diagnosis and analysis of diseases is achieved quickly due to the signals obtained through sensors.

Blood flow can be detected with the sensor. Thermal sensors are mainly used in these types of devices [13].

Thermal sensors are used in the device to receive information about changes in blood flow and temperature [14]. Thermal sensors can sense the flow. Thermal sensors can also generate a small amount of heat when receiving a response signal. Then the obtained values are sent to a computer. The blood flow rate is calculated on these computers. The thermal sensor is surrounded by other sensors, and these sensors are used to detect the size of the vein [13].

The signals obtained through the sensors are sent to a computer to calculate the blood flow rate. During the study, the sensor is placed on the proper vein. Even if the patient moves during the examination, it does not affect the measurement accuracy of these sensors that determine the blood flow rate. Sensors can also be used to determine blood flow in micro-sized vessels [14].

It is obvious that environmental effects during the reception of signals may cause artifacts in the signals. Therefore, the signal processing stage is very important. The Short-Term Fourier Transform is used to analyze the signals obtained from such devices. We can see the algorithm of these processes in the block diagram in Figure 5.

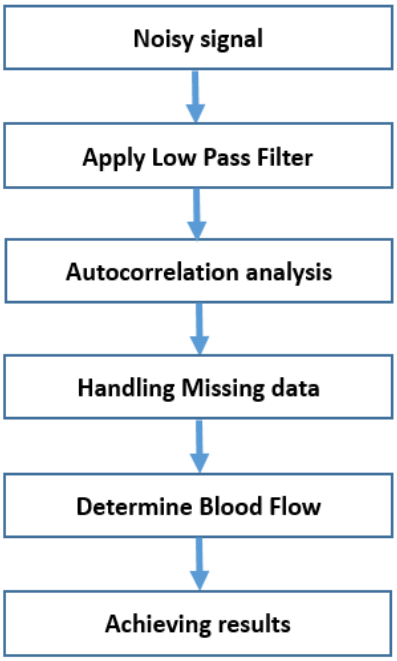


Figure 4. Description of the process of receiving, analyzing and obtaining results of noisy signals in the form of a block diagram

After collecting the values from the sensor, the analysis is performed on the values received to form knowledge about the patient's health. Some researchers work on noisy signals. Some researchers use correlation analysis when working with missing data [13].
We can see the block diagram of the blood flow sensor configuration system in Figure 5.

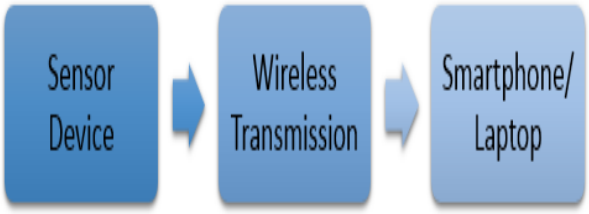


Figure 5. Blood Flow Sensor Configuration system

Devices using this type of Thermal sensors are intended only for non-invasive examinations. A Doppler ultrasound patch device is also used to monitor blood flow through the skin surface. However, the possibilities of using these sensors can be expanded now. In my opinion, these sensors can be replaced by biodegradable blood-flow sensors. Without the need for additional tests and such devices used for monitoring, we can get a lot of information through biodegradable sensors.

Biodegradable wireless blood-flow sensor
Implantable devices to measure blood flow are important for patient health management and disease progression monitoring. Biodegradable wireless blood-flow sensors are mainly used during surgical operations. Biodegradable sensors are an implantable system capable of sensing pressure, blood flow monitoring, temperature, and electrophysiological variables [15]. Such biodegradable devices have the same high sensitivity and precision as electronic systems. It is harmless to the body. It is biologically broken down in the human body and does not need to be removed from the body later [16].
Consisting of a sensor attached to the outer wall of the vessel, the device detects perceptible changes in capacitance, resulting in a shift in the resonant frequency of the inductor-capacitor-resistor circuit. This data is wirelessly transferred to a reader coil that is placed on the skin's surface via inductive coupling.
Recently, the use of biodegradable sensors in research has increased significantly. This calls for a more in-depth study of its material, physical, and geometric properties, and to conducting various studies to extend the device's service life. Additional coating layers of protective thermally grown silicon dioxide can be used as a protective layer without affecting the sensitivity of the sensor.
Although the technology is battery-free and wireless, a biodegradable energy source will be needed for continuous monitoring. Conventional batteries usually contain toxic chemicals. These toxic chemicals are also dangerous for the organs and tissues of the human body Therefore, it is not suitable for use.
I think that biodegradable batteries can be used as a power source for biodegradable sensors. For such an examination, it is enough to use this battery for up to 2 weeks. I think that it is possible to make biodegradable batteries that are both harmless to the human body and biodegradable from magnesium-molybdenum trioxide. Its constant output voltage (~1.6 V)).

Time dependence of frequency is important in blood flow velocity reports. The result of this dependence is shown in the graph shown in Figure 6.

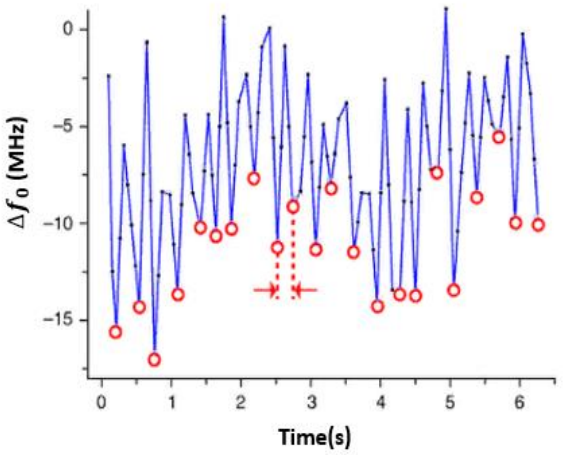


Figure 6: The construction of a frequency-time graph based on blood flow velocity reports

Through these implanted sensors, information about the patient's condition is obtained for several weeks or months after various surgical operations. It was possible to get the patient's information even from home.

Conclusions

Based on my research, Doppler ultrasound patch measurements will be more convenient than conventional ultrasound machines. So, depending on the purpose of use, ultrasound transmitters with different frequency ranges are used in conventional ultrasound machines. The skill of the specialist is very important in the selection of gears as well as how to properly place them on the human body. In such a case, considering the possibility of any error by the subject, it would be more appropriate to convert the system to a fully automated format. Before moving to this automated system, the device programming must be carefully controlled or improved.

In my opinion, the possibilities of using this type of device as a sensor can be slightly expanded. Because, this system is based on a certain program. Depending on the purpose of use, which pathologies are detected, if a suitable program is designed for each one, we can get information in a wider range than the image we get with the transmitter through these sensors connected to the device.

REFERENCES

1. P. A. Schneider, M. E. Ross man, E. F. Bernstein, S. Torem, E. B. Ringelstein, S. M. Otis, Effect of internal carotid artery occlusion on intracranial hemodynamics. Transcranial Doppler evaluation and clinical correlation.
2. R. C. Webb, Y. Ma, S. Krishnan, Y. Li, S. Yoon, X. Guo, X. Feng, Y. Shi, M. Seidel, N. H. Cho, J. Kurniawan, J. Ahad, N. Sheth, J. Kim, J. G. Taylor VI, T. Darlington, K. Chang, W. Huang, J. Ayers, A. Gruebele, R. M. Pielak, M. J. Slepian, Y. Huang, A. M.

Gorbach, J. A. Rogers, Epidermal devices for noninvasive, precise, and continuous mapping of macrovascular and microvascular blood flow. Sci. Adv. 1, e1500701 (2015).

3. Clement Kleinstreuer, "Biofluid Dynamics – Principles and Selected Applications", CRC Press, Taylor & Francis.
4. Arthur C. Guyton and John E. Hall, "Textbook of Medical Physiology", Elsevier Saunders, Pennsylvania.
5. Article- A.K. Jayanthy, N. Sujatha* & M. Ramasubba Reddy "MEASURING BLOOD FLOW: TECHNIQUES AND APPLICATIONS - A REVIEW" January 2011.
6. G. R. Bashford, Ultrasonic measurement of blood flow velocity and applications for cardiovascular assessments, in Biomarkers in Cardiovascular Disease, V. B. Patel, V. R. Preedy, Eds. (Springer, 2015), pp. 1–31.
7. Kenny J-ÉS, Barjaktarevic I, Eibl AM et al: The feasibility of a novel, wearable Doppler ultrasound to track stroke volume change in a healthy adult. J Emerg Crit Care Med 2020, 4:17 (10 April 2020).
8. Article - The Feasibility of a Novel Index from a Wireless Doppler Ultrasound Patch to Detect Decreasing Cardiac Output in Healthy Volunteers, MILITARY MEDICINE, 186, Jan 2021.
9. Wang, C., *et al.* (2021) Continuous monitoring of deep-tissue hemodynamics with stretchable ultrasonic phased arrays. *Nature Biomedical Engineering.* https://www.news-medical.net/news/20210722/Soft-stretchy-ultrasound-patch-can-continuously-monitor-blood-flow-in-real-time.aspx.
10. A novel, hands-free ultrasound patch for continuous monitoring of quantitative Doppler in the carotid artery. Jon-Émile S. Kenny, Joseph K. Eib., 2021.
11. Flexible Doppler ultrasound device forth monitoring of blood flow velocity, Fengle Wang, Peng Jin, Yingchao Zhang., 27 October 2021.
12. Hoskins, P. R. Estimation of blood velocity, volumetric fow and wall shear rate using Doppler ultrasound. Ultrasound 19, 120–129 (2011).
13. Shyamal Patel, Hyung Park, "A review of wearable sensors and systems with application in rehabilitation", Journal of NeuroEngineering and Rehabilitation 2012.
14. Albert Ruiz-Vargas, Scott A. Morris, Richard H. Hartley and John W. Arkwright, "Optical Flow Sensor for Continuous Invasive Measurement of Blood Flow Velocity" Journal in Biophotonics -May 2019.
15. Krishna Yeshwant and Roozbeh Ghafari "A biodegradable wireless blood-fow sensor" Nature Biomedical Engineering, JANUARY 2019.
16. Boutry, C.M.; Beker, L.; Kaizawa, Y.; Vassos, C.; Tran, H.; Hinckley, A.C.; Pfattner, R.; Niu, S.; Li, J.; Claverie, J.; et al. Biodegradable and flexible arterial-pulse sensor for the wireless monitoring of blood flow. Nat. Biomed. Eng. 2019, 3, 47–57.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

FMG-BASED INFORMATION MEASUREMENT SYSTEM FOR CONTROLLING A LOWER LIMB PROSTHESIS

Nelli Yaremchuk[1], Timur Aliyev[2]
[1]Undergraduate "Instrument Engineering" Department, nelly.yaremchuk@gmail.com
[2]PhD, Associate Professor, timur.aliyev.adnsu@gmail.com
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

Disability is one of the most pressing health and social problems worldwide. Despite significant medical advances, there are situations in which the only and most effective treatment is amputation. Most often people lose their legs as a result of accidents, wars and industrial injuries. A person's mobility is severely limited by the loss of a lower limb, which has a negative impact on both their physical and emotional health. It definitely reduces the quality of his life. In order for a person who has had an amputation to lead a full and active life in the future, it is necessary to have a well-designed prosthesis that can simulate the normal function of the lost limb as much as possible. There are different types of prostheses with different designs and functions, but the most advanced are those with built-in microprocessors. However, even these prostheses have problems integrating movement and adjusting their operation to the individual characteristics of the patient, which makes it necessary to create and improve modern prosthetic control systems. This research proposes the consideration of an information-measuring system based on the reading of muscle activity signals and their further analysis by means of Fourier transform. As a result, the prosthesis may be controlled more precisely and smoothly, normalizing the biomechanical aspects of human gait.
Keywords: Limb prosthesis, amputation, biomedical systems, force myography, signal processing, Fourier transform

Introduction

Walking is one of the basic and natural modes of human locomotion. It is a complex, symmetrical and cyclical movement that results from pushing the body away and moving it in space. Human movement is the consequence of the coordinated contraction of skeletal muscles that support posture and move body parts (limbs) through space. Bones and joints play a passive role in movement because they are merely subordinated to the action of muscles, but they are also important because they are the basis of supporting function. All human motor action is regulated by the central nervous system (CNS). Muscles and tendons have special nerve endings-receptors that receive signals from the CNS and send these impulses to cells at different muscle levels [1]. The process of controlling the contractile function of a muscle is shown in Figure 1 [1].

However, muscles are not only an executive mechanism but also a "special" sensory organ as each muscle fiber can generate a response signal. Therefore, we can conclude that the CNS and muscles connected cyclically: impulses generated in the CNS go through the muscle motoneurons and cause muscle contractions, and the muscles in response also generate impulses that inform the CNS about the moment of movement and position of the leg in space [2].

This centuries-old cycle works perfectly in a healthy person, but a person without a limb has problems with it. When a disabled person wants to move the leg, the CNS generates an

appropriate signal that passes through the nerves leading to the muscles of the limb. But because the limb is missing, the signal goes "nowhere". It is interrupted at the point where the limb begins to be absent. However, it is feasible to detect nerve impulses, which are still stored in the surviving limb, and, after analysis and processing, generate commands to control the prosthesis on their basis.

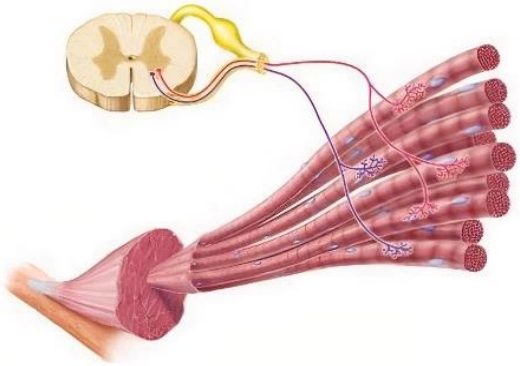


Figure 1: The process of controlling the contractile activity of a muscle

When signals pass from the CNS to the muscle, there is an increase in the biopotential at certain points, which are the most excitable part of the muscle. Until recently, electromyography (EMG) was the main method used to measure muscle potentials, which is based on registering the electrical biopotential in the muscle after a nerve impulse passes through it. However, this potential is not the only one, as in addition to the generation of the nerve impulse by motoneurons [2], there is the generation of force myography signals (FMS), which are based on changes in muscle stiffness during their contraction. These potentials can also be extracted using wearable sensors and can be used not only to monitor physical activity but also to process them to generate a control action.

Methodology

FMG vs EMG

As mentioned, the most widely used method for recording muscle activity potentials is the EMG method. However, the effectiveness of this method may be limited because EMG signal acquisition is highly dependent on changes in skin impedance that come from perspiration. This leads to a weakening of the contact between the skin and the sensor and a decrease in the accuracy of signal detection [3].

FMG, on the other hand, is an alternative method that directly detects changes in surface pressure on the skin due to changes in tendon stiffness and muscle volume caused by muscle activity [4]. FMG is a non-invasive and relatively inexpensive method of signal registration [3]. Most importantly, compared to EMG, FMG is more resistant to electrical interference and perspiration, and the resulting signal is more suitable for further processing.

The visual difference between EMG and FMG is shown in Figure 2 [5].

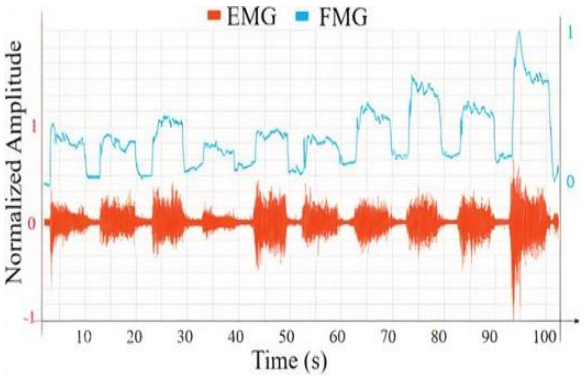


Figure 2, Differences between the same-area EMG and FMG signals.

Instead of using electrical activity that occurs during muscle contractions, FMG is based on using force-sensitive sensors to measure pressure at the skin's surface [6]. This pressure changes as the contraction changes and a study by Radmand [7] has shown that FMG can more accurately predict the point of generation of the next impedance change than EMG. In this study [7] a prediction accuracy of 99.7% was achieved using 8 sensors. The FMG signal also has the benefit of having less noise and therefore requires less complex equipment and a lower sampling rate than the EMG signal. The FMG signal was chosen for the study in this paper for this reason.

Sensor system for FMG signal detection

In order to obtain the most complete information on the musculotendinous stiffness of the various muscles, more than 1 sensor must be used. However, the number of sensors can vary from 2 to 30 to more, all depending on the signal detection device and the target. Most often, during medical examinations and scientific research, sensors are installed in straps or inside sleeves, for gesture recognition (for the arms) or to predict limb movement (for the arms and legs). In this research paper, the research was based on signals obtained during an experimental study conducted by a team of specialists who described their work in a related paper [8]. Therefore, the principle of FMG signal acquisition that they used in their study will be discussed.

In their study, they used a strap with 8 force-sensitive sensors (more than enough to detect signals from leg muscles) evenly placed on the inner surface of the strap. These sensors were positioned close to the muscle, each of which participates in the movement cycle and produces an associated FMG signal. A cross sectional view of the muscle and the positioning of the sensors according to each muscle is shown in Figure 3 [8].

During the experiment in which the signals were obtained, signals were taken from a healthy person's thigh and a disabled person's stump. During the signal acquisition in healthy subjects, the strap with sensors was wrapped around the middle surface of the thigh, and in people without a limb, the strap was wrapped at half the size of the stump [8]. Once they captured the signal, they subjected it to low-pass filtering with a cut-off frequency of 10 Hz [8]. The data were then smoothed using a 5-point moving average filter and processed using standard software [8]. Therefore, 2 cycles of signals from 8 sensors were obtained, which will be used for further analysis in this research.

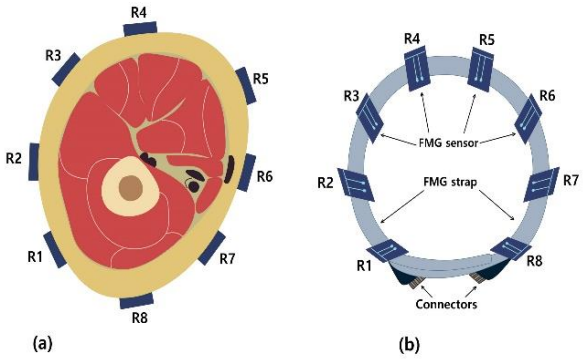


Figure 3: Cross-section of the thigh muscle (a) and positioning of the FMG sensors on the strap according to each muscle (b)

Processing of acquired FMG signal data using the Fourier transform.

Analysis and processing of FMG signals obtained during the study [8] is necessary to give the information-measuring system created in this research the ability to generate a control action in response to the occurrence of FMG signal in the surviving limb. The signal data analysis was performed using the Fourier transform, as very little information is lost in this signal transformation. The Fourier transform contains information about amplitude, harmonics and phase and uses all signal components to translate the signal across to the frequency range. Signal processing was carried out in a Google Colaboratory environment using the Python programming language. The NumPy library was used in signal analysis as an alternative to the MATLAB environment, since in the latter the movement of data between many functions required the manipulation of many variables and frequent reference to the documentation of input and output arguments. NumPy provides support for high-level mathematical functions, including the Fourier transform, on which this analysis was based. The analysis used the fast Fourier transform, which is calculated by the Formula 1.

$$y[k] = \sum_{n=0}^{N-1} e^{-2\pi j \frac{kn}{N}} x[n] \qquad (1)$$

The Matplotlib module was used to visualize the signal produced by the Fourier transform operation in Python.

Results

Information measurement system based on data obtained from the FMG signal.

In the process of this research and analysis of existing materials, a schematic diagram of the prosthesis control system was developed to read the FMG signals, which is shown in Figure 4.

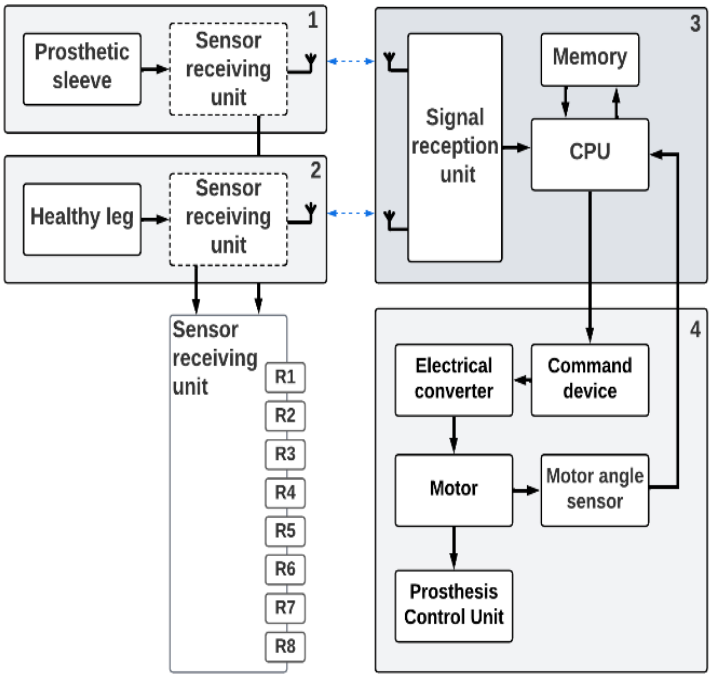


Figure 4: Block diagram of an FMG signal measurement system for controlling a lower limb prosthesis

The system is composed of 4 primary units, as shown in the diagram: a unit for recognition of FMG activity of an amputated limb (1), a unit for recognition of FMG activity of a healthy leg (2), a unit for information processing and generation of control action (3), and an active module control unit (4). The system is based on the force-sensitive sensors' measurement of the FMG signal generated in the leg and the survivable limb, its wireless transmission to the processing and control unit, which, after analyzing the signal data and comparing their values in the appropriate modes, generates a control signal to control the active module.
Control of the active module is necessary for the safe interaction of the disabled person with the environment, i.e. for his/her improved orientation in space and the smooth walking effect that can be achieved. This prosthetic leg system involves continuous interaction between the residual limb and amputee, potentially partially compensating for the lack of sensory feedback occurring in natural muscles. However, it is important to note that this diagram provides only a general picture of the prosthetic control system being designed and, even when fully built, will not be able to provide the prosthetic total, thought-provoking control.

FMG signal data collection and analysis
As stated earlier, the basis of this research is the FMG signals that were obtained by research [8]. In the control system diagram under development, the analysis of these signals will form its algorithmic basis, because after processing these signals, the control action will be regulated in accordance with the readings of these signals. This section will examine converting the signals from one sensor from a healthy leg and an amputated limb to demonstrate their processing by a

Fourier Transform. We use the readings taken from the first sensor, taken during the slow walking mode [8]. Initially, the signals have the following views shown in Figure 5.

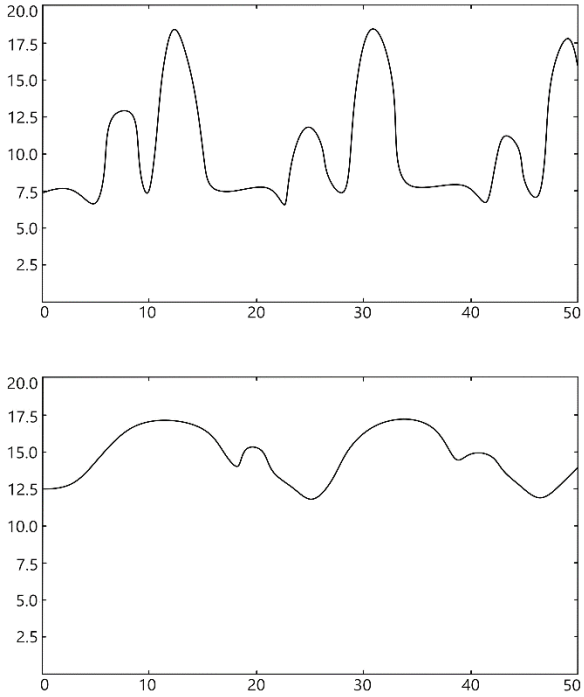
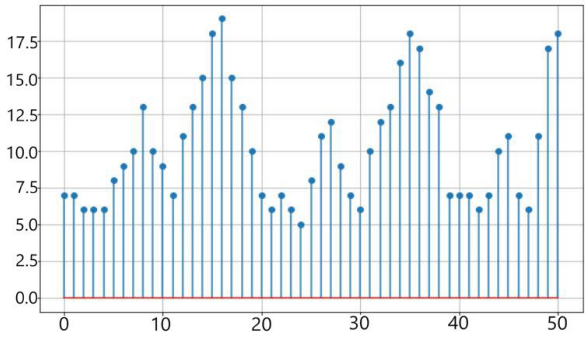


Figure 5. Signal from the healthy leg (above) and signal from the amputated leg (below). Initial view of signals obtained from FMG recording.

After integration into the Python environment and their further processing consisting of sampling and spectrogram compilation, the signals acquire the following view Figure 6.



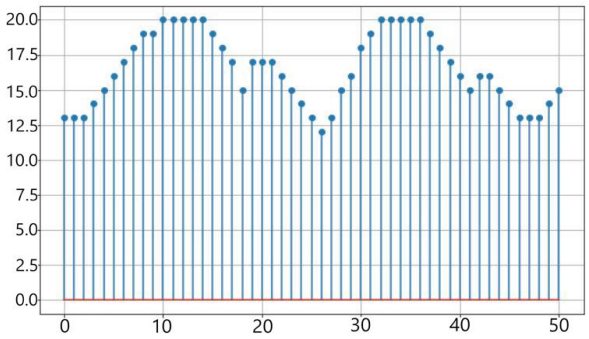
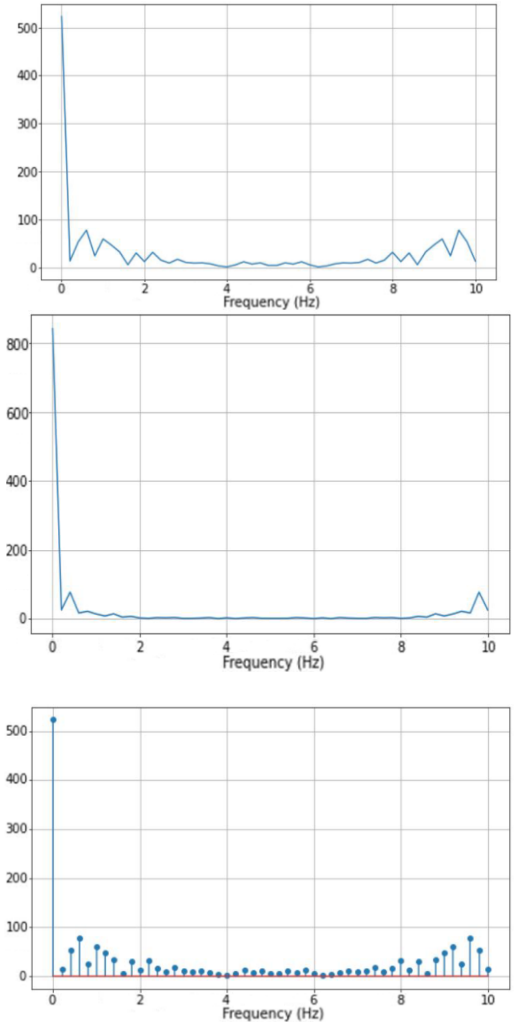


Figure 6: Signal from the healthy leg (above) and signal from the amputated leg (below). View of signals after sampling and plotting their spectrograms

If we apply the Fourier transform to the signals, considering the Nyquist-Shannon theorem, we get the following picture, shown in Figure 7.



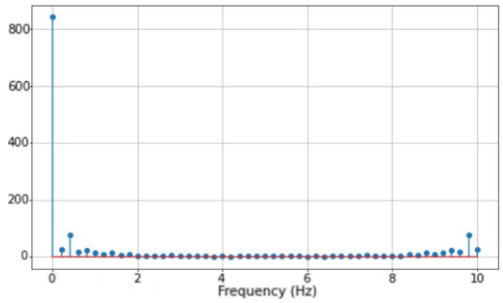


Figure 7: Signal from the healthy leg (above) and signal from the amputated leg (below). View of signals after the Fourier transform, obtaining their AFC and construction of their spectrograms

With this transformation, it becomes possible to determine the common harmonic points between the healthy limb and the amputated limb and select these points as the points at which the start signal can be generated. A table of common harmonic points is presented in Table 1.

Table 1. Common R8 sensor harmonic points for the Fourier transform

Frequency	Healthy leg M-S	Healthy leg F-M	Amputated leg M-S	Amputated leg F-M
...	...	...	...	...
1,20 Hz	-8,92	10,99	-6,51	5
...	...	...	...	...
3,00 Hz	10,64	-9,86	2,58	-1,85
...	...	...	...	...
3,60 Hz	-3,72	12,86	-0,4	2,15
...	...	...	...	...
4,00 Hz	2,66	5,02	1,47	3,19
4,20 Hz	-10,1	30	-0,22	2,26
...	...	...	...	...
6,00 Hz	-10,1	30	-0,22	2,26
6,20 Hz	2,66	5,02	1,47	3,19
...	...	...	...	...
7,20 Hz	10,64	-9,86	2,58	-1,85
...	...	...	...	...
9,00 Hz	-8,92	10,99	-6,51	5

Conclusion

The growing number of people who have lost a limb because of injury, regardless of their age, is increasing every year. And there is an increasing need for relatively inexpensive prostheses that can make life as active as possible for these people. It is becoming more feasible to develop more modern prostheses that meet modern standards of quality and ease of use. The system considered in this research may well satisfy these qualities, as it allows for better command control over the prosthesis, makes it more flexible, and is easy to operate. The underlying method of FMG signal extraction, although undeservedly understudied, has great potential for a breakthrough in the development of sensitive prostheses.

REFERENCES

1. Essentials of Human Anatomy & Physiology (11th Edition) Paperback – Jan. 2 2014 by Elaine N. Marieb (Author)
2. Dubrovsky V.I. Fedorova V.N. Biomechanics. Textbook for Higher and Secondary Institutions. M: VLADOS-PRESS, 2003. -672 pg.
3. "A Review of EMG-, FMG-, and EIT-Based Biosensors and Relevant Human–Machine Interactivities and Biomedical Applications" by Zhuo Zheng ORCID, Zinan Wu, Runkun Zhao, Yinghui Ni, Xutian Jing and Shuo Gao, School of Instrumentation and Optoelectronic Engineering, Beihang University, Beijing 100191, China 2022.
4. FMG Versus EMG: A Comparison of Usability for Real-Time Pattern Recognition Based Control, Alex Belyea, Kevin Englehart, Erik Scheme, IEEE Trans Biomed Eng. 2019.
5. A Novel, Co-Located EMG-FMG-Sensing Wearable Armband for Hand Gesture Recognition Shuo Jiang, Qinghua Gao, Huaiyang Liu, Peter B. Shull, 2019
6. A Review of Force Myography Research and Development, Zhen Gang Xiao and Carlo Menon, 2019
7. Radmand et al., "High-density force myography: A possible alternative for upper-limb prosthetic control," Journal of Rehabilitation Research and Development, vol. 53, no. 4, pp. 443–456, 2016
8. "A New Force Myography-Based Approach for Continuous Estimation of Knee Joint Angle in Lower Limb Amputees and Able-bodied Subjects", Amit Kumar, Anoop Kant Godiyal, Pradeep Joshi, and Deepak Joshi, Alex Belyea; Kevin Englehart; Erik Scheme.
9. Biomedical Signal Processing: Advances in Theory, Algorithms and Applications (Series in BioEngineering) 1st ed. 2020 Edition by Ganesh Naik (Editor)
10. Gait Analysis: Normal and Pathological Function, Perry, Jacquelin, Vol.12(6), p.815-815.
11. Huiying Yua, Murad Alaqtasha, Eric Spierb, T.Sarkodie-Gyan, Analysis of muscle activity during gait cycle using fuzzy rule-based reasoning, Department of Electrical and Computer Engineering, University of Texas at El Paso, El Paso, TX 79968, USA.
12. A Study on EMG-Based Control of Exoskeleton Robots for Human Lower-limb Motion Assist H.Hel, K.Kiguchil, Department of Advanced Systems Control Engineering, Saga University, Japan 2007.
13. Analysis of force myography, based locomotion patterns Anoop Kant Godiyal, Upinderpal Singh, Sneh Anand, Deepak Joshi.
14. Centre for Biomedical Engineering, Indian Institute of Technology Delhi, India Department of Biomedical Engineering, All India Institute of Medical Sciences, New Delhi, India Department of Physical Medicine and Rehabilitation, All India Institute of Medical Sciences, New Delhi, India 2017.
15. EMG-driven control in lower limb prostheses: a topic-based systematic review, Andrea Cimolato, Josephus J. M. Driessen, Leonardo S. Mattos, Elena De Momi, Matteo

Laffranchi & Lorenzo De Michieli, 2022.

16. Knee Joint Optimization Design of Intelligent Bionic Leg Based on Genetic Algorithm Hualong Xie, Shusheng Wang, Fei Li, China 2014.
17. Design of a Semi-Active Prosthetic Knee for Transfemoral Amputees: Gait Symmetry Research by Simulation Zhewen Zhang, Hongliu Yu, Wujing Cao, Xiaoming Wang, Qiaoling Meng and Chunjie Chen, China 2021.
18. A review on design of lower appendage prosthesis K.R. Rakeshasharma, K. Hemanth a, V. Shamanth, India 2020.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

FIBER OPTICAL SENSORS FOR IOT FACILITIES

Yashar Hajiyev
PhD, Associate Professor, Computing Engineering department, yasharhaji@gmail.com
Azerbaijan State Oil and Industry University.

ABSTRACT

Mass development of the latest applications for the famous 19 services of the Internet of things (IOT) becomes dominant a factor in the intellectually intensive segments of automation of technological systems. IoT is supported by regulatory switching of IoT components and devices to the Internet for information exchange with these facilities in order to control and regulate their functional modes. Our article prescribes the use of fiber optic sensors devices that can be equipped with technological and industrial installations in order to monitor them and detect deviations from operating modes. The development of fiber optic communication and monitoring devices makes IOT systems easily manageable and remotely adjustable.
The integration of devices for reading technological parameters and their further transmission over a fiber optic network gives rise to several problems that were analyzed in detail in the article. In this regard, it can be established that fiber optic IOT has a broad development perspective. This article describes the current capabilities of the Internet of Things, and the constituent components of the Internet of Things, and also presents the theoretical premises that underlie the Internet of Things.
Keywords: Internet of things, fiber-optical sensor, fiber network, signal processing, home safety monitoring, technological parameters acquisition.

Introduction

The growth of Internet of Things (IOT) is the latest trend [1,2] of IT-development focusing on moving to realizing the concept of hyperconnected world. One of the popular definitions is - "The Internet of Things refers to technologies that allow networked devices to sense other devices and interact and communicate with them." IOT is fitted by different information sensing devices, that in accordance with the agreed protocol, are interconnected through the Internet, and support information exchange and communication to enable to control, to manage, to regulate different real-world objects. industrial objects and domestic equipment through the Internet. The 'Things' mean the real-world objects – industrial and technological processes and domestic equipment [3,4].
Development of the IOT encompasses a set of major technological innovations such as miniaturized modern electronics, nanotechnology, networking, and other newest smart technologies. One of the key components is the newest sensing technique, information processing, and acquisition methods.
The general principle of IoT organization is depicted in the below diagram (Fig.1).
As can be seen from the figure, the IoT is combined from sensors and actuators through which the IoT "feels" and manages the objects that are called 'things. Measured data from the sensors [5,6], as well as control signals to the actuators are transmitted through gateway over fiber-optical, GSM, Bluetooth, Wi-Fi and other communication channels.

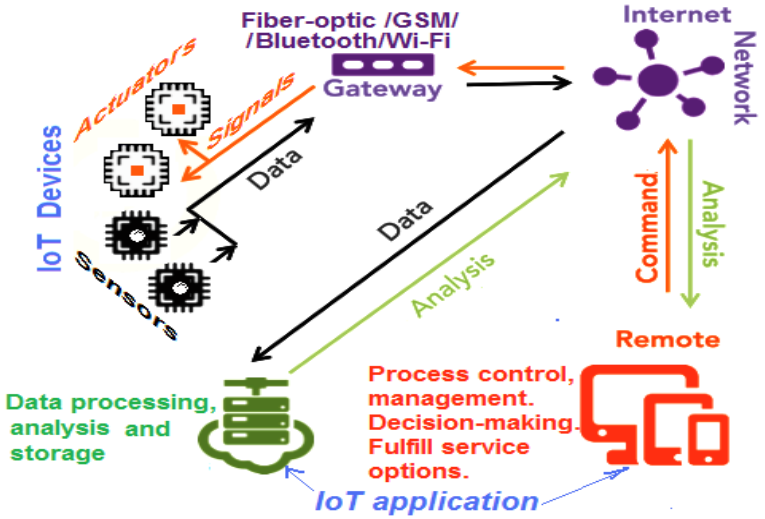


Figure 1: General principle of IoT organization

Over gateway, data and codes are transmitted via Internet to control units to manage relevant IoT related services.
The specific field where IoT applications have been successfully implemented [5,7] is the energy industrial processes and specifically the energy resources Those types of applications allow remotely control over embedded sensors what is happening in energy power module or machines when we are not there, automatically adjust the working regimes. Other applications allow sensors, embedded in our power units to communicate to inform about force majeure situation in energy delivery performance and etc.

Instruments Optimized Architecture of IoT
According to ITU-T recommendations, the structure of IoT is made up [7,9] of lamination of *five* layers — sensor networks, access network, backbone network, middleware and application platforms.
The simplified architecture of the Ubiquitous Sensor Network (USN) based on M2M i.e. "machine to machine" abbreviation includes the intelligent and interactive link between human, machine and system, to automatically transfer the data contained in these devices.
In accordance with the current universal approved network architecture of IoT, the basic configuration structure of Internet of Things is broadly divided into three layers: perception/sensing layer, network layer and application layer, as it pictured in Fig. 2.

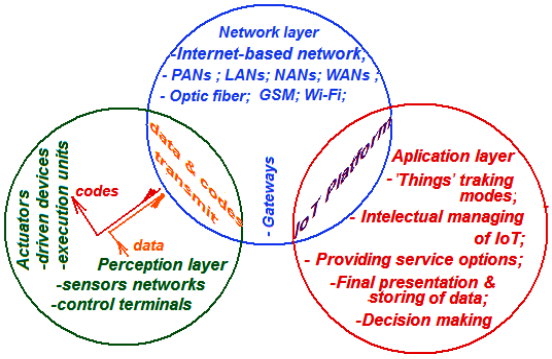


Figure 2: Layered structure of IoT

Perception layer, — is subdivided into perceived control and communication interlayers. Perceived or sensing interlayer consists of various types of sensor networks, control modules, and variety of terminals.

Sensing interlayer realizes acquisitions of underlying data collected from sensing devices and transmit it to the upper layer via wireless or fiber-optic connections.

Network layer, —collects the data from the lower perception layer and passes them to the Internet. Network layer is configurated over the topology of existing networks, by means of expanding and merging of different heterogeneous networks into form of unified integrated information exchange network.

Network's range is conditionally categorized in four classes — Personal Area Networks (PANs), Local Area Networks (LANs), Neighborhood Area Networks (NANs), and Wide Area Networks (WANs).

PANs works over wireless lines with low radio transmission power, operate on tiny batteries and cover a range of about 10 m. LANs might be built over wired or wireless lines, or their combination.

The wireless LANs (WLANs) cover a range up to 100 m. NANs are mostly wireless and can cover area with 25 km in diameter. NAN supports high power levels of transmitting, but usually carries low data traffic. Finally, WANs are able to operate over extensive area and in most cases for WANs the fiber optical network is used.

Network layer is to support integration and expansion the existing heterogeneous networks. Network topologies that widely used in IoT are star and mesh. Star topology is to enable central node to operate as a gateway for all other adjacent nodes. Mesh topology is to enable capability to connect individually to various other nodes, when several other nodes can operate as a gateway. Mesh network can expand covering range by means of many hops.

Application layer, — is the application center or control center of IoT system. Application layer receives information from the Network layer and processes that information to the form convenient to fulfill the management of the current application.

Optical Fiber Sensing Technologies in IoT

At the perception layer the IoT utilizes mainly techniques [6,7] for data acquisition from wide variety of types of sensors are designed to measure exact and adequate information on processes are running in controlled entity.

Unfortunately, the most of smart wirelessly working non-contact sensors couldn't be employed in power entities because of hard severe exploiting conditions.

The fiber optical sensors (FOS) and affiliated sensing techniques have many advantages over other types of conventional sensors, so the development of fiber optical sensor and measuring technology has become a new direction for development of smart instruments and probes for energy segment.

FOS conditionally can be divided into two categories by sensing principle:

- functional sensors or intrinsic type (directly sensing type), the role of optical fiber in which, are both the signal transmission and sensing of relevant physical parameters.
- second category is known as non-functional sensors, non-intrinsic type (light transmission type), which only operates as an fiber optical transmitter of the signal gotten from relevant optical sensor.

In 1st category FOS ─ the modulated light (laser beam) pulses are fed into optical fiber and then are beamed to explored object. Upon interaction the optical characteristics of pulses (e.g., light intensity, wavelength, frequency, phase, modifier state, etc.) are changed. That change is caught by light detector and after demodulation, the system detects the parameters of explored object [14].

In 2nd category FOS ─ the optic fibers are not directly implicated in process of sensing of parameters of explored object. The function of optic fibers, here is limited to transferring the detected data from sensors to network layer of IoT. The wide variety of separate sensors might be used here and they have to be equipped with converters to transform sensed signals from electrical or other forms to optical signals, to be transmitted via optic fiber.

Sensing techniques to probe physical parameters for Optic Fiber based IoT

Sensors form the front end of IoT, and they are to sense the physical/chemical parameters [4,6, 7] of objects, to convert it into a signal suitable for processing (e.g. optical, electrical and etc.).

In 2nd category FOS the optic fibers are not implicated in process of sensing of parameters of explored object. Here the any typical sensor, operating on the basis of any physical principles, can be used to be connected to fiber optic networks.

For the 1st category of FOS the sensing are performing by the fiber-optic lines themselves.

The specific physical properties of fiber allow to create the sensors to probe different (temperature, pressure, displacement, etc.) physical parameters of objects.

The most used effect in fiber-optic sensors is the Fabry Perot effect, as well as its special cases. Based on this effect, several pressure sensors, deformation /force sensors operate.

The figure below illustrates the operation of the pressure sensor realized on the basis of the Fabry Perot interferometer, where the sensor holder has a semitransparent mirror that is formed on the inner surface of the diaphragm, which is bulged inward under pressure [4,6]. The stronger the pressure, the more the diaphragm bends and the smaller the distance between the mirrors.

The light / laser probe pulses coming out optical fiber are split into two impulses on a semi-transparent mirror. The first is directly reflected from the semitransparent mirror back into the optical fiber. The second pulse crosses the semi-transparent mirror and then reflects off the mirror surface of the diaphragm and enters back to the fiber.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

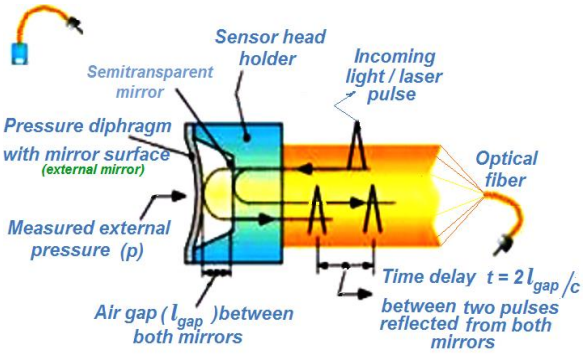


Figure 3: Conceptual schema of fiber-optic pressure sensor based on Fabry Perot interferometer.

The time delay between two reflected pulses

$$t_{delay} = 2l_{gap} / c \qquad (1)$$

determines the amount of deflection of the diaphragm, which, in turn, will determine the value of the measured pressure.

For continuous measurement of dynamically changing external pressure, a series of light pulses should be fed into the system to repeat the measurements many-fold.

Based on the same basic principle the transducer type sensors for measuring temperature, displacement, strain, force and etc. were created (Fig. 4).

In below diagram the principal schema [7,8] of optical fiber-based temperature sensor is depicted, where the sensor holder equipped by dielectric mirror.

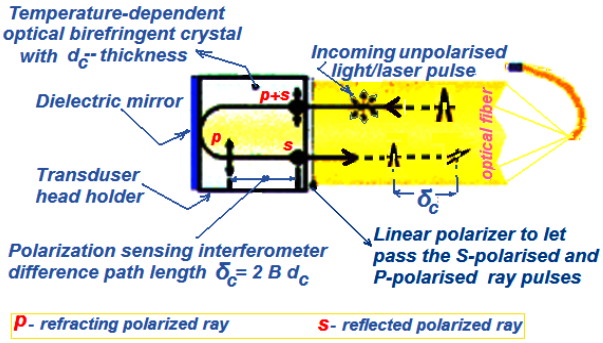


Figure 4. Conceptual schema of fiber-optic temperature transducer/sensor based on polarization interferometer.

The unpolarized probing light/laser pulse through fiber is fed to linear polarizer that is placed at the input of birefringence crystal and is used for transduction mechanism. Polarizer splits pulse in two different — s- and p- polarized light pulses.

P- polarized light is polarized in the plane of incidence, not strong reflects from surface of optical crystal, but it refracts inside of crystal. The refraction degree varies with the temperature of the crystal.

S-polarized light is polarized perpendicular to plane of incidence. It is reflected from crystal surface and reflection degree varies with the incidence angle. In case of perpendicular incidence – no reflection for S- polarized light and no undergo refraction inside of crystal.
At a special angle known as Brewster's angle, no p-polarized light is reflected from the surface, thus all reflected light must be s-polarized. Both polarized light pulses fall into optical birefringent crystal.
P-polarized pulse undergoes refraction up to reach mirror and after reflection back to linear polarizer.
S-polarized pulse runs straight to mirror and then is reflected straight back to linear polarizer. Thus, it is obvious, that travel path of p-polarized pulse longer than path of s-polarized pulse.
Path length difference between them:

$$\delta_c = 2 \bullet B \bullet d_c \qquad (2)$$

Where B – temperature dependent birefringence; d – crystal thickness.
With increasing of crystal temperature the refraction will strengthen and difference between paths of both polarized pulses will increase.
That difference is the temperature measurand [9]. The transducer signal output as function of temperature T is given by following equation:

$$\delta_c(T) = S \bullet T + \delta_0 = 2 \bullet \frac{\partial B}{\partial T} d_c \bullet T + \delta_0 \qquad (3)$$

It is seen from above equation that sensitivity of transducer depends of temperature coefficient of crystal birefringence $\frac{\partial B}{\partial T}$.
So, sensor can be adjusted for various temperature ranges.
Interferometer [8] is used also for creating sensor that measures displacement of external object.
As it is seen from diagram [8] the glass wedge-prism with two mirrored surfaces are fixed over shaft of sensor. The shaft being in mechanical contacts with external object is sliding depending of displacement of object.

The schema of that sensor is depicted in diagram below (Fig.5).

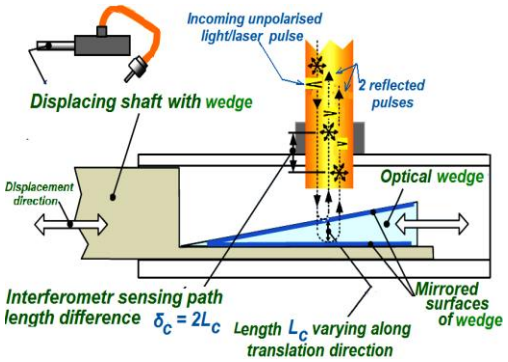


Figure 5: Conceptual schema of fiber-optic sensor for displacement measuring.

The modulated unpolarized incoming pulse is fed to sensor via optic fiber. Pulse partially reflected from first mirrored surface of wedge, and partially from second mirrored rear surface.
The path difference between two reflected pulses is

$$\delta_c = 2 \bullet L_c \qquad (4)$$

where L_c - the height of the cross-section of the wedge at this point.
L_c - varies linearly along the wedge and forms time delay (δ_c) between pulses reflected from 1st and 2nd mirrors:

$$t_{delay} = \delta_c / c = 2L_c / c \qquad (5)$$

To meter the displacement, it is necessary to calibrate magnitude of the displacement on the thickness of the wedge at the different positions. From the measured by interferometer the value of t_{delay} it is easy to calculate the wedge thickness at current position, and, knowing calibration ratio, to derive the magnitude of shaft displacement.
As in the case of pressure sensor, temperature sensors, and motion sensor, one of the critical components is the modulator that forms probing light pulses to be fed to sensor. The ratio and relative duration of the probing light/laser must be tuned precisely and the interval between probing pulses must be several times longer than the interval between both reflected pulses.

Conclusions

IOT framework technology and fiber optic sensing technology has been studied in this paper. The conceptual principles of optical fiber sensing technology applications are analyzed in IOT perception layer, and the specific applications of the optical fiber sensing things are studied in mine functional operability, that fiber-optic sensor network is found to provide greater new options for supporting functionality of modulator. Based on this, it could be predicted that the fiber-optic sensing things will have the greater perspectives for operatively controlling and monitoring of electrical power facilities.
Our paper focuses on physical principles of working of designed IoT based system to be used in power producing and power distribution systems.
The optical fiber sensor (OFS) considered in paper for using in IoT systems for controlling and regulation of power industry objects has many advantages compared to traditional sensing techniques.
OFS used the newest technological advances achieved in the field of fiber optic technology, laser technology and optical detection. OFS is greatly promoted in the information transmission and sensing aspects, and it has a wide range of applications.

REFERENCES

1. Ramos, C.; Marreiros, G.; Santos, R.; Freitas, , C.F. Smart Offices and Intelligent Decision Rooms. In Handbook of Ambient Intelligence and Smart Environments; Nakashima, H., Aghajan, H., Augusto, J.C., Eds.; Springer: New York, NY, USA, 2010; pp. 851–880.
2. Reijula J.; Gröhn M.; Müller K.; Reijula K. Human well-being and flowing work in an intelligent work environment Intell. Build. Int. 2011, 3, 223–237.

3. Doukas C. Building Internet of Things with the Arduino; CreateSpace: North Charleston, SC, USA, 2012.
4. Zhao C.; Li X.S.; Chen J.S. Study on the application of internet of things in the logistics in forest industry. Appl. Mech. Mater. 2011, 97–98, 664–668.
5. Want, R. Near field communication. IEEE Pervasive Comput. 2011, 10, 4–7.
6. Ashton, K. That ―Internet of Things‖ Thing. RFiD J. 2009, 22, 97–114.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

INTELLIGENT APPROACH TO LOCAL AND GENERAL PHYSIOTHERAPY DEVICES

Aynur Jabiyeva[1], Anar Baghirov[2]
[1]PhD, Docent, aynur.jabiyeva@outlook.com
[2]Undergraduate "İnstrument Engineering" Department, anarbaghirov01@gmail.com
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

This paper discusses the usage of intelligent approach to a physiotherapy. Physiotherapy as a branch of medicine has existed for a long time, but its methods of application remain about the same as they were a hundred years ago. This causes a number of problems, in particular a sceptical attitude towards physiotherapy itself. The use of traditional techniques in this field has a major influence on its attitude. Even though even traditional methods of treating patients with physiotherapy show good results, people are increasingly turning to medication. However, these methods are not directed at the individual patient, with his or her personal problems, and can be detrimental to the patient, let alone the treatment. Every patient, irrespective of gender, race or age, has his or her own individuality. Physiotherapists now prescribe treatment to patients on the basis of their findings and personal experience. But this is not always the right approach, especially if we're talking about the severely or chronically ill patients.But we are lucky to live in the era of computer progress, when machines can not only help in determining the correct diagnosis, but also autonomously make decisions about the patient's treatment. With this modern approach to health care, it is even possible to automate certain areas. A global collection of data on patients, with their different illnesses and experiences, will help. By processing this data, we can create knowledge bases, with different patterns, so that the patient's treatment plan will be as appropriate and accurate as possible. This approach is already being used in other areas of medicine, for instance for the recognition of X-ray images. Using fuzzy logic, machine learning and artificial intelligence algorithms, data from databases can be used to create predefined patient treatment patterns. This can help in determining the diagnosis and prescribing the right treatment in cases where doctors take a long time to decide on the right approach.
Keywords: Physiotherapy devices, Fuzzy logic, Machine learning, Artificial Intelligence, Data bases, Biofeedback.

Relaxation as a trend appeared abroad in the mid-30s-40s of the 20th century. It was aimed at relieving muscular and nervous tension. It is accepted to distinguish involuntary (going to sleep) and voluntary (taking a calm pose, relaxation of muscles) relaxation.
Muscle relaxation techniques are the earliest body therapy techniques.
Relaxation techniques are based on Eastern spiritual and religious practices.
The first Western specialists who used muscle relaxation were the psychologist E. Jacobson and the German neurologist I. Schultz.
E. Jacobson studied the manifestations of emotions. He found changes in muscle tone in psycho-emotional disorders and psychosomatic diseases. The discovered relationship was called hypertension. E. Jacobson managed to prove that relaxed muscles relieve hyper-excitation of the nervous system and help it to restore balance.

This is why it is so important to develop muscle relaxation skills to relieve mental tension and eliminate the symptoms of disease (headaches, heart pain, gastritis, hypertension, etc.).
Additional effects of muscle relaxation are improvement of sleep, elimination of "muscle clamps", emotional "discharge" and increase in performance.
Also, it is important to note that one of the most common areas in medicine, responsible for relaxation, relaxation and relief of stress of the patient, is physiotherapy.
Physiotherapy (Greek physis - nature + therapeia - treatment) is a field of medicine that studies the effect on the human body of natural (natural) or artificially produced (preformed) physical factors and uses them to preserve, restore and improve human health. The term "physiotherapy" was established in connection with the use of natural physical factors (climate, sun, mud, bathing, etc.) to improve health. In its development, physiotherapy went through several stages, which led to its formation as a scientific discipline and specialty.
Physiotherapy was born at the dawn of civilization as a result of human interaction with nature. As evidenced by the surviving historical monuments of primitive society, thousands of years before our era people began to use natural physical factors for therapeutic purposes. Physicians of the ancient world in different continents actively used in their practice mud, mineral waters and climate. People who lived on the shores of the Mediterranean Sea knew that the touch of certain species of fish - stingrays, eels, catfish - causes muscle twitching, numbness and soothing of pain. Doctors of ancient India almost two thousand years before our era first described the technique and methodology of therapeutic massage and gymnastics.
The greatest flowering of the use of natural healing factors reached ancient Greece and Rome.
In ancient China, physical methods of treatment were embodied in the so-called zhen-juju therapy (zhen means needle, juju moxibustion), as well as in the technique of acupressure.
In the Middle Ages, physical therapies developed mainly due to the efforts of physicians in Byzantium and the East, summarized in the works of Avicenna (980- 1037). He was the first to formulate detailed indications for the treatment as well as prevention of various diseases with the help of the sun, air and water. Healers of Ancient Russia used in their practice "sour water" (narzan – mineral water) as well as steam baths for treatment of joint diseases.
During the Renaissance, many natural scientists (T. Paracelsus, R. Broglie, W. Gilbert, B. Franklin, etc.) sought to use the results of their experiments to treat patients. Starting with the artificial sources of electricity (electric machines and Kleist jars) created in the first half of XVIII century, each new discovery immediately led to the attempts of its application in medicine. At the same time, by the end of the 18th century, the dissonance between the accumulated successful experience of the empirical use of physical factors and the existing interpretation of the mechanisms of their therapeutic effect became apparent. The latter was often based only on intuition or even on a mystical perception of reality.
By the beginning of the 19th century, the descriptive approach to the study of nature had been finally supplanted by the scientific approach. The scientific worldview of physicians began to form on the solid foundation of the exact sciences - physics, chemistry, and mathematics. For physical therapies, it became possible to obtain experimental confirmation of their therapeutic effect. This stimulated the interest of scientists to explain the mechanisms of action of already existing therapeutic methods, their modification and modernization.
The arsenal of physical therapies during this period was significantly expanded.
The justification of the electromagnetic field theory (D.C. Maxwell, 1865) stimulated J. Wimshurst to create in 1882 the first apparatus for Franklinization. The invention of the high-

frequency oscillator by N. Tesla (1891) allowed J.A. D'Arsonval in the same year to propose the first method of high-frequency electrotherapy, later named after him (darsonvalization).
In the XIX century apparatus methods of phototherapy were introduced into medical practice. Thanks to the works of J. Herschel, A. Dobereiner, A. Duoia, A. Blount, A. N. Maklakov the first information about the mechanisms of physiological and therapeutic action of UV- and infrared rays was received. N. Finzen, who was awarded the Nobel Prize in 1903, laid down the scientific foundations of phototherapy.
In the XVIII-XIX centuries in Europe, and later in the Caucasian Mineral Waters in Russia, the first and immediately became popular spas were opened. It was during this period that the first scientific research on the problems of hydrotherapy, mud therapy, and mechanotherapy appeared (W. Winternitz, J. Berzelius, V.A. Manassein, A.P. Nelyubin, B.A. Libov, etc.). Since 50-ies of the XIX century in St. Petersburg, Vienna, Paris and Berlin began to function independent chairs of balneotherapy. Later on the issues of electrotherapy were included in the curricula of the major medical universities.
Later, with the development of technology, physiotherapy, as a branch of science and medicine, became more and more clear, as a separate direction.
Thus, by the beginning of the XX century, a qualitatively new transition in the development of physical medicine was generally accomplished and a large amount of clinical-experimental data on various therapeutic effects of physical factors was accumulated. This was the main impetus and basis for combining different physical methods of treatment into a single scientific and clinical discipline - physiotherapy, which took place at the I Congress of Physiotherapists in Liège (Belgium) in 1905.
The scattered studies devoted to individual types and methods of physical medicine in the past were replaced in the 20th century by targeted research on the whole spectrum of physical therapy problems. They were especially active in the countries of Western Europe and Russia, which, perhaps, determined the most successful development of physiotherapy in these countries.

Biological active communication technologies (Biofeedback)
Biofeedback is a technology that includes a set of research, non-medical, physiological, prophylactic and therapeutic procedures in which the person, through an external feedback loop, organized mainly by means of microprocessor or computer technology, is presented with information about the state and changes of their own physiological processes.
Visual, auditory, tactile and other stimuli are used, which makes it possible to develop self-regulation skills by training and increasing the lability of regulatory mechanisms.
The biofeedback procedure consists in continuous real-time monitoring of certain physiological indicators and conscious control of them with the help of multimedia, games and other techniques in a given area of values. In other words, the biofeedback interface represents for a person a kind of "physiological mirror" in which his internal processes are reflected. Thus, during the course of biofeedback sessions it is possible to strengthen or weaken a given physiological index, and thus the level of tonic activation of that regulatory system, whose activity this index reflects.
With the help of biofeedback you can get information about such physiological processes as muscle activity, breathing, vascular blood flow, skin resistance, heart rate, brain activity.
For example, learning to raise the temperature of the fingertips voluntarily with the biofeedback method leads to reduction of sympathicotonia and arrest of spasm of peripheral vessels. By learning how to relax the muscles voluntarily with the biofeedback method, a patient with one

way or another manifested fear and mental agitation learns to overcome them, since fear, agitation and muscle tension are connected to each other.

The list of areas in which biofeedback is applied is quite extensive:

Clinical - psychology, neurology, cardiology, gastroenterology, urology, pediatrics, geriatrics, regenerative medicine, preventive medicine.

Non-clinical - in effective stress management, which allows to increase performance in big sports, art, as well as in any activity requiring long efforts and great responsibility, for the correction of so-called borderline conditions caused by uncontrolled influence of chronic stress, in pedagogy, where using biofeedback technologies solves the issues of increasing the effectiveness of training, development of creative abilities, etc.

BAC can be used, in particular, for:

- vasomotor headaches, migraine
- cervical syndrome
- spastic torticollis
- stuttering, tremor, tics
- high blood pressure
- heartbreak
- gastric ulcer
- chronic constipation
- impotence, vaginismus
- sleep problems
- epileptic seizures.

Theoretical foundations and creation of biological active communication technologies

The basis for the creation of the biofeedback method was the fundamental research of mechanisms of regulation of physiological and pathological processes, as well as the results of applied research of rational ways to activate adaptive brain systems in healthy and sick people.

Active study of the method began in the late 1950s.

Around the middle of the twentieth century, methods began to be developed and used that established biological feedback to the body based on changes in various parameters (pulse wave, muscle strength, blood pressure).

In the 1970s, considerable attention was paid to the study of the so-called alpha learning and alpha states caused by the enhanced alpha rhythm in the human EEG.

In the late 1980s and early 1990s, Peniston and Kulkosky conducted their experiments to study the possibility of treating patients with alcoholism with biofeedback technology. They also created the session protocol that has now become classic: first there is temperature training (pre-therapy), and then there is alpha-theta training by EEG.

An overview of application of fuzzy logic principles in medicine

In recent years, there has been an increased interest in developing various systems using fuzzy logic. This is due to the fact that humanity has realized the need to analyze information based on subjective data. Hence, the need to create various systems based on fuzzy logic in medicine as well. Today, there is a need to create such systems, as in medicine it is often necessary to use subjective (fuzzy) data. As a consequence, increased attention to the use of fuzzy logic in medicine and the application of this approach in the latest developments, as evidenced by the

numerous studies and developments of Russian numerous studies and developments of Russian and foreign authors testify. Thus, the relevance of this article is determined by the lack of study of possibilities for the use of fuzzy logic in medicine and physiotherapy in particular.

Despite the name, the purpose of using fuzzy logic is to be able to create a program that is able to give a clear answer to a particular query, taking into account the circumstances. Fuzzy logic systems are often used as expert systems. The ideal system should take in information, process the data with regard to the circumstances, and produce a clear answer. However, these systems often fail to account for human factors such as prejudice and uncertainty.

Medicine encompasses a huge amount of information from completely different fields. In the medical field, there is always a degree of uncertainty when making different diagnoses. Specialists point out that the traditional approach to treating illnesses is often insufficient. A fuzzy logic approach must be used for rational treatment and prevention.

For example, in 2003, scientists Nieto and Torres used fuzzy logic to to study the effects of smoking and alcohol consumption on the body. The authors assessed dependence from 0 (not smoking) to 1 (smoking like a steam engine) and concluded that the degree of dependence can significantly affect drug use. A recent study to diagnose breast cancer using fuzzy logic. The authors created the Fuzzy-AIRS system, which is able to calculate the possibility of breast cancer by inputting patient parameters.

From this we can conclude that the same disease can manifest differently in different people. The same symptom can refer to different diseases. On the other hand, several diseases of the same patient may interfere with making correct diagnosis. Thus, it is necessary to use an approach that takes into account these particular conditions - fuzzy logic.

In medicine, information is often incomplete, inconsistent, or inaccurate. Sources of such information may include: patient information, patient medical history, physical examination, laboratory tests, exaggerated symptoms, nervous disorders.

Among the studies in this field today, it is customary to highlight the studies of foreign authors, who have done a great job in identifying the merits of fuzzy logic and using the method in treatment and diagnosis. Among the achievements foreign authors can be singled out the following: the development of early diagnosis of postoperative complications; evaluation of cardiac activity; evaluation of the degree of burns; diagnosis of central nervous system cancer tumors and others.

From this we can conclude that the use of fuzzy logic in medicine gives positive results. Also, this direction can be considered in the perspective of using information systems for medical record keeping, such as patients' medical histories, results of laboratory tests and doctors' examinations. Creation of a system which will use fuzzy logic for medical records will have positive results, as the system will take into account the medical characteristics of each individual.

Application of fuzzy logic in physiotherapy

One of the oldest fields of medicine is physical therapy. For many years practitioners around the world, and particularly in the East, have been perfecting various techniques of non-medicinal treatment. With the development of technology, completely new methods of patient treatment appeared, such as magnetotherapy, electrotherapy, ultrasound therapy, etc. They are renowned for their non-invasive effect and sufficient efficacy. But, unfortunately, not many people believe in their effectiveness and often ignore them. They are understandable, because not every patient will

be equally well affected by the same type of physical therapy. And there is a reason for that - all people are different and individual.

Fortunately for us, individuality is expressed in many parameters that we can take into account. For example: weight, height, age, BMI, thickness of body fat, predisposition to chronic diseases, intolerance to certain drugs, times of séances and more. By recording this data in certain tables, we can create patient databases. Further, by prescribing certain procedures for different patients, we can identify patterns between certain input criteria. In the future, with the development of these patterns, we can create knowledge bases. This will be the starting point for us to prognosticate the best and most appropriate treatment for a particular patient. In general, all work will be aimed at identifying patterns between certain groups of people and which of the physiotherapy modalities helped them more or less. In this way it will be possible to avoid the human factor, to a certain extent. But in any case we should not forget that this algorithm of work is only intended to help doctors, and not to completely replace them.

To illustrate the example, I propose to consider the dependence of the advisability of treatment with electric current (electrotherapy) on the degree of hypertonia and the severity of pain in the patient's spine.

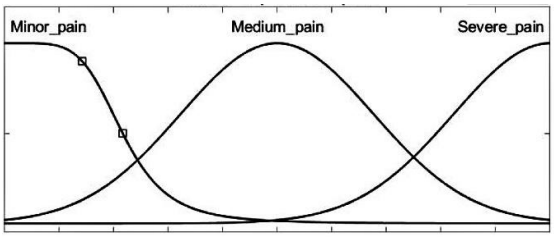


Figure 1: Degree of pain in the spine

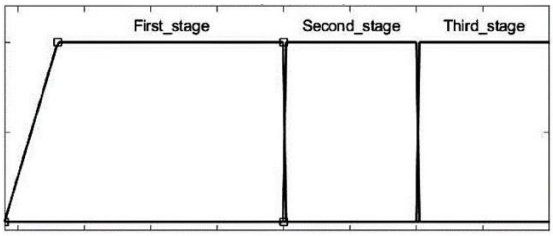


Figure 2: Hypertension stage

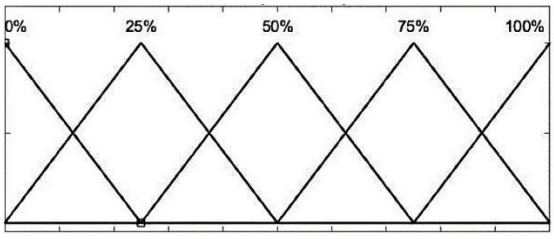


Figure 3: Feasibility of treatment expressed as a percentage

After applying fuzzy logic algorithms, with pre-written rules for it, we get graphs of the dependence of the desirability of treatment on both parameters, as well as a surface of the dependence on both input parameters for greater clarity.

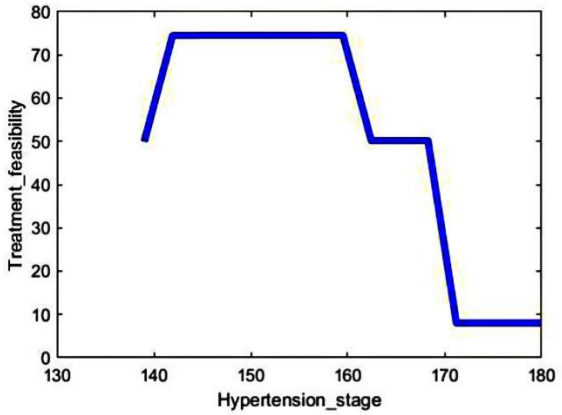


Figure 4: Graph of the reasonableness of treatment depending on the degree of hypertension.

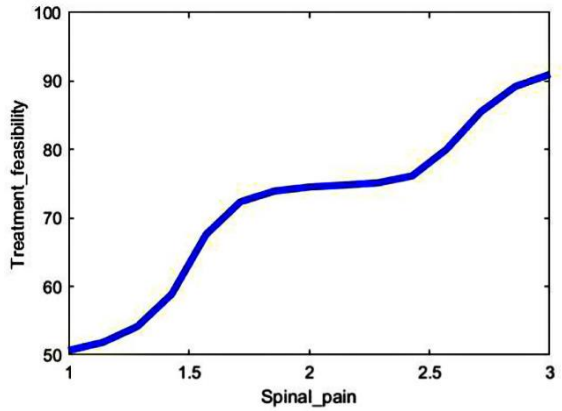


Figure 5: Graph of the reasonableness of treatment depending on the degree of spinal pain.

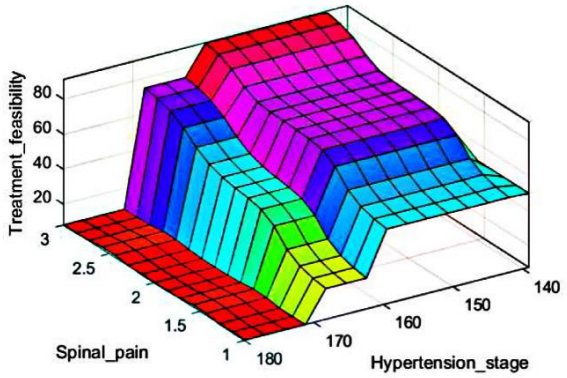


Figure 6: Surface of the reasonableness of treatment depending on both degree of spinal pain and hypertension stage

As we can see from the chart, we are not recommended to treat with electrotherapy at all if the patient has stage 3 of hypertension.

Conclusions

Fuzzy logic algorithms can help us take treatment to another level. Doctors will no longer make mistakes based on the many experiences they have gained, which will be recorded in databases and structured. Eliminating the human factor is one of the biggest challenges of applying this technology.

In the end, we would like to mention again the fact that this system is not designed to replace a person completely, it is designed to help in the prescription of treatment or online counseling of patients.

REFERENCES

1. Novák, V., Perfilieva, I. and Močkoř, J. (1999) Mathematical principles of fuzzy logic Dodrecht: Kluwer Academic. ISBN 0-7923-8595-0.
2. Paklin N.N. Mathematical foundations of fuzzy logic .
3. Joly, H., et al., "Application of Fuzzy Set Theory to the Evaluation of Cardiac Functions," MEDINFO '80, Proc. 3rd World Conference on Medical Information, Tokyo: North Holland
   Publications, Vol. 1, 1980, pp. 91-95.
4. Nieto J.J., Torres A. Fuzzy logic in medicine and bioinformatics. - Journal of biomedicine & biotechnology, 2006
5. Bashlykov I.A., Bunyaev V.V., Gadalov V.N. The use of fuzzy logic decision-making methods for prediction and diagnosis of peptic ulcer disease. - Bulletin of new medical technologies. - 2006.
6. Lapytov A.I., Radchenko S.V. Application of fuzzy logic in differential Diagnostics of stomatological diseases.
7. Sakaguchi, S., et al, "Development of an Early Diagnostic System Using Fuzzy Theory for Postoperative Infections in Patients with Gastric Cancer," Digestive Surgery, Vol. 21, No. 3,
   2004, pp. 210-214.
8. Acha, B., et al., "CAD Tool for Burn Diagnosis," Information Processing in Medical Imaging, Vol. 18, July 2003, pp. 294-305.
9. Belacel N,Boulassel MR. Multicriteria fuzzy classification procedure PROCFTN: methodology and medical application Fuzzy Sets and Systems 2004.
10. Nieto J.J., Torres A. Midpoints for fuzzy sets and their applications in medicine. - Artificial Intelligence in Medicine, 2003.
11. Ahmadian, M., (2001). Transmission Line Matrix (TLM) modelling of medical ultrasound, A thesis submitted for the degree of Doctor of Philosophy, The University of Edinburg, June.

12. Ebenbichler, G., & Resch, K. L. (1994). Critical evaluation of ultrasound therapy [Kritische Uberprufung des therapeutischen Ultraschalls]. Wiener Medizinische Wochenschrift, 144(3), 51–53.
13. Pocock, B. J. Z. (1994). The effect of therapeutic ultrasound on the mechanical properties of surgical incisions in Wistar rats. BSc thesis. London: University of London.
14. Webster, D. F., Harvey, W., Dyson, M., & Pond, J. B. (1980). The role of ultrasoundinduced cavitation in the 'in vitro' stimulation of collagen synthesis in human fibroblasts. Ultrasonics, 18, 33–37.
15. Wilkinson, J., (1995). Additional advances in fuzzy logic temperature control. In Conference record of the 1995 IEEE industry applications (vol. 3, pp. 2721– 2725).
16. Kahn J. Elektroterapia – zasady i stosowanie. Wydawnictwo Lekarskie PZWL, Warszawa 2005.
17. Elektrostymulator na nietrzymanie moczu Sure Pro – manual
18. S. Samaee and H.R. Kobravi, Predicting the occurrence of wrist tremor based on electromyography using a hidden markov model and entropy based learning algorithm, Biomedical Signal Processing and Control 57 (2020)
19. C.H. Liu, K.T. Chu, Y.C. Mai, P.C. Hsieh, K.C. Hsu, H.W. Lee and H.C. Tseng, Kinect who's coming—applying Kinect to human body height measurement to improve character recognition performance, Smart Science 3(2) (2015), 117–121.
20. I.B. Aabdallah, Y. Bouteraa and C. Rekik, Design of smart robot for wrist rehabilitation, International Journal on Smart Sensing & Intelligent Systems 9(2), 2016.
21. T. Chih-Hsiao, K. Yin-Hao, K.-C. Chu and J.-C. Yen, Development and evaluation of game-based learning system using the microsoft kinect sensor, International Journal of Distributed Sensor Networks 2015 (2015), 1–10, 07.
22. I.B. Bouteraa, Y. Abdallah, A. ElMogy, A. Ibrahim, U. Tariq and T. Ahmad, A fuzzy logic architecture for rehabilitation robotic systems, International Journal of Computers Communications Control 15(4), 2020.
23. P. Phukpattaranont, A. Phinyomark and C. Limsakul, Feature reduction and selection for emg signal classification, Expert Systems with Applications 8 (2012), 7420–7431.

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 24 ISSUE 03 2023

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

DETECTİON OF HAND MOVEMENTS BY ANALYZING EEG SIGNALS USING CNN

Aynur Jabiyeva[1], Mardaxay Ravinov[2]
[1]PhD, Docent, aynur.jabiyeva@outlook.com
[2]Undergraduate "İnstrument Engineering" Department, alfredrockankeur@gmail.com
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

In this paper a method for detecting six specific hand movement events in a 32-component brain EEG signal by using an ensemble of convolutional neural networks (CN) as a multiclass classifier is considered. The paper proposes and empirically evaluates several options for the architecture of convolutional neural networks, as well as an ensemble that combines the proposed options for the architecture of convolutional neural networks, using a blending algorithm and a final classifier based on logistic regression. The advantages of the chosen classification method for the problem being solved are shown. The results obtained make it possible to say that the use of a classifier in the form of an ensemble of several models of convolutional neural networks allows one to effectively identify characteristic features in the initial EEG signals, and at the output of the classifier to obtain the probabilities that the input signal belongs to one of the given classes of hand movements. The use of the blending algorithm makes it possible to obtain optimal classification results by integrating the best estimates of several models, which individually on the entire test set may give a non-optimal result.

Introduction

Electroencephalography (EEG) - a method of recording and analyzing brain activity; based on the results of the analysis, conclusions can be drawn about the state of the brain, possible deviations, lesions, disorders and their nature.

Currently, neurocomputer interfaces are being actively developed that allow collecting electroencephalography (EEG) data through the use of non-invasive dry electrodes. Compared to traditional medical-grade EEG devices, these devices are affordable, compact, and ergonomic. Also, recent advances in the field of robotics and 3D printing make it possible to create more and more advanced limb prostheses, including hands.

Modern technologies, which have made it possible to automate part of the ongoing research and create various software options, facilitate the work of specialists and reduce the time spent on registration, analysis and the formation of a preliminary conclusion. Undoubtedly, the main advantages of these software tools are the variety of data processing methods, the use of various data processing algorithms, the possibility of automatic analysis and the conclusion of a preliminary conclusion based on the results of the analysis. At the same time, the software tools have a number of shortcomings in the first place - this is compatibility only with special software (in some cases) and the impossibility of conducting wavelet analysis, bispectral analysis. In addition, the EEG has a number of features that complicate the research process, therefore, at present, a promising direction is the use of artificial intelligence methods, in particular, artificial neural networks.

Neural networks use non-linear systems by setting it is better to classify the data than the linear ones are commonly used methods. In the application to medical diagnostics, they make it possible to significantly increase its specificity, insensitivity to hypersensitivity.

The wide application of neural network modeling methods to medical problems is also facilitated by some features of such methods in terms of compared to linear:

- neural networks do not require the formulation of any rules for decision making, they are trained by examples;
- neural networks have the ability to generalize (the ability "see" through the noise);
- neural networks have the ability to abstract (the ability to extract the ideal from imperfect inputs) - which allows them to be applied to a wide class of pattern recognition problems.

One of the types of neural networks in the EEG is the Kohonen neural network with different (160, 32…) neurons in the input layer and four neurons in the output Layer. The analysis is based on the fast Fourier transform. This a neural network model that allows you to automatically classify electroencephalograms of an organized type.

There is an automated EEG data classification system based on the Kohonen neural network, which includes:

- data preprocessing module (module includes fast Fourier transform);
- intermediate classification module (represents the trained network Kohonen designed for classifying input data);
- EEG classification module (final EEG conclusion formation module);
- neural network classifier (designed for the main parameters classifier).

Alternative options for using neural networks are:

- development of a diagnostic system, which consists of four modules: preprocessing, segmentation, calculation of the senior Lyapunov exponent, detection, which allows analyzing EEG signals (a neural network module for calculation of the highest Lyapunov index of EEG signals), to localize epileptic outbreaks in a group of signals of one registration and to identify those signals in which the appearance of epileptic seizures occurs earlier than others activity;
- the use of a set of neural networks combined in a cascade, to analyze the information received from each sensor, and make an attempt interpretation of results using group numbers. So the cascading the structure of the neural network will allow you to find patterns at the 1st level of the cascade in each EEG sensor and form clusters of activity isolated from EEG, at the second level of the cascade, using the generated activity clusters isolated from the EEG, it is possible to interpret the final result. The proposed approach is one of the possible ones for interpreting EEG results.
- use of a neural network based on the wavelet method. As a result, the selection of parameters using a discrete wavelet transform, as opposed to the currently accepted simple Fourier transform, will allow one to obtain a more flexible and accurate function of frequency over time. Further use of wavelet neural networks for classification should also increase the effectiveness of the technique.

However, the considered options for the use of neural networks for EEG analysis have the following disadvantages: the lack of confirmation of the effectiveness of their use in clinical conditions, the absence in most cases of automated systems or automated modules for diagnostics.

Taken together, these technologies enable researchers to solve the problem of at least partial rehabilitation of people with lost or limited physical abilities by creating widely available limb prostheses that could be controlled by brain. control signals. One alternative is to use a camera with a depth sensor to recognize dactyl gestures.

The task of using neurocomputer interfaces for prostheses controlundefined requires a deep study of the relationship between EEG signals of the brain and motor activity of the limbs, as well as the creation of effective algorithms for detecting and interpreting EEG signals into control signals. These issues have not been fully explored in the existing literature. Therefore, the purpose of this work is to increase the efficiency of detecting a certain a set of hand movement events in brain EEG signals using convolutional neural networks.

Experiment

In this paper, open research data records EEG signals collected and provided by Umea University are used.

In the collection of research data adopted participation of 12 people. Each participant in the experiment participated in 10 data collection sessions about 30 attempts to perform the necessary actions in each session. Each attempt contained 10,000–11,000 points EEG signal with a fixed sampling interval by time. The total amount of collected data was 3936 attempts to "pick up and lift".

The task of one attempt for the participants of the experiment was set in the following form:

1. reach out to a small object;
2. take it with the index and thumb fingers;
3. lift the object a few centimeters above the table surface;
4. hold the object in the air for a few seconds;
5. put the object in place;

1. return the hand to its original position.

In order to obtain homogeneous data moments of the start of the attempt and neo the rate of lowering the object were set using a light signal (lamp).

In all data collection sessions, without prior notice to the participants in the experiment, the properties of the object used for lifting changed several times: weight (165, 330 or 660 g) and the surface of the object (emery paper, suede or silk). These changes were made with the aim of introducing some variability in muscle activity when performing attempts. For example, the compression force subject matter and the effort put into it. lifting, increase with increasing weight of the object. However, with a constant weight, but a different surface of the object, increases only compression force.

During all attempts, the data EEG brain signals were recorded electrode non-invasive neuro-computer interface ActiCap. Frequency sampling of the signals of this neurocomputer interface is 5 kHz, the resolution of single values of the signal amplitudes 0.1 μV. The layout of the electrodes of the ActiCap brain-computer interface is shown on Figure 1.

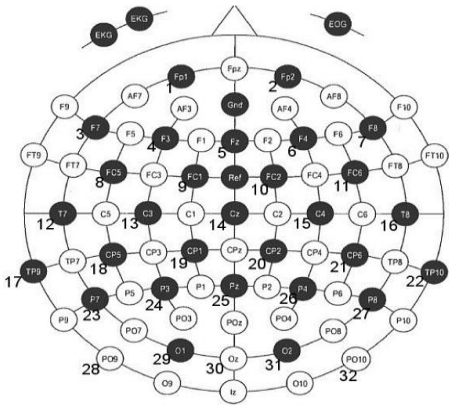


Figure 1: The layout of the electrodes of the neurocomputer interface ActiCap

The received data has been converted special signal processing methods and to each moment of time in each attempt were compared the events that took place in this moment of the event (task execution phase) from next set:

1. the beginning of the movement of the hand;
2. the initial touch of the object with the fingers;
3. both fingers hold the object;
4. lifting the object;
5. returning the object to its place (table surface);
6. both fingers released the object.

Choice of classification method and its implementation

Based on the results derived from previous studies, it was decided to implement a classifier based on a convolutional neural network, so how the properties of this type of classifiers allow you to automatically select features in the original dataset.

It was decided to take as a basis for the new classifier four best options for the configuration of the convolutional neural, these configurations are presented in Table 1.

Table 1. CNN Configuration Options.

Layer number	Layer type	Map count	Map size
Option 1			
1	Input	1	32 × 48
2	Convolutional	64	32 × 64
3	Max pooling	64	32 × 23
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 2			
1	Input	1	32 × 64
2	Convolutional	64	32 × 62
3	Max pooling	64	32 × 31

4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 3			
1	Input	1	32 × 80
2	Convolutional	64	32 × 78
3	Max pooling	64	32 × 39
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 4			
1	Input	1	32 × 96
2	Convolutional	64	32 × 94
3	Max pooling	64	32 × 47
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 5			
1	Input	1	32 × 48
2	Convolutional	64	32 × 46
3	Max pooling	64	32 × 23
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 6			
1	Input	1	32 × 64
2	Convolutional	64	32 × 62
3	Max pooling	64	32 × 31
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 7			
1	Input	1	32 × 80
2	Convolutional	64	32 × 78
3	Max pooling	64	32 × 39
4	Fully connected	128	1
5	Output (fully connected)	6	1
Option 8			
1	Input	1	32 × 96
2	Convolutional	64	32 × 94
3	Max pooling	64	32 × 47
4	Fully connected	128	1
5	Output (fully connected)	6	1

The first layer is the input and is a plane, the dimensions of which are given by the following formula:

$$X = EEG\_channels \times time\_points\,, \qquad (1)$$

where $EEG\_channels$ is the number of EEG signals from various electrodes of the used neurocomputer interface; $time\_points$ - number of time points.

The second layer of the NN is convolutional. He consists of a set of planes and is intended to highlight characteristic features in the original EEG signals in the form of a feature map. In this study, the kernel was used convolutions of size 1 × 3, as it was assumed that characteristic signs should be looked for in the EEG signals in the time dimension. Process functioning of the convolution layer neuron is given by:

$$y_{i,j}^{k} = \sigma\left(b^{k} + \sum_{l=0}^{N-1}\sum_{m=0}^{M-1} w_{l,m}\, a_{i+l,j+m}\right), \qquad (2)$$

where $y_{i,j}^{k}$ is the neuron output value k-th plane of the convolutional layer; b^{k}– neural displacement of the k-th plane; $w_{l,m}$ is an element of the convolution kernel matrix; $a_{i+l,j+m}$ – the value of the outputs of neurons of the previous layer; N, M – kernel size convolutions; σ is the neuron activation function.

The third layer of the NS is a layer subsampling and performs the function of reducing the dimension of the feature maps generated on the previous layer. In this study, the kernel of the subsampling operation was chosen size 1 × 2.

The last two layers are fully connected, consisting of standard neurons with a specific activation function, which produce the final classification of features identified in the previous layer. Because set of classifiable motion events hands consists of 6 elements (options), then the output layer of the NN contains 6 neurons.

As a neuron activation function hidden layers of the NS (2 - 4 layers), in this study, we used rectified linear - the activation function, which is given by the expression:

$$\sigma(x) = \max(0, w \times x + b)\,, \qquad (3)$$

where *w* is the vector of weights; *x* is the vector of input values for the neuron, *b* is the neuron bias.

Since in the work considered in this classification task needs to be obtained on output of the NN of the probability that the input signal belongs to one of the classes, then as activation functions of output layer neurons the softmax function was used, which is given by the expression:

$$\sigma(x)_i = e^{x_i} \Big/ \sum_{j=1}^{n} e^{x_j}\,, \qquad (4)$$

where *x* is the vector of input values for the neuron; *i* - neuron number; *n* is the number of neurons in the layer.

This function transforms a vector x of dimension n, consisting of real values, into a vector σ(x) of dimension n, consisting of real values in the interval (0, 1), the sum of which is 1.

As a function of classification error cross entropy was used:

$$E = -1 \Big/ Q \sum_{q=1}^{Q}\sum_{i=1}^{n} t_i^q \ln y_i^q\,, \qquad (5)$$

where *Q* is the number of examples in training set; *n* is the number of outputs in the network; t_i^q is the required value of the i-th network output at giving an example q; y_i^q is the real value of the i-th network output when giving an example q.

To explore the possibility of improvement results of models, it was decided to implement a new classifier in the form of an ensemble of four convolutional neural networks using blending. Each convolutional NN is a base classifier. Results base classifier predictions for parts of the training sample are called metafeatures. To obtain the final result of the predictions of the ensemble as a whole, another classifier is used, as a rule, simpler than basic classifiers. The training sample for the final classifier is metafeatures.

The algorithm for obtaining a prediction for a test sample using blending looks like in the following way:

1. split the training sample X into k parts, where X_k is the k-th part of the training sample;
2. train each base classifier on each of the $X \backslash X_k$ parts of the training sample;
3. with each trained base classifier get predictions for X_k parts of the training sample;
4. with each trained base classifier to get predictions for test sample;
5. for each base classifier average the results of predictions for the test sample;
6. train the classifier on a sample consisting of metafeatures of all basic classifiers;
7. using a trained classifier get final prediction results ensemble for a sample consisting of predictions for the test sample of each of the base classifiers obtained in step 5.

For $k << |X|$ partitioning seems logical in such a way that each part had an equal number objects, and also that for each fixed class the proportion of objects in each of k parts were the same. This method is accepted called a partition into k blocks with class stratification (Stratified K-fold). In this study, this partitioning method was used for $k = 10$.

As a final classifier, it was decided to use logistic regression.

Experimental results according to the classification of EEG signals using CNN

To construct the NN, the language was used Python programming and algorithm packages machine learning scikit-learn, Theano, Lasagne, Neon.

To train all the above variants of NN architectures, we used the algorithm ADADELTA. The data of the 1st–8th sessions of experiments for each of the participants were used as a training sample. For test sample, on which the quality of the classification was assessed, used data from the 9th and 10th sessions of the experiments for each of the participants.

Table 2 and Table 3 presents the integral results of assessing the classification quality of each studied hand movement event for each NN architecture used in the study separately, as well as the ensemble of these convolutional NNs. Conventions C.1–C.6 correspond to the events under investigation hand movements.

Table 2. Results of assessing the quality of the classification of CNNs (C.1 - C.3)

Option of network architecture	Activation function type	C.1, %	C.2, %	C.3 %
1	rectified linear	92.9	89.4	87.0
2		95.8	92.7	90.3
3		95.1	91.9	89.7
4		94.7	91.5	89.3
Ensemble		97.1	93.8	91.9

Table 3. Results of assessing the quality of the classification of CNNs (C.4 - C.6).

C.4, %	C.5, %	C.6, %	% of correct classification
87.2	93.3	90.7	90.0
90.5	96.0	93.2	93.2
89.8	95.3	92.8	92.6
89.4	94.9	92.4	92.1
92.2	97.5	94.9	94.6

Thus, using an ensemble of four convolutional NNs of various configurations and the use of a blending algorithm made it possible to improve the results of classifying all hand movement events. The percentage of correct classification was 94.6%, which is better than any of the convolutional NN models used in the work.

Conclusions

Using convolutional NN as multiclass classifier allows you to effectively determine the characteristic features in the original EEG signals without the need preliminary application of selection methods and feature extraction.

Using a classifier as an ensemble of several models of convolutional neural networks can significantly improve the quality of classification.

The use of the blending algorithm makes it possible to obtain optimal classification results by integrating the best estimates of several models, which individually on the entire test set can give not the best result.

REFERENCES

1. Jasper, H.H. The ten-twenty electrode system of the International Federation // Electroencephalogr Clin Neurophysiol. – 1958. – № 10. – P. 371–375.
2. Johansson, R. S., Westling, G. Programmed and triggered actions to rapid load changes during precision grip // Exp. Brain Res. – 1988. – № 71. – P. 72–86.
3. Johansson, R. S., Westling G. Coordinated isometric muscle commands adequately and erroneously programmed for the weight during lifting task with precision grip // Exp. Brain Res. – 1988. – № 71. – P. 59–71.
4. LeCun Y., Bengio Y., Hinton G. Deep learning // Nature. – 2015. – № 521. – P. 436–444.
5. LeCun Y., Bottou L., Bengio Y. Gradient-based learning applied to document recognition // Proceedings of the IEEE. – 1998. – № 86(11). – P. 2278–2324.
6. LeCun Y., Kavukcuoglu K., Farabet C. Convolutional Networks and Applications in Vision // International Symposium on Circuits and Systems (ISCAS'10). – 2010. – P. 253–256.
7. Luciw, M., Jarochka, E., Edin, B. Multi-channel EEG recordings during 3,936 grasp and lift trials with varying weight and friction // Scientific Data. – 2014. – № 1. – Available at: http://www.nature.com/articles/sdata201447.
8. Nielsen, M. Neural Networks and Deep Learning // Determination Press. – 2015. – Available at: http://neuralnetworksanddeeplearning.com/.

1. Ranky, G.N., Adamovich, S. Analysis of a Commercial EEG Device for the Control of a Robot Arm // Bioengineering Conference, Proceedings of the 2010 IEEE 36th Annual Northeast. – 2010. – Available at: http://www.ieee.org/ portal/innovate/search/article_details.html?article=545818.
2. Westling, G., Johansson, R. S. Factors influencing the force control during precision grip // Exp. Brain Res. – 1984. – № 53. – P. 277–284.
3. Wolpert, D. H. Stacked generalization. – Available at: https://www.researchgate.net/publication/222467943_Stacked_Generalization.
4. Zeiler, M. D. ADADELTA: An Adaptive Learning Rate Method // arXiv:1212.5701. – 2012. – Available at: http://www.matthewzeiler.com/pubs/googleTR2012/googleTR 2012.pdf.
5. Ramadan RA, Vasilakos AV. Brain computer inter-face: control signals review. Neurocomputing. 2017, 223: 26–44.
6. Palazzo S, Spampinato C, Kavasidis I, et al. Gener-ative adversarial networks conditioned by brain signals. In 2017 IEEE International Conference on Computer Vision (ICCV), Venice, Italy, 2017, pp 3430–3438.
7. Abdelfattah SM, Abdelrahman GM, Wang M. Au-gmenting the size of EEG datasets using generative adversarial networks. In 2018 International Joint Conference on Neural Networks (IJCNN), Rio de Janeiro, Brazil, 2018, pp 1–6.
8. Mudgal S.K., Sharma S.K., Chaturvedi J., Sharma A. Brain computer interface advancement in neurosciences: Applications and issues. Interdiscip. Neurosurg. 2020;20:100694. doi: 10.1016/j.inat.2020.100694.
9. Soltanmoradi M.A., Azimirad V., Hajibabazadeh M. Detecting finger movement through classification of electromyography signals for use in control of robots; Proceedings of the 2014 Second RSI/ISM International Conference on Robotics and Mechatronics (ICRoM); Tehran, Iran. 15–17 October 2014;
10. Anam K., Nuh M., Al-Jumaily A. Comparison of EEG Pattern Recognition of Motor Imagery for Finger Movement Classification; Proceedings of the 2019 6th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI); Bandung, Indonesia. 18–20 September 2019;
11. Branco M.P., Freudenburg Z.V., Aarnoutse E.J., Bleichner M.G., Vansteensel M.J., Ramsey N.F. Decoding hand gestures from primary somatosensory cortex using high-density ECoG. NeuroImage. 2017;147:130–142. doi: 10.1016/j.neuroimage.2016.12.004.
12. Jia T., Liu K., Lu Y., Liu Y., Li C., Ji L., Qian C. Small-Dimension Feature Matrix Construction Method for Decoding Repetitive Finger Movements From Electroencephalogram Signals. IEEE Access. 2020;8:56060–56071. doi: 10.1109/ACCESS.2020.2982210.
13. Edelman B.J., Baxter B., He B. EEG Source Imaging Enhances the Decoding of Complex Right-Hand Motor Imagery Tasks. IEEE Trans. Biomed. Eng. 2016;63:4–14. doi: 10.1109/TBME.2015.2467312.
14. Onaran I., Ince N.F., Cetin A.E. Classification of multichannel ECoG related to individual finger movements with redundant spatial projections; Proceedings of the 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society; Boston, MA, USA. 30 August–3 September 2011;

15. S. Liu and W. Deng, "Very deep convolutional neural network based image classification using small training sample size," in Proceedings - 3rd IAPR Asian Conference on Pattern Recognition, ACPR 2015, 2016, doi: 10.1109/ACPR.2015.7486599.

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023
ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

EXAMINATION OF THE CONTROL SYSTEM OF AN ARTIFICIAL EYE IMPLANT

Aynur Jabiyeva[1], Rashad Khalilov[2]
[1]PhD. Docent, aynur.jabiyeva@outlook.com;
[2]Undergraduate "İnstrument Engineering" Department, rashad.khalilov99@gmail.com
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

Due to various reasons, a person who is missing one eye may experience psychological as well as excruciating suffering. Enucleation and evisceration surgery are the most often used methods to remove a sick or injured eye. The patient is often fitted with a bespoke implant into the orbital tissues after the surgeon removes the eye. In order to keep the socket from looking hollow and depressed, this replaces volume. Once the socket has stabilized, a prosthetic shell—also known as an artificial eye, glass eye, or ocular prosthesis—is placed within. An ocular implant can mechanically replace the lost eye. There have been significant developments in this field. To replace the missing eye, an ocular prosthesis was developed. Physically, the prosthetic seems natural. The eye, however, is stationary or just slightly mobile. development of an independent ocular motor system is the objective of this study in order to give the artificial eye more realistic movement. The detection of natural eye movement is a crucial issue. This study includes an overview of eye movement detecting techniques. Then eye movement detection using the fusion approach is created. The first aspect that is recorded and stored is the eye movement. Then, during the experiment, the sensor array yields the eye movement signal, and the matching rule yields the eye position. The experimental system, fusion technology, and early findings are covered in the majority of this work.
Keywords: Sensor array, fusion, artificial eye, orbital implant, and ocular control.

Introduction

A stunning deformation is caused by losing an eye. For a variety of reasons, a person who is missing an eye may suffer immensely psychologically in addition to physically. Reconstructive surgeons who want to create artificial eyes are typically concern about these issues. The artificial eye has a lengthy history that dates back to antiquity. The artificial eye was made of metal before the eighteenth century. They were unpleasant to wear, heavy, and expensive. Glass eyes then took the place of metal ones at the start of the nineteenth century. The prosthetic was made to replace the missing eye. It's an artificial eye that seems real. However, it is static.

The static artificial eye does not satisfy the patients. They want the artificial eye to move in the same way that the human eye does. Dedicated research teams were formed in this field. The hydroxyapatite orbital implant after enucleation was the most successful method. This method was developed to improve the motility of patients' prostheses after enucleation. All of the patients who received the implant had improved cosmetic results. The prosthesis had excellent small-degree motility. The large-degree movement was not ideal.

Any axis can be used to rotate the eye. To describe the movement of the eye, a three-dimensional model (Figure 1) can be used. Around the x-axis, the eye can rotate from side to side. Eye

movements that are directed upward or downward are caused by rotation around the horizontal y-axis. Torsional eye movement happens along the z-axis.

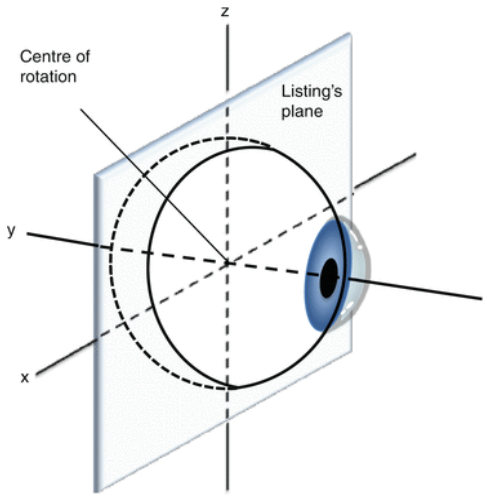


Figure 1. The three axes of rotation of the eye

Natural eye movement is controlled by three antagonistic pairs of muscles: the superior and inferior recti, the superior and inferior oblique, and the lateral and medial recti, as depicted in Figure 2.

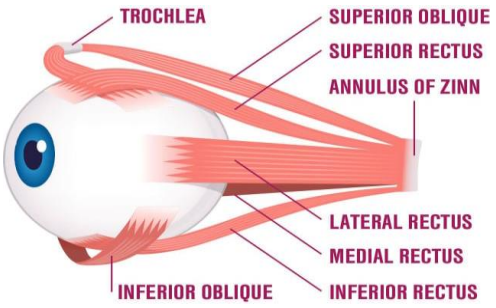


Figure 2. Superior view of the eye muscles

In order to give the artificial eye the same functionality as the muscle, we mount it on a very small servomotor. Our research's objective is to detect natural eye movement and manage the motor to move the artificial eye to a corresponding position.
Finding eye movement in the natural eye is the first step. Over the past 35 years, a large number of researchers from various disciplines and countries have become interested in eye movement and eye blink detection. Many researchers began investigating eye movement as early as the 1950s. Young reviewed the main categories of eye movement and discussed the benefits and drawbacks of different approaches. Electrodes, magnetic induction, optical sensing, photoelectric techniques, infrared oscillography, and video imaging are all used for eye movement sensing.

Instead of measuring the mechanical movement of the eyeball itself, many techniques measure the induced potential that causes the eye movement. These include the sensing of the electrooculography and electromyogram signals.
Although the systems are large and complex, the methods mentioned above can detect eye movement. They can't be used effectively in a compact system like the ocular motility project. Takagi et al. used magneto-inductive elements made of amorphous wire to build a displacement sensor for tracking eyelid movement. It is an intrusive technique as well.

Instruments of democracy at national and local levels
Driving the artificial eye was a relatively small servomotor. One of the lightest conventional servos is the motor in Figure 3, which weighs only 3.5 g. The motor can drive the artificial eyeball mounted on it with a 5 V supply, which is its maximum output force.

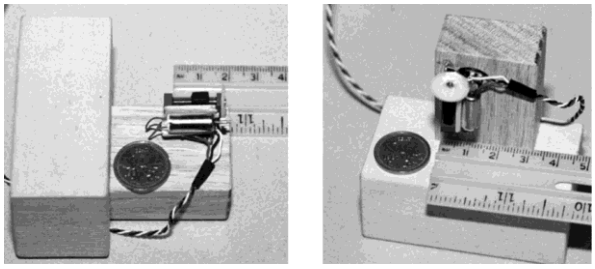


Figure 3. Light servo motor

Pulse-modulated signals are used to control servo motors. The pulse's width serves as a code to indicate which direction the shaft should rotate. The servo motor system's control diagram is shown in Figure. 4.

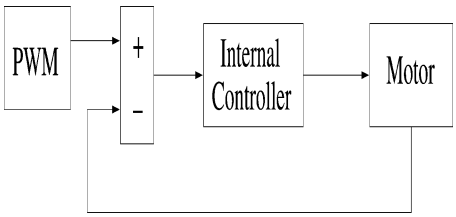


Figure 4. The motor system

Sensor
A problem is always using the incorrectly kind of sensor. We've experimented with a variety of sensors. The size of the sensors is too much.
The first setup employed a pair of emitter and detectors. Infrared signals were emitted by the emitter. This signal was picked up by the detector. Both the emitter and the detector needed to be mounted to the front of the eyes, upper and lower, respectively. Additionally, the position of the emitter and detector must take angle into account in order for the detector to pick up the signal reflected by the eye. It is shows in Figure.5.

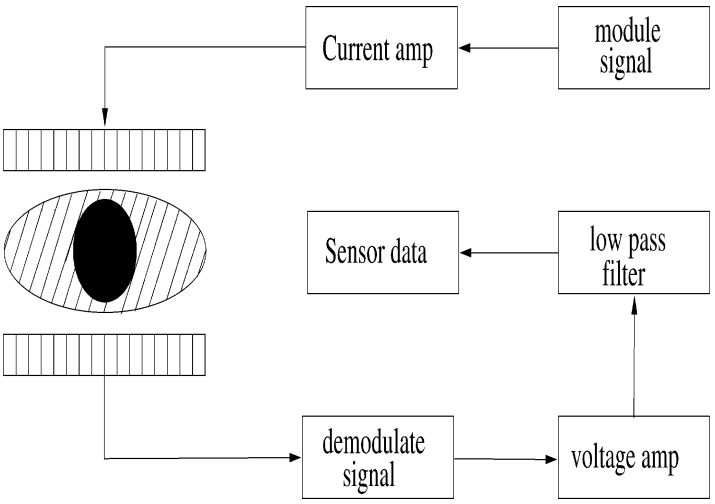


Figure 5: Eye position acquisition block diagram

To illuminate the eye, the emitter transmits an infrared light, and the detector array detects the reflected infrared light. The position of the detector is fixed because the detector array is fixed. The angle of the eyes will affect how the light is reflected. The modulated signal is used to prevent interference because the reflected light may be affected by the surrounding light.
The light that is reflected from an object is collected by a linear array photodiode. Assume that binary data from the sensor exists. The output of the photodiode is 1 if it detects a reflection; otherwise, it is 0. The reflected data vector will then be V [V1, V2, V3,..., Vm], where m is the sensor's dimension. This process has shown in Figure.6.

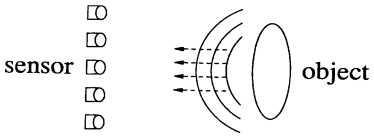


Figure 6: Use the sensor array to detect the object

Formula for to use the sensor array to detect the object:

$$V_i = 0 \sim No\ reflection \qquad (1)$$
$$V_i = 1 \sim Reflection$$

While the shape of the object cannot be determined using this method, information regarding whether the object is occupying the space can be. It is possible to detect an object using this single algorithm. If the sensor is a sonar, then the information relates to range.:

$$V_i = 0 \sim No\ reflection \qquad (2)$$
$$V_i = d_i \sim 0 < d_i < 255 \quad Reflection$$

The information shows how far away the target is from the sensor. The reflected data structure is the same, with the exception of the different value, if the range data value is 0-255.

If the sensor is an infrared sensor, it gives details about the surface color of the item in addition to the distance between it and the sensor. In order to track the eye movement, this characteristic will be investigated. To find infrared reflection from the eye, a linear sensor array is used. The detection of eye movement can be done in a variety of ways. In Young's review, the survey of eye movement recording techniques is presented. In this instance, the sensor measurement is distinct from that of an autonomous mobile robot. An unpredictable environment will always be encountered by the mobile robot. Except when the eye is moving, the sensor in this instance is always towards the normal eye.

The data collected must be maximized when the sensor is utilized to investigate an object's property. The property of the thing is altering throughout time. The object will be detected at a greater sample rate, making any changes to its properties throughout the time span insignificant. This results in very smooth data for each sensor, which may be approximated by a polynomial equation. A polynomial equation typically has the following form:

$$f(t) = a_0 + a_1 + a_2 t^2 + \cdots + a_n t^n \qquad (3)$$

where [a0, a1,..., an] are coefficients and [t] is the time.

There are n 1 equations necessary to find all the coefficients. The (n 1) order polynomial can be used to fit the data if there are n equations, which means. Considering that the data are sampled at times [t1, t2,..., tn], respectively, let's have a look at the first row of the timing matrix, which is [y11, y12,..., y1n]. The polynomial is fitted using a least mean square approach. The fi(ti) and the sampled data y1i are present for each time point ti. For this E1 curve fitting, the mean square error is:

$$E_1 = \frac{1}{n-1\tau=1}^{n-1} \; a_j t^j - y_{1j} \qquad (4)$$

The n linear equations with the coefficients [a0, a1,..., an] are obtained by partial differentiating E1 with regard to [a0, a1,..., an], respectively.

The following equation illustrates the matching rule. The selection of a threshold is followed by the calculation of the separation of two vectors. The distance and threshold are then compared. The two vectors match if the distance is smaller than the threshold; otherwise, there is no match.

$$\begin{aligned} D_i < D_{tm} &\sim Matching \\ D_i > D_{tm} &\sim No\ matching \end{aligned} \qquad (5)$$

The project's goal is to track natural eye movement and utilize that signal to steer an artificial eye's movement. It displays the block diagram of the system. The intended location of the natural eye is captured by the infrared sensor. It obtains feedback data from the motor, transmits angle data signals, and combines input and signal. The PWM signal for the motor was produced using the actuation error signal. The motor will subsequently move the ocular implant into place. The experiment made use of an eye pit model. The model's eye pits are the same size as the actual pit in the eye. This model has shown in Figure 7.

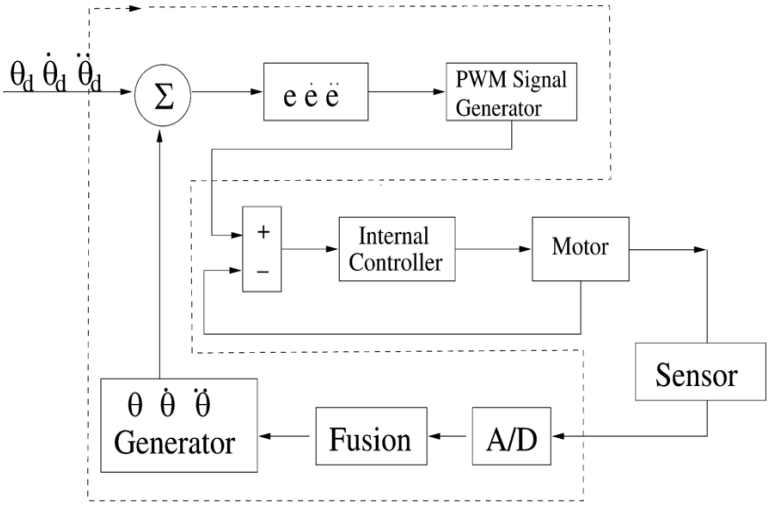


Figure 7. The control block diagram

The positions of the natural and prosthetic eyes were simulated using an eye pit model. The model's pits are the same size as the eye pits used for natural movement. The eye pit model has the eyeglass frame attached to it. The eye pits were fitted with two prosthetic eyes. The genuine eye was represented by one eyeball. It can be manually rotated. The other eyeball was placed in the eye pit after being put on a motor. The artificial eye is mimicked by this eye. In front of the artificial eye simulation, the infrared transmitter and detector were installed into the top front eyeglass frame. Technical difficulties for systems with sophisticated electronics include power consumption, communication range, data transfer speeds, size, ruggedness, and price. The use of ultra-low power circuits in conjunction with energy-harvesting techniques has been investigated to ad**dress power consumption issues. By utilizing these techniques, energy is produced in the implant from vibrations, rotations, and deformations that occur during activities like walking. Although energy harvesting techniques appear promising, there is not enough energy to power the electronics from them. Recently, a family of wireless, battery-free, telemetry-free, and wire-free passive resonator-based sensors have been described. The small, straightforward sensors can be constructed in many sizes and forms to measure factors like force, pressure, temperature, pH, and certain target analytes. They can be manufactured for less than previously. These sensors have the potential to be integrated into commercially available implants with little to no implant modification due to their small size and simplicity.

The need to modify the host implant in order to accommodate sensors and electronics has likely been the biggest obstacle to integration into clinical practice. Creating hollow cavities to house complicated electronics and strain gages is technically difficult and expensive, but most importantly, it changes the properties of the implant and ultimately jeopardizes its performance.

The artificial natural eye was manually rotated during the experiment from one extreme to the other. The eye position signal will be picked up by the detector. The ocular signal is converted into a code and sent as a PWM signal. It refers to the precise location of the "actual eye"; a built-in control on the motor moves the artificial eyeball to the desired location.

Conclusions

Smart implants are implantable medical gadgets that have therapeutic and diagnostic advantages. Smart implants can facilitate personalised therapy, enhance outcomes while reducing costs, and improve patient care. As diagnostic tools, smart implants can offer details about the environment inside the body that cannot be learned any other way. By using this data, medicines may be tailored to the individual, care transitions can be started, and adverse events can be caught earlier. Smart implants' clinical efficacy has been amply shown, and the technology has immense potential to influence clinical treatment and advance customized medicine. The expenses of entry, however, have made utilizing smart implants in routine clinical practice impractical. In five decades of study, a total of 100 individuals have received permanent smart orthopedic implants that have been employed in clinical settings for all purposes. However, with quickly expanding technology, the widespread usage of smart implants is imminent. New sensor technology that requires little modification to existing implants is the key to incorporating smart implants into routine clinical practice. Through the integration of application-specific technologies with the implant, physical sensations are measured. Improvements in implant design, surgical technique, and methods for postoperative care and rehabilitation have been made thanks to data from smart implants. With very few instances, smart implants have not yet entered routine clinical practice despite decades of development. This is primarily due to the fact that the implants must be significantly modified in order to include contemporary sensor technologies. Although the underlying technology for smart implants has advanced greatly over the past few decades, there are still major technological obstacles to be solved before smart implants may be used in the majority of medical procedures. Future smart implants' sensors will be compact, straightforward, durable, and affordable, and they won't necessarily require major changes to the designs of currently used implants. With technology progressing so quickly, smart implants will soon be used widely. The key to integrating smart implants into routine clinical practice is new sensor technology that minimizes alterations to current implants.

This study describes the construction of an assistive device that can track normal eye movement and drive a prosthetic eye to perform the same function. A lab prototype that has been built successfully carries out the desired objectives. The device's sensing components will be improved, the control algorithm will be improved, the circuit design will be miniaturized, and clinical testing will be carried out to confirm the final design.

REFERENCES

1. O. Martin, L. Clodius, The history of the artificial eye Annals of Plastic Surgery 3 (2) (1979) 168–171.
2. G.G. Massry, J.B. Holds, Coralline hydroxyapatite spheres as secondary orbital implants in anophthalmos, Ophthalmology 102 (1) (1995) 161–166.
3. Sheilds, C.L. Shields, P. De Potter, Hydroxyapatite orbital implant after enucleation experience with 200 cases Mayo Clinic Proceedings 68 (12) (1993) 1191–1195.
4. Q. Chen, J. Yi, H. Liao, L. Wan, Clinical application of a new mobile integrated orbital implant Chinese Journal of Ophthalmology 32 (3) (1996) 182–184.
5. Roberts, John B.; Roberts, Elizabeth A. (2009). Freeing Tibet: 50 years of struggle, resilience, and hope. AMACOM Div American MGMT Assn. p. 160. ISBN 978-0-8144-0983-1. Retrieved September 19, 2011.

6. "Tex Avery Loses an Eye, 1933". Walter Lantz Archive. Cartoon Research. Retrieved March 16, 2018.
7. Marshak, H; Dresner, SC (2005). "Multipurpose conical orbital implant in evisceration". Ophthalmic Plastic and Reconstructive Surgery. 21 (5): 376–78.
8. [8] Orsouw, Michael (14 July 2021). "The 'Vaudois' King of Thailand". Swiss National Museum - Swiss history blog. Retrieved 15 July 2022. The driver involved in the accident was 21-year-old Bhumibol Adulyadej, the designated King of Thailand. The future monarch lost an eye in the accident in Vaud, and from then on had to live with a glass eye and some facial paralysis.
9. "Prosthetic Eye Care". ocularpro.com. Ocular Prosthetics, Inc. Retrieved 2016-11-09.
10. Collins, Francis. "The Amazing Brain: Making Up for Lost Vision". NIH Director's Blog. National Institutes of Health. Retrieved 10 November 2019.
11. "USC Eye Institute ophthalmologists implant first FDA-approved Argus II retinal prosthesis in western United States". Reuters. 27 August 2014. Archived from the original on 5 January 2015. Retrieved 5 January 2015.
12. Gupta A, Lam J, Custis P, Munz S, Fong D, Koster M (2018). "Implantable miniature telescope (IMT) for vision loss due to end-stage age-related macular degeneration". Cochrane Database Syst Rev. 2018 (5): CD011140.
13. "HKU performed the first subretinal microchip implantation in Asia Patient regained eyesight after the surgery". HKU.hk (Press release). The University of Hong Kong. 3 May 2012. Retrieved 23 May 2016.

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023
ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

SPARSE REPRESENTATION IN THE RECONSTRUCTION OF ULTRA-HIGH RESOLUTION PET IMAGES

Aynur Jabiyeva[1], Naggov Naggayev[2]
[1] PhD. Docent, aynur.jabiyeva@outlook.com;
[2]Undergraduate "İnstrument Engineering" Department, naggov289@gmail.com
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

Reconstructed pictures in positron emission tomography (PET) research are frequently noisy and low quality. The low-count issue is the main source of these issues. Sparse prediction is more likely to be chosen as the solution as sparse technology is employed more frequently. I suggest a brand-new sparse prior technique in this research to process low quality PET reconstructed pictures. Two dictionaries (D1 for low-resolution PET images and D2 for high-resolution PET images) are trained from plenty of actual PET image patches in the proposed approach. The sparse representation for each patch of the input PET picture is then obtained using D1. Finally, D2 is used to create a high-resolution PET image from this sparse representation. The results of the studies show that the suggested strategy has superior effects that improve image resolution and detail recovery that are stable. In terms of root mean square error, this technique performs better quantitatively than older methods (RMSE). The suggested method offers a fresh and effective way to enhance the image quality of PET reconstructions. The back projection technique was created for magnetic resonance imaging (MRI) picture reconstruction of under sampled data and has been used to denoise dynamic PET images.
Keywords: PET imaging, data acquisition, artifacts, resolution, information technologies.

Introduction

In recent years, positron emission tomography (PET) has been widely studied by researchers for diagnosing diseases. However, low-count PET projection data is a continual challenge that results in noisy images and generates artifacts.

Many methods have been proposed to improve the quality of the PET images. The traditional reconstruction algorithms typically have high computational and equipment costs. In this paper, a new idea is proposed for PET image reconstruction that incorporates prior information. Edge-preserving regularization is the most common way to achieve good results. By evaluating different regularization methods that use spatial prior information, we found that Bicubic interpolation [1], which uses selected adjacent pixel methods for each pixel in the prior image, surpasses others in terms of performance and computational complexity. Another class of methods used to incorporate prior information are related to post-processing the reconstructed images. The highly constrained back projection method synthesizes images as prior information. The back projection method was developed for image reconstruction of under sampled data in magnetic resonance imaging (MRI) and has been applied to denoise dynamic PET images.

Inspired by the success of image super-resolution through sparse representation [2], we propose a similar method to obtain high-resolution PET images by using appropriate sparse representations of low-resolution PET images. Because the reconstruction constraint is not unique and the measurements cause errors, this is a severely ill-posed problem. Consequently, we use

regularization methods to solve the problem. Therefore, this method relies on two coupled dictionaries D_1, trained on low-resolution PET image data, and D_2, trained on high-resolution image data. Finally, the sparse representation of a low-resolution PET image input based on D_1 would be used to obtain a high-resolution PET image from the D_2 dictionary, based on the linear relationships between the input and output data.

The suggested algorithm performs adaptive selection well, which contributes to its improved capacity to enhance resolution and denoising when compared to the regularization-based methods previously stated. This work demonstrates how low-count PET reconstruction images can be enhanced by using sparse prior information. It is a cutting-edge strategy addressing the low-count problem in the field of PET.

It is well recognized that the SR image reconstruction problem is poorly posed due to a lack of LR images and reconstruction limitations. The aforementioned techniques necessitate massive databases of HR and LR patch pairings, which necessitates a lot of calculations. In order to address this issue, regularization techniques are used in this paper. D_1 and D_2 are two connected dictionaries that are used in this strategy. D_1 and D_2 are trained using LR PET image data and HR image data, respectively. Both dictionaries have too many entries.

Methodology

We model the problem as follows, based on [1]. Given a low-resolution PET image Y, generate a high-resolution PET image X that exhibits the same conditions. We adopt two constraints in this work to solve this problem. First, for the sparse reconstruction, the high-resolution image X should be consistent with the low-resolution image Y:

$$\boldsymbol{Y} \square SH\,\boldsymbol{X} \qquad (1)$$

In the preceding equation, H is a sparse matrix, and S is the sampling matrix. Second, it reflects the sparsity prior. The high-resolution PET image $\boldsymbol{X}$ is segmented into a series of small patches, $\boldsymbol{x}$, that can be sparsely represented in terms ofthe D_2 dictionary as follows:

$$x \approx D_2 a \text{ for some } a \in RK \text{ with } "a"_0 \ll K \quad (2)$$

where a is the sparse representation of patch x for the input image Y. In this idea, the sparse condition (3) is used to obtain the representation of each local patch. Then, using constraint (1) as the premise of this step, the representative results are used as the basis for recovering the entire image. Therefore, there are two models in the method, a local model and a global model, Using the local model, we train two dictionaries and D_1, which represent the textures of the images and cause the low- and high-resolution PET images to have the same sparse representation. Then, according to D_1, the process of finding the sparsest representation can be depicted as follows

$$\min "a"_0 \quad \text{s.t.}$$

$$"FD_1 - Fy"^2 \le c \qquad (3)$$

where F is the feature extraction operator of the low-resolution PET image. F is equivalent to a high-pass filter because the finer elements of an image frequently include its high-frequency content. The function of F is to ensure that the a calculated in (3) is closely related to the image to be recovered, thus making the prediction more reasonable. The global model from constraint (1)

is used to guarantee the robustness of the recovered image, and it can also suppress possible artifacts that arise from the local model.

In the model, the core of the problem is finding the sparse representation of the image. The most significant stage is to obtain an appropriate, overcomplete dictionary that matches your needs (3). In this paper, we trained two related dictionaries D_1, and D_2, with given PET image patch pairs ($\{T \mid T = y_1, y_2, \cdots, y_n\}$ and $\{X \mid X = x_1, x_2, \cdots, x\}$), which can be formulated as follows:

$$D_C = \arg\min \text{"}X_C - D_C Z\text{"}^2 + \lambda \text{"}Z\text{"}_1, \qquad (4)$$

where $D_C = \{D_1, D_2\}$, $X_C = \{Y, X\}$, and the P_1 norm $\text{"}Z\text{"}_1$ is present to enforce sparsity. The parameter λ is intended to balance the sparsity of the solution.

Comparing the recommended algorithm to the regularization-based approaches previously mentioned, the suggested algorithm conducts selection well, which is part of its increased capacity to boost resolution and denoising. This study shows how limited prior knowledge can improve low-count PET reconstruction images. It is a state-of-the-art approach to the low-count issue in the field of PET.

Identifying the image's sparse representation is the main challenge with these models. Getting a proper overcomplete dictionary that fits Eq is the most crucial stage (3). In this paper, we trained the dictionaries D_1 and D_2, which are connected. The corresponding low- and high-resolution images would have about the same sparse representation thanks to these two dictionaries.

Dictionary training

Three phases make up the suggested algorithm. A collection of dictionaries LR and HR picture pairs are trained during the first stage, which is called the training stage. The second stage involves sparsely reconstructing the HR patches from their associated LR patches by choosing the optimal dictionary combination. The third stage is the iterative SR reconstruction stage, where each HR image that has been rebuilt is sent into the stage after it to improve the image quality.

A set of HR images and a set of LR images are needed for the training stage. The related HR images are down - sampled and blurred using an average filter to create the LR images. Additionally, using an interpolation process, the LR images are enlarged to have the same dimensions as the corresponding HR images. A feature extraction filter is applied to the interpolated LR pictures to extract features. Due to their efficiency and simplicity, we adopt the first- and second-order derivatives in this article as the feature for the LR patch. The dictionary learning process and sparse coding of the LR patches both use these obtained features. Finally, pairs of LR and HR patches are handled once they correspond to the same spatial locations. The K-singular value decomposition (K-SVD) approach is used to train the dictionaries to produce sparse signal representations that better fit the data.

In this part, we give examples of how the suggested SR technique works. We select a thousand of the best images for each dictionary. The original high-resolution HR photos were used to create all of the LR images used in the training or testing phases.

Figure 1. depicts the suggested SR algorithm's flowchart.

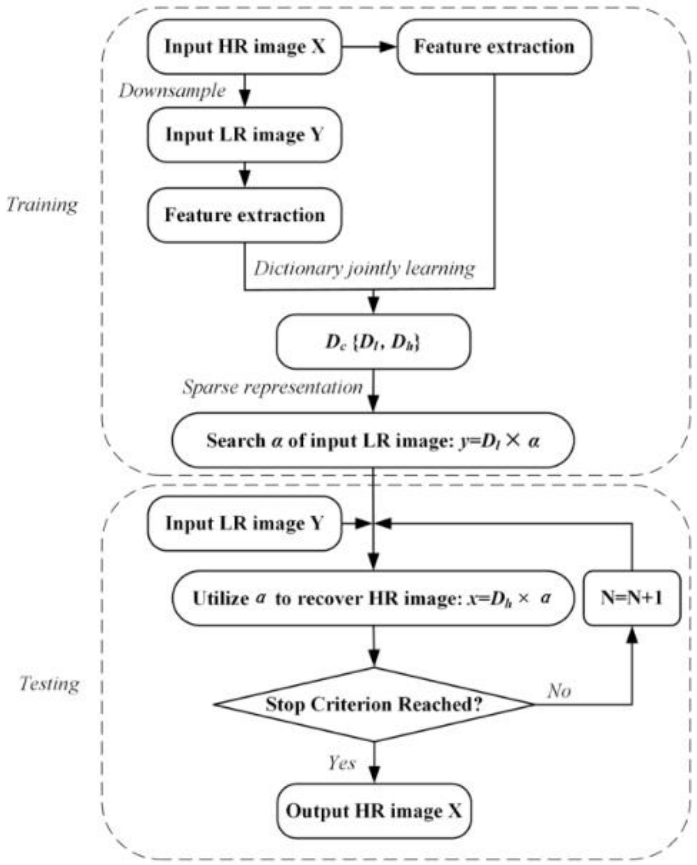


Figure 1: Proposed algorithm of two different phases in learning of the dictionaries while using the suggested methodology

Noise has been added to the test photos that have been downsampled and blurred. 100,000 patch pairings randomly selected from CT images collected from clinical hospitals were used to train two dictionaries before the LR picture was processed (Dl and Dh). To establish a balance between computation and image quality, we selected a dictionary size of 2048 atoms; this number of atoms can completely characterize the features of the photos without being very computationally taxing for our computer system.

An LR image is initially magnified using bicubic interpolation to have the same dimensions as the equivalent HR image at the SR reconstruction step, which is identical to the training stage. Applying feature extraction filters allows for the extraction of features, which are subsequently molded into vector forms. We apply a certain patch overlap with specified pixels in order to guarantee local consistency between the reconstructed patches.

We initially determine the sparse representation coefficient vector of the appropriate HR feature vector across the cluster LR dictionary using the dictionary pair of the discovered cluster. Following that, the HR patch is rebuilt by right multiplying the cluster HR dictionary by the derived sparse representation coefficient vector. By integrating the two-dimensionally reshaped and reconstructed HR patches, an HR image is finally produced.

Experimental Results

To observe the performance of the proposed method, we use an emission activity phantom a simulated data experiment as shown in Fig. 2 (a). The resolution of each image is 256×256. The low-resolution image is the result of the PET iterative reconstruction that used the maximum likely hood expectation maximization (MLEM) algorithm. The bicubic interpolation algorithm was been utilized and compared with our method. Before processing the low-resolution image, we trained two dictionaries D_1 and D_2 from 100,000 patch pairs randomly sampled from PET images collected from medical image libraries on the internet. In our experiment, we fixed the dictionary's size to 1024 to reduce the amount of time needed for training. We selected 3 x 3 pixel patches for the low-resolution PET pictures, and 9 x 9 pixel patches from high-resolution PET images for the high-resolution dictionaries. To limit the time spent for training the dictionary, we fixed its size to 1024 in our experiment. For the low-resolution PET images, we chose 3 × 3-pixel patches, while for the high-resolution dictionary, we chose 9 × 9-pixel patches from high-resolution PET images.

At the SR reconstruction stage, which is analogous to the training stage, an LR image is first enlarged using bicubic interpolation to have the same dimensions as the equivalent HR image. The extraction of features, which is then transformed into vector forms, is made possible by the application of feature extraction filters. To ensure local consistency between the reconstructed patches, we apply a certain patch overlap with predetermined pixels.

We demonstrate the effectiveness of the suggested SR approach in this section. For each dictionary, we choose 1000 photos of the highest calibre. All of the LR images used in the training or testing phase were created by simply down sampling and blurring the original high-resolution HR photographs. The down sampled and blurred test images have noise applied to them. Prior to processing the LR image, 100,000 patch pairings randomly picked from CT images gathered from clinical hospitals and phantom simulations were used to train two dictionaries (Dl and Dh). We chose a dictionary size of 2048 atoms to achieve a compromise between computation and image quality; this number of atoms can fully describe the aspects of the photos without being too computationally demanding for our computer setup.

It is well acknowledged that the lack of LR images and the restrictions on reconstruction make the SR image reconstruction challenge inadequately posed. Large databases of HR and LR patch pairs are required for the aforementioned strategies, which means a lot of calculations are needed. In this study, regularization approaches are applied to deal with this problem. This method uses two linked dictionaries called D1 and D2. Using HR image data and LR PET image data, respectively, D1 and D2 are learned. There are too many entries in both dictionaries. s.

Empirically, we chose 5 5-pixel patches with an overlap of 4 pixels between them and a sparsity regularization of = 0.4. In this study, the proposed approach was assessed using head data from *clinical CBCT and XCAT phantom simulation. To assess the output SR image quality, we employed the metrics RMSE, PSNR, and SSIM.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023

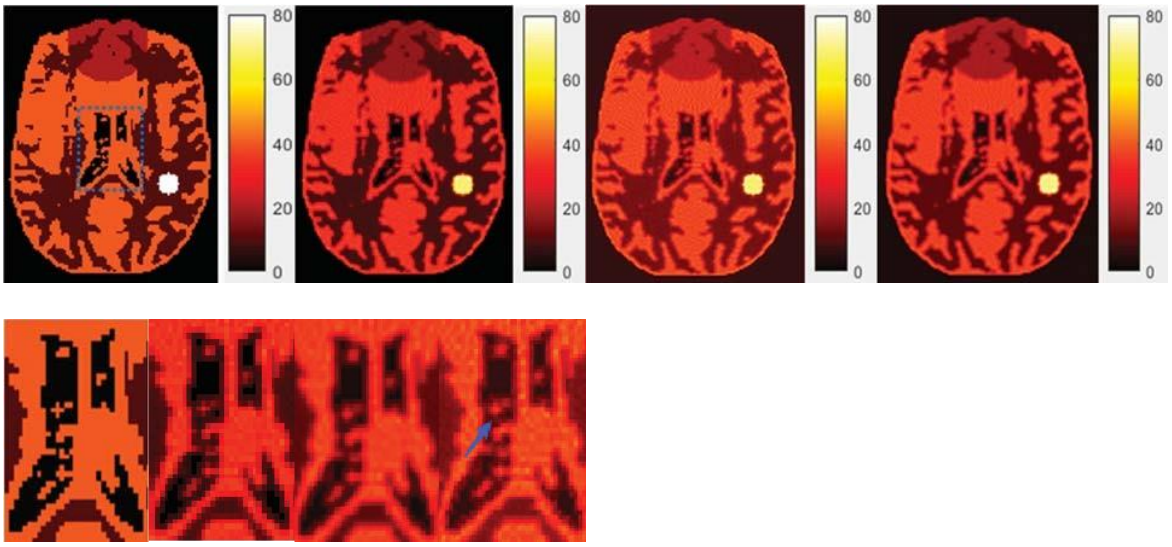


Figure 2 Results with a brain phantom. (a) Original normal-resolution image (b) the low-resolution image; (c) Output processed by bicubic interpolation; (d) Output processed by our method; (e)–(h) are the zoomed areas of (a)– (d)

In Figure 2, the low-resolution image (b) is blurry and contains artifacts, especially in the zoomed area of the image. Compared to (b), image (c), which was recovered by bicubic interpolation, has an obvious improvement. In (c), the edges have become clear and the detail of the zoomed area has been recovered. Simultaneously, the noise is reduced, but the bicubic algorithm's performance in suppressing artifacts is unsatisfactory. Although image (c) has a better quality than image (b), the edges in the zoomed area in (g) are slightly blurrier than the edges in (h). We also provide the RMSE values for the images compared to the true image (a) in Table. The proposed method achieved the lowest RMSE score.

Conclusions

A single-CT image SR reconstruction approach is suggested in this research. This SR reconstruction method is based on dictionary training with a collection of LR and HR picture patch pairs and sparse representation theory. The applied sparse domain's ability to accurately represent the target image by jointly training the LR and HR dictionaries has a significant impact on the quality of the SR reconstruction images. We create a sparse representation for each patch of LR photos and make sure that the local patches in LR and HR are similar. The HR counterpart is rebuilt using the coefficients from the LR domain. We incorporate a number of iteration methods throughout the HR image reconstruction process to enhance image quality.

Due to the poor quality of low-quality PET images, recovery work has become a hot field for researchers. The application of sparse prior information in processing the PET images seems to be a potential strategy for solving the problems caused by low-count PET image reconstruction; specifically, better image reconstruction means that PET scan times and radiation doses can be reduced. In this study, a super-resolution method was proposed for PET image

After multiple operational rounds, we observe that the quality of the reconstructed HR image has improved. The outcomes of the planned experiments show that the suggested algorithm can

increase resolution in noisy images while also producing reduced RMSE, greater PSNR, and higher SSIM values.

REFERENCES

1. Sum HY, Son J, Xu ZB, and Son G. super-resolution of an image using a gradient profile. Computer Vision and Recognition Ieee Conference 2008.
2. Yang W, Liao Q, and Zhou F. Multisurface Fitting-Based Interpolation-Based Image Super-Resolution Journal of Image Processing, IEEE An IEEE Signal Processing Society publication. 2012.
3. Robinson MD, Elad M, Milanfar P, Farsiu S strong multiframe super resolution that is quick. 2004. Ieee T Image Process.
4. In Computer Vision and Pattern Recognition, Lin, Z. & Shum, H. Y. 2001
5. DH Trinh and others New Example-Based Method for Medical Image Super-Resolution and Denoising. 2014 Ieee T Image Process.Sun J, Sun J, Xu ZB, Shum HY. Image super-resolution using gradient profile prior. Computer Image analysis And pattern Acknowledgement Ieee Conference 2008.
6. Wu XL, Dong XS, Zhang L, and Shi GM. Image Deblurring and Super-Resolution Using Adaptive Regularization and Sparse Domain Selection. 2011 Ieee T Image Process.
7. Fair-view image reconstruction with dual dictionaries: Lu Y, Zhao J, Wang G. Physics in Biology & Medicine. 2012.
8. Ji DJ, Qu GR, and Liu BD. Algebraic reconstruction method based on guided image filtering that operates simultaneously. 2016; Optics Express.
9. Freeman WT, Jones TR, Pasztor EC. Example-based super-resolution. IEEE Computer graphics and Applications. 2002.
10. Aharon M, Elad M, Bruckstein A. A method for creating overcomplete dictionaries for sparse representation is K-SVD. IEEE Transactions on Signal Processing. 2006.
11. Mendonca S, Segars WP, Sturgeon G, Grimes J, and Tsui BMW. 4D XCAT phantom for multimodality imaging research. Medical Physics. 2010.
12. Donoho DL. The minimal for the majority of large underdetermined systems of linear equations. Pure and applied mathematics communications, 2006.
13. Tibshirani, R. Regression shrinkage and selection via the lasso. Journal of the Royal Statistical Society. Series B (Methodological), 2006.
14. Yun SJ, et al. A Meta-Analysis Comparing Low- and Standard-Dose CT for the Diagnosis of Acute Appendicitis. Am J Roentgenol. 2017.
15. Cristy M. and Eckerman K. Specific absorbed fractions of energy from internal photon sources at various ages, F., ORNL Report No.. TM-8381 (Oak Ridge National Laboratory, TN, 1987)*
16. Tsui B. M. W. and Segars W. P., “Applications of computer-generated phantoms to medical imaging and dosimetry calculations,” Handbook of Anatomical Models for Radiation Dosimetry (Informa Healthcare, New York, NY, 2009).
17. Jan S. GATE: A PET and SPECT simulation toolset, et al Phys. Med. Biol. 49, 4543–4561 (2004).

18. Harrison R., Haynor D., Gillespie S., Vannoy S., Kaplan M., and Lewellen T., “A public-domain simulation system for emission tomography: photon tracking through heterogeneous attenuation using importance sampling,”1993.
19. Veress A. I., Segars W. P., Tsui B. M. W., Weiss J. A., and Gullberg G. T. "Utilizing virtual data and physiologically appropriate left ventricular finite element calculations based on both normal and abnormal NCAT visual information, Medical IEEE Trans Imaging 25(12), 1604–1616 (2006).

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 24 ISSUE 03 2023
ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

MODULATION FOR INFORMATION MEASUREMENT SYSTEM IN CONTEXT OF SOFTWARE DEVELOPMENT USING NODE BASED GRAPHICAL EDITOR

Rahim Mammadzada[1], Kamala Alieva[2]
[1]Undergraduate "İnstrument Engineering" Department, rahim.mammadzada00@gmail.com,
[2]Associate Professor, "İnstrument Engineering" Department, kamalann64@gmail.com,
[1,2]Azerbaijan State Oil and Industry University.

ABSTRACT

In this paper information measurement system (IMS) modulation integrated with a graphical node editor (GNE) is carried out for engineering applications to build software capable of both editing and simulating different scenarios. A modulation characteristic measuring and classification system for classifying a discreet signal that includes a preprocessor, stage measuring system and modulation classifier. Preprocessor detects impulse begins and finishes, determines impulse time, and changes the discreet signal into digital signals. The stage measuring system determines short chip counts, long chip counts, stage jump magnitudes, number of stage states, and polynomial coefficients for stage modulation of the discreet signal. Modulation classifier identifies modulation type on base of measurements using both rules-based and similarity-based classification methods. The lack of educational-oriented software in the IMS field leads to a more challenging learning curve resulting in a drop in student motivation. Software integrated with GNE is purposed to minimize the overwhelming feeling in students in the IMS field by simultaneously providing understandable execution order for the machine. An application consisting of GNE with the addition of custom node architecture and their interaction logic is built to conduct laboratory work using this software. Executed laboratory work result shows that having GNE integrated into the software can significantly impact visual understanding, leading to higher motivation and interest in the subject in students.
Keywords: Node, Graphical Editor, GPIOS, Information measurement system.

Introduction

Requirements such as industry standards, experience in the field, minimal operating systems, and license costs have made access to industrial-level software hard for an average person [1]. Thus, lighter software can be purposed to increase accessibility for educational purposes across the world. Lighter versions of industrial software are one of the alternatives used as a more accessible experimental tool to introduce new students to the specialization [2,3]. Despite its simplicity and experimental nature, lighter software's main benefit is its development which has no constraints on modifications or implementation of new features unlike industry applications [2]. The design of experimental software is generally more simplistic than their industrial counterparts however, they do inherit functionality from them in a modified manner which can have a varying impact depending on implementation [2,3]. Also, it is important to note that all software started as experimental at one point and if they met certain demands with time, they became standard used in their respective industry.

Industrial software is developed to satisfy the needs of an industry which is essential in the work environment [1]. However, in an educational environment, most stuff can be minimized to general

sketches of each object rather than each small detail [3,4]. A widely used approach for this representation is known as a functional block diagram which shows sketched ideas of what each block represents [4]. Conveniently engineering applications, including IMS are already represented in this way. This form of representation consists of blocks that contain GPIOS built into them with chain execution order starting from input nodes and ending at output nodes. A commonly used modular approach for implementing this is known as a node graph editor (NGE). This is a graphical interface widely implemented inside the software to minimize visual representation and at the same time provide more settings with settings and tabs. The benefit of NGE is its modular design pattern which allows the creation of a node pattern once and then creating more nodes by only changing with computation equation, relinking references, and tweaking GPIOS settings. To experiment with scenarios light software integrated with NGE was designed, after that scenario was built inside the application using node editor, simulated on run time and results noted.

Node Based Software

For visual representation one of the most spread ways is known as functional block diagrams. Functional block diagrams show each block by its name as an abstraction of a complex object. Fig.1 represent general-purpose node architecture for handling various simulation in different fields, including IMS [5,6].

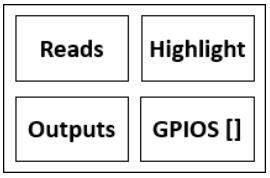


Figure 1: General purpose node architecture

In Figure 1, Reads represents a filter that only allows the correct entry type to connect with the node. Output is the node computation result. The highlight is an outline around the node to indicate selection or issues. GPIOS is responsible for keeping track of all node junctions.

Node GPIOS Architecture

GPIOS is a term that stands for general purpose input output system. This term is used everywhere from electronic engineering to medicine describing entries and results of certain actions or computations. In software development, it is also used to describe how a user will interact with the software. Apart from this interaction in the modular approach, it is also used to describe how different modules interact with each other [2,7].

Figure 2 shows an example of how two nodes connect. Here we can see first node's connection point CP at Id1 is connected to the second nodes CP at Id1. Only the first node CP has a line render LR instance with AP located on LR's point references. The second node only references the first Node's LR. Both of these Nodes reference each other and Both of these CP reference Id of other [2,4,7].

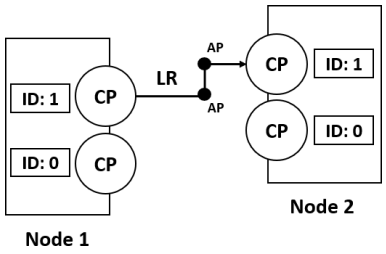


Figure 2: Node GPIOS architecture

Node GPIOS Array

Architecture must be scaled for nodes containing more than one GPIOS port. To do this first two things must be considered.

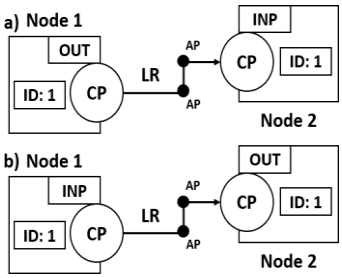


Figure 3: Node I/O perspective with respect to: a) Node object b) Line renderer

Figure 3 represents two ways of thinking about node entry and result points. In a) node is taken as the point of reference where the output of one node is the other node's input. In b) connection line is taken as the point of reference where the lines start is input and end is output. Both of these ways can be considered correct; however, this application will utilize the approach shown in Figure 3a [2,6,7].

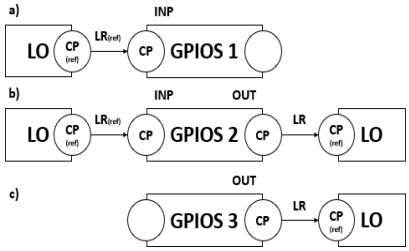


Figure 4: GPIOS Cases a) only transmission b) both receiving and transmitting c) only receiving

Node interaction by design maybe is one-sided or two-sided. Figure 4 illustrates all GPIOS use scenarios a) for nodes that only provide initial variables and launch execution chain b) used in two-sided nodes c) is for output nodes that only receive variables and mark end of each execution chain [4,5,7].

The final issue we need to address is when referencing the selected node's information CP will not remember at what index it has been connected. To solve this, we can add an integer field to store Id.

Graphical Editor

Apart from node architecture, software requires a component that will perform actions made with node interaction. Figure 5 contains the architecture of all required arguments for graphical editor operations [2, 5, 8].

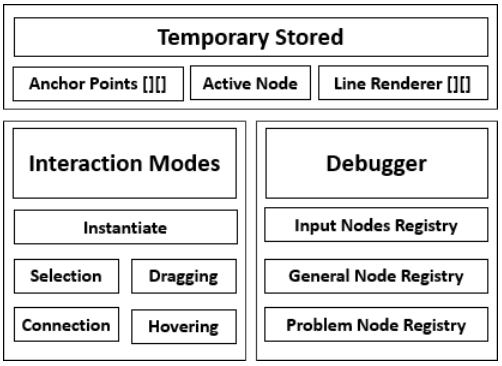


Figure 5: Node Graph Editor Architecture

From the architecture provided above, we can see in node graph editor variables can be divided into flowing categories:

- Temporary variables that change each time node is selected.
- The debugger stores reference to nodes for separate input type nodes, all nodes, and problemed nodes.
- Interaction mode variables are by default referenced elements that get activated when the corresponding interaction mode is triggered.

User Interaction Functions

User interaction can be divided into two main sections graphical editor and quick menu. What function's both of these have been represented in Figure 6 [2,7,8].

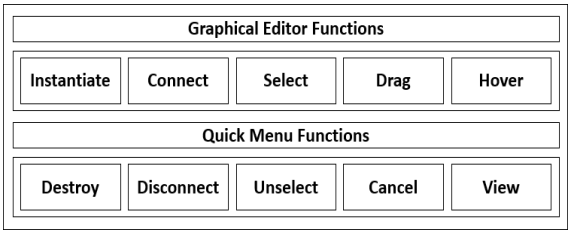


Figure 6: Graphical Editor Functions

When it comes to the execution of quick menu functions, we can show generalized logic for all of them in Figure 7 [2,7].

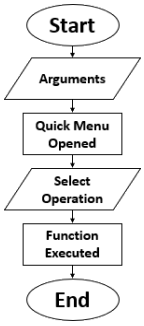


Figure 7: Quick menu function execution

Graphical Editor Functions

The main difference between the graphical editor and quick menu functions is that the editor's functions run on an update for each frame application that is active.

This results in a need for a modified approach which will divide function execution into two stages as it is represented in Figure 8.

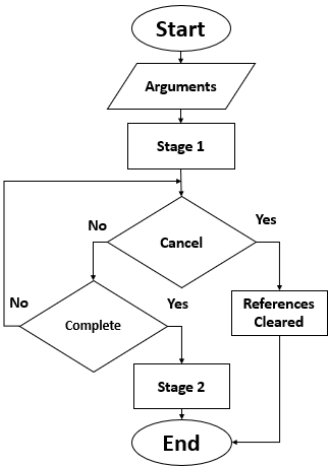


Figure 8: Graphical editor function execution

The logic provided in Figure 8 starts when the designated key is pressed. Afterward, required arguments are taken from the selected node. The first stage activates the function and it starts its execution. During execution two conditions are checked for cancelation of the action and completion of the action. Stage two is finishing the function by applying changes to involved node architectures [2,7,8].

Simulation

In Figure 9 image taken from the purposed software is displayed. This image represents a generalized IMS setup. Where INP node represents float variable representing physical parameter value. TDC is a transducer that simulates the measurement process of this variable and then passes its results to OP: AMP to amplify the signal. OP: AMP passes it to ADC which converts it

into 1 and 0's. Finally, ADC output and a value set in constant CON node are compared inside condition node CDN which decides to activate either display DP or shutdown SD [2,3].

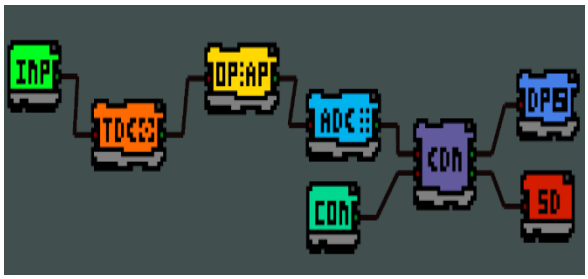


Figure 9: Example Made in proposed software

After editor configuring is done run time can be triggered. For run-time simulation execution order given in table 1 and the computational logic behind each node must be known.
Figure 10 represents and Table 1 shows that the execution order was linearly passed until it got into condition node CDN which has requirements of two inputs. Since the first execution chain provides only one of the required inputs, in this case, CDN was incremented and the first chain's execution was terminated.

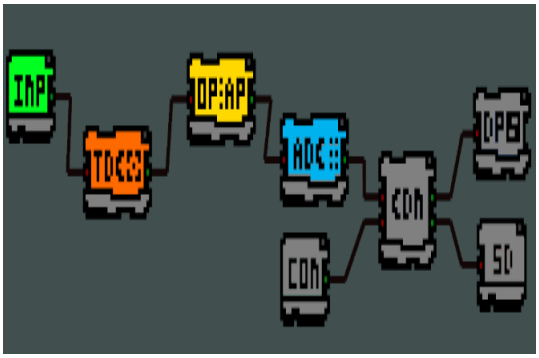


Figure 10: Chain 1 Highlighted

Table 1. Chain 1 Execution Order.

Node	Execution Type
INP	Linearly passed
TDC	Linearly passed
OP: AMP	Linearly passed
ADC	Linearly passed
CDN	Incremented

Figure 11 represents and Table 2 shows the execution of the second chain. The second chain starts from constant node CON which represents constant value during the simulation process. After the chain starts CON passes its value to CDN. At this point, CDN receives both of its required inputs and performs chosen operations to determine which node will be executed at the end.

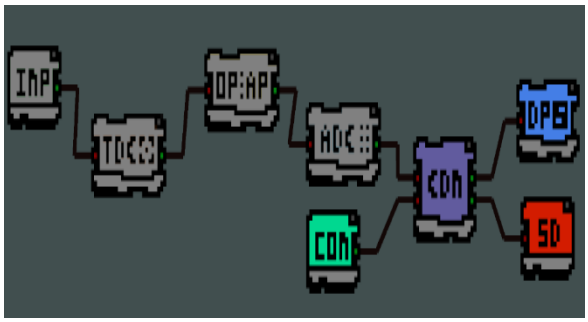


Figure 11. Chain 2 Highlighted.

Table 2. Chain 2 Execution Order.

Node	Execution Type
CON	Linearly passed
CDN	Triggered
DP or SD	Condition Based

Once the execution order is determined, we can start the simulation and note down the results in Table 3. To ensure there were no mistakes results are compared with the results produced by the equations. Firstly, we know RTD Pt100 has a measuring range between (-200 to 850) as it is provided in the article by Texas instrumentation [9]. We can calculate the resulting mA Hart communication value by the following equation:

$$It(mA) = \frac{(Tc - Tmin)}{(Tmax - Tmin)} * 16 + 4 \quad (1)$$

This results in 7.2 mA in Hart communication TDC reading. But we need a voltage reading for this we convert the Hart signal in lowered scale:

$$Is = \frac{It}{4} \quad (2)$$

Table 3. Simulation Results of Each Node.

Input	Node	Output
Chain 1 Start	INP	62.5°
62.5°	TDC	0.45V
0.45V	OP: AMP	2V
2V	ADC	001100110011
Chain 2 Start	CON	200°
ADC; CON;	CDN	62.5° > 200°
CDN False	DP	Print
CDN True	SP	Interrupt

The result of this equation is 1.8 mA which we can run through a 250 Ohm resistor to get the voltage value:

$$Vt = Is\ 250 \quad (3)$$

From this equation, we get 0.45V which has offset due to the Hart protocol starting from 4mA instead of 0mA. The reason for this in Hart protocol is to be able to tell difference between fault and zero signal. To fix this we need to account for the offset current of 4mA:

$$Vt = Vt - \frac{Io}{4} * 250 \quad (4)$$

From this subtraction, we will get 0.2V. However, this signal even at its maximum reading of 1.25V is not enough [10]. We need to amplify this signal with an OP: AMP. The gain required here needs to satisfy 10V peek voltage value of ADC input. For gain, we can simply use OP: AMP's equation:

$$Av = \frac{R2+R1}{R1} \quad (5)$$

This is the equation for none inverting OP: AMP input and to achieve our goal we must use a ration of ADC required 10V with a range of our TDC output 1V. This is a 9:1 ratio between the feedback resistor and the input resistor. Thus OP: AMP's output will be scaled ten times [10]:

$$Va = Vt * 10 \quad (6)$$

This will give us 2V. Lastly, we need to calculate 2V reading in Binary representation to do this first we will need to find the bit depth of ADC. Since we know we are using 12 Bit ADC with 10V peek in this case Step is:

$$Step = \frac{Vcc}{4096-1} \quad (7)$$

From this, we get a step of 2.442 mV. Now we can calculate the bit number by:

$$\text{Bit number} = \frac{Va}{2.442} \quad (8)$$

This equation will give us 819.2 which in binary is represented as 1100110011.

Conclusions

Graphical node editor-integrated software for IMS applications has been purposed in this paper. An example circuit was built with the node editor and simulated on run time. The execution order went as predicted and was noted for both chains. Results for each node's output were also noted and the same results were calculated on paper. A comparison between both results showed no mistakes during the simulation.

REFERENCES

1. R. Patel, P. Breton, C. M. Baker, Y. N. El-Glaly, and K. Shinohara, "Why software is not accessible: Technology Professionals' Perspectives and challenges," Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems, 2020.
2. J. Melegati, X. Wang, and P. Abrahamsson, "Hypotheses engineering: First essential steps of experiment-driven software development," 2019 IEEE/ACM Joint 4th International Workshop on Rapid Continuous Software Engineering and 1st International Workshop on Data-Driven Decisions, Experimentation and Evolution (RCoSE/DDrEE), 2019.
3. L. Fathauer and D. M. Rao, "Accessibility in an educational software system: Experiences and design tips," 2019 IEEE Frontiers in Education Conference (FIE), 2019.

4. A. Fernández-Fontecha, K. L. O'Halloran, S. Tan, and P. Wignell, "A multimodal approach to visual thinking: The scientific sketchnote," Visual Communication, vol. 18, no. 1, pp. 5–29, 2018.
5. M. Viggiato, J. Oliveira, E. Figueiredo, P. Jamshidi, and C. Kastner, "Understanding similarities and differences in software development practices across domains," 2019 ACM/IEEE 14th International Conference on Global Software Engineering (ICGSE), 2019.
6. E.-M. Arvanitou, A. Ampatzoglou, A. Chatzigeorgiou, and J. C. Carver, "Software engineering practices for scientific software development: A systematic mapping study," Journal of Systems and Software, vol. 172, p. 110848, 2021.
7. A. Baabad, H. B. Zulzalil, S. Hassan, and S. B. Baharom, "Software architecture degradation in open source software: A Systematic Literature Review," IEEE Access, vol. 8, pp. 173681–173709, 2020.
8. A. Oulasvirta, N. R. Dayama, M. Shiripour, M. John, and A. Karrenbauer, "Combinatorial optimization of Graphical User Interface Designs," Proceedings of the IEEE, vol. 108, no. 3, pp. 434–464, 2020.
9. Texas Instruments (2018). "A Basic Guide to RTD Measurements". https://www.ti.com /lit/an/sbaa275/sbaa275.pdf
10. Texas Instruments (2016). "Understanding Basic Analog – Ideal Op Amps". https://www.ti.com/lit/an/slaa068b/slaa068b.pdf?ts=1666186520172

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES

ISSN: 2613-5817; E-ISSN: 2613-5825

VOLUME 23 ISSUE 02 2023

EDITORIAL BOARD & INTERNATIONAL ADVISORY

Bahrain

Bangladesh

Bosna & Hercegovina

Brazil

Bulgaria

Director of first English school named "Nino". Doctor of Economical Sciences. Full Professor.
Larisa Korghanashvili
Tbilisi State University (TSU) named Ivane Javakhishvili. Full Professor
Larisa Takalandze
Sokhumi State University, Faculty of Business and Social Sciences. Doctor of Economic Sciences. Professor.
Lia Davitadze
Batumi Shota Rustaveli State University. Higher Education Teaching Professional. PhD in Educational Sciences.
Lia Eliava
Kutaisi University.Economic expert in the sphere of economy and current events in financial sector.Full Professor.
PhD in Business Administration.
Lia Matchavariani
Ivane Javakhishvili Tbilisi State University (TSU). Head of Soil Geography Chair, Faculty of Exact & Natural Sciences (Geography Dep.), Full Professor.
Loid Karchava
Doctor of Business Administration, Association Professor at the Caucasus International University, Editor-in-Chief of the international Scientific Journal "Akhali Ekonomisti" (The New Economist)
Maia Matoshvili
Tbilisi State Medical University. The First University Clinic. Dermato-Venereologist. Assistant Professor. PhD in DAPS.
Mariam Darbaidze
Davit Aghmashenebeli National Defense Academy of Georgia. The Head of Education Division. PhD in Biology.
Mariam Kharaishvili
Sulkhan-Saba Orbeliani University, School of Medicine, Associated Professor, PhD in Medicine, MD.
Mariam Nanitashvili
Executive Director - Wise Development LTD (Training Centre). Associated Professor at Caucasus University. PhD in Economics
Nana Shoniya
State University of Kutaisi named Akakhi Tsereteli. Doctor of Economical Sciences. Full professor
Natia Beridze
LEPL National Environmental Agency of Georgia, Invited Expert at International Relations and PR Division. PhD in Political Science.
Natia Shengelia
Georgian Technical University, Business Technology Faculty, Associate Professor.
Nelli Sichinava
Akaki Tsereteli State Universiry . Associate. Professor. PhD
Nino Didbaridze
Microbiology and Immunology Department. Immunologi Direction. Tbilisi State Medical University. PhD MD.
Nino Gogokhia
Tbilisi State Medical University. Head of Laboratory the First University Clinic. Professor.
Nino Museridze
GGRC Georgian-German Center for Reproductive Medicine, Owner and Clinical Director. The Doctor of Medicine, Full Professor.
Nino Pirtskhelani
Tbilisi State Medical University, Department of Molecular and Medical Genetics, Associated Professor. Alte University, Ken Walker International University, Professor.
Paata Koguashvili
Georgian Technical University. Doctor of Economical Sciences. Full Professor. Academician. Member of Georgia Academy of Sciences of Agriculture.
Rati Abuladze
St. Andrew the first-called Georgian University of the Patriarchate of Georgia. Faculty of Economics and Eusiness Edministration. Manager of the Faculty Quality Assurance Office. PhD in Business Administration.
Rusudan Kutateladze
Georgian Technical University. Doctor of Economical Sciences. Full Professor
Rusudan Sujashvili
School of Medicine, New Vision University, Ivane Beritashvili Center of Experimental Biomedicine, Professor, Doctor of Biology.
Tamar Didbaridze
Tbilisi State Medical University, Microbiology Department, Associate Professor First University Clinic. PhD in MD.
Tamar Giorgadze
Tbilisi State Medical University. Department of Histology, Cytology and Embryology. Assistant Professor.
Tamila Arnania-Kepuladze
Akaki Tsereteli State University. Department of Economics. Professor.
Timuri Babunashvili
Georgian Business Academy of Science. Doctor of Economical Sciences. Full Professor.
Vladimer Papava
Tbilisi State Medical University. Assistant-Professor. PhD. MD.
Zurab Khonelidze
Sokhumi State University. Doctor of Political Sciences. Professor.

Germany

Alexander Dilger
University of Münster. Professor of Business Economics. PhD in Economy.

Alessandra Clementi
Nazarbayev University School of Medicine. MD, GP. Assistant Professor of Medical Practice and Family Medicine
Anar Mirzagalieva
Astana Internationl University. Vice-President. PhD in Biology.
Anna Troeglazova
East Kazakhstan State University named Sarsen Amanjolov. PhD
Gulmira Zhurabekova
Marat Ospanov West-Kazakhstan State Medical Academy. Department of Human Anatomy. Associate Professor
Nuriya Kharissova
Karaganda Medical University. Associate Professor of Biological Science.
Nikolay Kurguzov
State University of Pavlodar named S. Toraygirova. PhD. Professor.
Zhanargul Smailova
Head of the Department of Biochemistry and Chemical Disciplines named after MD, professor S.O. Tapbergenova NAC Medical University of city Semey.
Zhanslu Sarkulova
West Kazakhstan Marat Ospanov Medical University, Doctor of Medical Sciences, Professor, Department of Anesthesiology and Reanimatology.

Libya

Salaheddin Sharif
University of Benghazi, Libyan Football Federation- Benghazi PhD in Medicine (MD)

Latvia

Tatjana Tambovceva
Riga Technical University. Faculty of Engineering Economics and Management, Professor.

Lithuania

Agne Simelyte
Vilnius Gediminas Technical University, Associate professor. Phd in Social Sciences (Management)
Ieva Meidute – Kavaliauskiene
Vilnius Gediminas Technical University. Doctor of Technological Sciences. Head of Business Technologies and Entrepreneurship Department, Faculty of Business Management.
Vilma (Kovertaite) Musankoviene
e-Learning Technology Centre. Kaunas University of Technology. PHD
Laura Uturyte
Vilnius Gediminas Technical University (VGTU). Head of Project Manager at PI Gintarine Akademy. PhD in Economy.
Loreta (Gedminaitė) Ulvydiene
Professor of Intercultural Communication and Studies of Translation. Vilnius University. PHD
Zhaneta Simanavichienė
Mykolas Romeris University, Head of the Sustainable Innovation Laboratory, Public Security Academy, professor. Honorary Consul of the Republic of Estonia in Lithuania

Macedonia

Liza Alili Sulejmani
International Balkan University. Head of Banking and Finance department. Assistant Professor. PhD of Economics.
Learta Alili Ademi
Pediatrician in University, Clinic for pediatric diseases, department of neurology.

Malaysia

Anwarul Islam
The Millennium University. Department of Business Administration. Associate Professor.
Kamal Uddin
Millennium University, Department of Business Administration. Associate Professor. PhD in Business Administration.

Morocco

Mohammed Amine Balambo
Ibn Tufail University, Aix-Marseille University. Free lance. Consultant and Trainer. PhD in Philosophy. Management Sciences, Specialty Strategy and Logistics.

AIMS AND SCOPE

ICRET MTÜ The Baltic Scientific Journals publishes peer-reviewed, original research and review articles in an open access format. Accepted articles span the full extent of the social and behavioral sciences and the humanities.

ICRET MTÜ The Baltic Scientific Journals seeks to be the world's premier open access outlet for academic research. As such, unlike traditional journals, ICRET MTÜ The Baltic Scientific Journals does not limit content due to page budgets or thematic significance. Rather, ICRET MTÜ The Baltic Scientific Journals evaluates the scientific and research methods of each article for validity and accepts articles solely on the basis of the research. Likewise, by not restricting papers to a narrow discipline, ICRET MTÜ The Baltic Scientific Journals facilitates the discovery of the connections between papers, whether within or between disciplines.

ICRET MTÜ The Baltic Scientific Journals offers authors quick review and decision times; a continuous-publication format; and global distribution for their research via ICRET MTÜ The Baltic Scientific Journals Online. All articles are professionally copyedited and typeset to ensure quality.

Those who should submit to ICRET MTÜ The Baltic Scientific Journals include:

- Authors who want their articles to receive quality reviews and efficient production, ensuring the quickest publication time.
- Authors who want their articles to receive free, broad, and global distribution on a powerful, highly discoverable publishing platform.
- Authors who want their articles branded and marketed by a world-leading social science publisher.
- Authors who want or need their articles to be open access because of university or government mandates.

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 23 ISSUE 02 2023

TOPICS OF JOURNAL

AGRICULTURAL, ENVIRONMENTAL & NATURAL SCIENCES

Agriculture, Agronomy & Forestry Sciences
History of Agricultural Sciences
Plant Breeding and Seed Production
Environmental Engineering Science
Earth Sciences & Organic Farming
Environmental Technology
Botany, Zoology & Biology

SOCIAL, PEDAGOGY SCIENCES & HUMANITIES

Historical Sciences and Humanities
Psychology and Sociology Sciences
Philosophy and Philology Sciences
History of Science and Technology
Social Science
Pedagogy Science
Politology
Geography
Linguistics

MEDICINE AND BIOLOGY SCIENCES

Clinical Medicine
Prophylactic Medicine
Theoretical Medicine
Stomatology & Dentistry
Innovations in Medicine
Biophysics and Biochemistry
Radiology and Microbiology
Molecular Biology and Genetics
Botany and Virology
Microbiology and Hydrobiology
Physiology of Plants, Animals and Humans
Ecology, Immunology and Biotechnology
Virology and Immunology
History of Biology
Entomology

COMPUTING AND APPLIED SCIENCES

History of Science and Technics
Information, Computing and Automation
Innovative Technologies
Mathematics & Applied Mathematics

ECONOMIC, MANAGEMENT & MARKETING SCIENCES

Economics and Management of Enterprises
Economy and Management of a National Economy
Mathematical Methods, Models and Information Technologies in Economics

Accounting, Analysis and Auditing
Money, Finance and Credit
Demography, Labor Economics
Management and Marketing
Economic Science

LEGAL, LEGISLATION AND POLITICAL SCIENCE

Theory and History of State and Law
International Law
Branches of Law
Judicial System and Philosophy of Law
Theory and History of Political Science
Political Institutions and Processes
Political Culture and Ideology
Political Problems of International Systems and Global Development

NGO International Center for Research, Education & Training (Estonia, Tallinn) is publishing scientific papers of scientists on Website and in Referred Journals with subjects which are mentioned below:

ISSN: 2613-5817; E-ISSN: 2613-5825; UDC: 0 (0.034);
DOI PREFIX: 10.36962/PIRETC
Proceeding of The International Research Education & Training Center.
https://bsj.fisdd.org/index.php/piretc

ISSN: 2674-4562, E-ISSN: 2674-4597, UDC: 620.9 (051) (0.034);
DOI PREFIX: 10.36962/ENECO
Proceedings of Energy Economic Research Center. ENECO
https://bsj.fisdd.org/index.php/eneco-peerc

ISSN: 1609-1620, E-ISSN: 2674-5224; UDC: 62 (051) (0.034);
DOI PREFIX: 10.36962/PAHTEI
Proceedings of Azerbaijan High Technical Educational Institutions. PAHTEI
https://bsj.fisdd.org/index.php/pahtei

ISSN: 2663-8770, E-ISSN: 2733-2055; UDC: 672, 673, 67.01-67.02
DOI PREFIX: 10.36962/ETM
ETM Equipment, Technologies, Materials
https://bsj.fisdd.org/index.php/etm

ISSN: 2733-2713; E-ISSN: 2733-2721; UDC: 33
DOI PREFIX: 10.36962/SWD
SOCIO WORLD-SOCIAL RESEARCH & BEHAVIORAL SCIENCES
https://bsj.fisdd.org/index.php/swd

E-ISSN: 2587-4713; UDC: 620.9 (051) (0.034)
DOI PREFIX: 10.36962 / ECS
Economics
https://scia.website/index.php/ecs

Society of Azerbaijanis living in Georgia. NGO. (Georgia, Tbilisi) is publishing scientific papers of scientists on Website and in Referred Journals with subjects which are mentioned below:

ISSN: 2346-8068; E-ISSN: 2346-8181; UDC: 611-618
DOI PREFIX: 10.36962/ALISJMSC
Ambiance in Life-International Scientific Journal in Medicine of Southern Caucasus.
http://scsj.fisdd.org/index.php/ail

Representation of the International Diaspora Center of Azerbaijan in Georgia. NGO (Georgia Tbilisi) is publishing scientific papers of scientists on Website and in Referred Journals with subjects which are mentioned below:

ISSN: 2298-0946, E-ISSN: 1987-6114; UDC: 3/k-144
DOI PREFIX: 10.36962/CESAJSC
The Caucasus-Economic and Social Analysis Journal of Southern Caucasus
http://scsj.fisdd.org/index.php/CESAJSC

ISSN: 2613-5817; E-ISSN: 2613-5825
PIRETC
JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 23 ISSUE 02 2023

Title of the Paper (14 point, Bold, Times New Roman)

First Author's Name[1], Second Author's Name[2] , Third Author's Name[3], ...
[1] [Author affiliations – position, department, institute, city, state, country, email ID, ORCID ID]
[2] [Author affiliations – position, department, institute, city, state, country, email ID, ORCID ID]
[3] [Author affiliations – position, department, institute, city, state, country, email ID, ORCID ID]
Corresponding author's email:
(Affiliation1,2,3 Times New Roman, 10)

Article Type: Refer to the section policy of journal for acceptable article types.

ABSTRACT
(Times New Roman, 12)
The manuscript should contain an abstract within 300 words. The manuscript should have a self-contained, citation-free abstract and state briefly the purpose of the research, methodology, key results and major conclusions. Abstract should be in a single paragraph with running sentences. Do not use any subheading or point list within the abstract. Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.
Keywords: Authors are advised to writes **3-5 keywords** related to the article, separated by comma. These keywords will be used for indexing purpose.

SUMMARY (OPTIONAL) (Times New Roman, 12 Bold)

[This section of the manuscript is optional. It is up to the author(s) to decide whether to include this section in the manuscript.]

["Summary" of your work is a short description of the work being presented in your article. It is longer than the "Abstract" which is limited to 250 words for all types of articles. After reading the "Summary" a reader should be able to understand the background information, why the work is being reported, what the significant results are, and what may be the explanation for the results.]

[Although writing an additional section in the form of "Summary" of your work may seem like and extra burden on your time and resources, it will be an important part of your manuscript especially for articles which are highly technical. Many times readers who are students, or who are not expert on the subject of the article or readers who are experts but in related subjects may skip reading an article if on first look the article appears to be very technical with lot of data, facts and statistics. Some other articles may not be easy to understand, on first reading, even by experts in the subject of the article. The "Summary" section will help the readers in understanding the results of your study.]

- The recommended word limit for "Summary" for Review Article is – 800 words (2 pages)
- When writing the "Summary" use as simple and as non-technical language as possible. Write the "Summary" as if you are explaining your study to a first year graduate student.
- Do not repeat or copy text verbatim from the main text of your manuscript. "Summary" will probably be the most important and most widely read part of your manuscript. Write it fresh as a separate section.

- In the "Summary" give: 1) relevant background information, 2) why the work was done, 3) what were the significant results, 4) possible explanation of the results.
- Only give the significant results of your study and give their possible explanation.
- Do not compare your results with other studies.
- Do not give references in the "Summary" section. First reference should start in main text of your manuscript from the "Introduction" section.

Introduction (Times New Roman, 12)

Mostly Papers starts with introduction. It contains the brief idea of work, requirement for this research work, problem statement, and Authors contribution towards their research. Sufficient recent reference citation [1] from last 2 years should be included for showing the existing challenges and importance of current work. This section should be succinct, with no subheadings unless unavoidable [2, 3]. State the objectives of the work and provide an adequate background related to your work, avoiding a detailed literature survey or a summary of the results.

Research Methodology (Times New Roman, 12)

This part should contain sufficient detail to reproduce reported data. It can be divided into subsections if several methods are described. Methods already published should be indicated by a reference [4], only relevant modifications should be described. Methodology should be written concisely in detail by maintaining continuity of the texts.

Theory and Calculation (Times New Roman, 12)

A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis. Do not add extensive basic definitions or well-known theories, instead highlight theoretical background and its specific usages in view of your work only.

Mathematical Expressions and Symbols (Times New Roman, 12)

Mathematical expressions and symbols should be inserted using **equation tool** of Microsoft word. References may be added for used equations to support its authenticity, e.g. this result has been analysed using Fourier series [5].

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right) \qquad (1)$$

Results and Discussion (Times New Roman, 12)

This section may each be divided by subheadings or may be combined. A combined Results and Discussion section is often appropriate. This should explore the significance of the results of the work, don't repeat them. Avoid extensive citations and discussion of published literature only, instead discuss recent literature for comparing your work to highlight novelty of the work in view of recent development and challenges in the field.

Preparation of Figures and Tables (Times New Roman, 12)

Authors are supposed to embed all figures and tables at appropriate place within manuscript. Figures and tables should neither be submitted in separate files nor add at the end of manuscript. Figures and Tables should be numbered properly with descriptive title. Each Figure/Table must be explained within the text by referring to corresponding figure/table number. Any unexplained or unnumbered Figure/Table may cause rejection of the paper without being reviewed.

Formatting Tables (Times New Roman, 12)

Table should be prepare using table tool within the Microsoft word and cited consecutively in the text. Every table must have a descriptive title and if numerical measurements are given, the units should be included in the column heading. Formatting requirement has been summarized in the Table 1.

Table 1: Summary of formatting requirement for submitting paper in this journal. (Times New Roman, 12)

Layout	**Size**	**Margin (Normal)**	Header	Footer	
Single column	A4 (8.27" X 11.69")	Top=1" Bottom=1" Left=1" Right=1"	Do not add anything in the header	So not add anything in the footer	
Font	**Article Title**	**Headings**	**Subheadings**	**Reference list**	**Text**
	Times New Roman, 16 pt, Bold, centred	Times New Roman, 11 pt, Bold, Left aligned	Times New Roman, 10 pt, Bold, Left aligned	Times New Roman, 8 pt, Justified	Garamond, 11 pt, Justified
Line Spacing	1.15	1.15	1.15	1.15	1.15
Page number	We will format and assign page numbers				

(Times New Roman, 10)

Formatting Figures (Times New Roman, 12)

All figures should be cited in the paper in a consecutive order, author may be asked to provide separate files of the figure. Figures should be used in bitmap formats (TIFF, GIF, JPEG, etc.) with 300 dpi resolution at least unless the resolution is intentionally set to a lower level for scientific reasons. If a bitmap image has labels, the image and labels should be embedded in separate layer. Figure 1 shows the logo of AIJR Publisher.

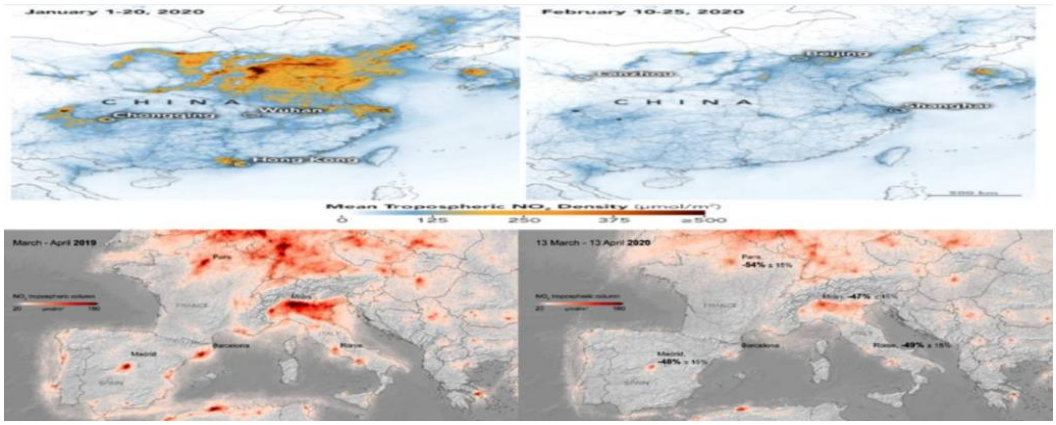


Figure 1: Logo of the AIJR Publisher (Times New Roman, 12)

Conclusions (Times New Roman, 12)
Each manuscript should contain a conclusion section within 250-450 words which may contain the major outcome of the work, highlighting its importance, limitation, relevance, application and recommendation. Conclusion should be written in continuous manner with running sentences which normally includes main outcome of the research work, its application, limitation and recommendation. Do not use any subheading, citation, references to other part of the manuscript, or point list within the conclusion.

Declarations (Times New Roman, 12)

Study Limitations (Times New Roman, 12)
Provide all possible limitation faced in the study which might significantly affect research outcome, If not applicable write, none.

Acknowledgements (Times New Roman, 12)
All acknowledgments (if any) should be included in a separate section before the references and may include list of peoples who contributed to the work in the manuscript but not listed in the author list.

Funding source (Times New Roman, 12)
Provide funding source, supporting grants with grant number. The name of funding agencies should be written in full, if no funding source exist, write, none.

Competing Interests (Times New Roman, 12)
Declare any potential conflict of interest exist in this publication.

Human and Animal Related Study (Times New Roman, 12)
If the work involves the use of human/animal subjects, each manuscript should contain the following subheadings under the declarations section-

Ethical Approval (Times New Roman, 12)
Provide ethical approval authority name with the reference number. If ethical approval is not required, provide an ethical exemption letter of not required. The author should send scan copy (in pdf) of the ethical approval/exemption letter obtained from IRB/ethical committee or institutional head.

Informed Consent (Times New Roman, 12)
Write a statement of informed consent taken from the participants to publish this research work. The editor may ask to upload scan copy if required.

References (Times New Roman, 12)
Author(s) are responsible for ensuring that the information in each reference is complete and accurate. **Do not use grey literature (unauthentic website, news portal, social media, Wikipedia etc) as reference, only scholarly literature (Journal, online books, proceedings, patents, authentic websites with permanent archival policy) are acceptable references.** Author should include sufficient recent (last 2 years) references in the article. All references must be numbered consecutively and citations of references in the text should be identified using numbers in square brackets (e.g., "as explained by AIJR [1]"; "as discussed in many reports [2]-[6]"). All references should be cited within the text correctly; do not add only list of references without citation within the text. All cited references should be listed after declarations section in the following style-

1. W. S. Author, "Title of paper," Name of Journal in italic, vol. x, no. x, pp. xxx-xxx, Abbrev. Month, year. https://doi.org/10.21467/ajgr
2. Bahishti, "Peer Review; Critical Process of a Scholarly Publication", J. Mod. Mater., vol. 2, no. 1, pp. 1.1-1.2, Oct. 2016. https://doi.org/10.21467/jmm.2.1.1.1-1.2
3. Bahishti, "A New Multidisciplinary Journal; International Annals of Science", Int. Ann. Sci., vol. 1, no. 1, pp. 1.1-1.2, Feb. 2017. https://journals.aijr.in/index.php/ias/article/view/163
4. W. S. Author, "Title of paper," Name of Journal in italic, vol. x, no. x, pp. xxx-xxx, Abbrev. Month, year. Access online on 20 March 2018 at https://www.aijr.in/journal-list/advanced-journal-graduate-research/
5. W. S. Author, "Title of paper," Name of Journal in italic, vol. x, no. x, pp. xxx-xxx, Abbrev. Month, year. Access online on 5 March 2018 at https://www.aijr.in/about/publication-ethics/
6. M. Ahmad, "Importance of Modeling and Simulation of Materials in Research", J. Mod. Sim. Mater., vol. 1, no. 1, pp. 1-2, Jan. 2018. DOI: https://doi.org/10.21467/jmsm.1.1.1-2

Main features of citation style are given as-

- The author name format is, "first name (Initial), middle name (Initial) and last name". This differs from other styles where author's last name is first.
- The title of an article (or chapter, conference paper, patent, etc.) is in quotation marks.
- The title of the book or journal is in italics.
- Online link of the original paper. If any reference is not available online, it should be modified with available online reference

Complete Detail of Each Author
Provide complete detail of each author in the following format as well as add each author with complete detail during online submission (step 3) in the same order as appears in the manuscript.

First Author's Full Name: (Times New Roman, 12)
Highest Qualification:
Department:
Post/Rank (If a student, provide course name and course year):
Affiliation (College/University/Institute) with postal address:
email id:
ORCID:
Mobile:

Second Author's Full Name: (Times New Roman, 12)
Highest Qualification:
Department:
Post/Rank (If a student, provide course name and course year):
Affiliation (College/University/Institute) with postal address:
email id:
ORCID:
Mobile:

Third Author's Full Name: (Times New Roman, 12)
Highest Qualification:
Department:
Post/Rank (If a student, provide course name and course year):
Affiliation (College/University/Institute) with postal address:
email id:
ORCID:
Mobile:

ISSN: 2613-5817; E-ISSN: 2613-5825
VOLUME 23 ISSUE 02 2023

NOTES

JOURNAL INDEXING

ISSN: 2613-5817; E-ISSN: 2613 – 5825; UDC: 0 (0.034)
©Publisher: NGO International Center for Research, Education and Training. R/C: 80550594
MTÜ Rahvusvaheline Teadus-, Haridus- ja Koolituskeskus.
©Publisher: NGO Azerbaijan International Diaspora Center in Georgia.
Management Board Member and founder of organization: Seyfulla Isayev.
©Editorial office: Harju county, Tallinn, Lasnamäe district, Väike-Paala tn 2, 11415
©Typography: NGO International Research, Education & Training Center. The Baltic Scientific Journals.
Registered address: Narva mnt 5, 10117 Tallinn, Estonia.
Tel: +994 552 807 012; +994 518 64 88 94
Whatsapp: +994 552 41 70 12
E-mail: info@scia.website, sc.mediagroup2017@gmail.com
Website: https://bsj.fisdd.org/

ISSN: 2613-5817; E-ISSN:2613-5825, DOI PREFIX: 10.36962/PIRETC

VOLUME 24 ISSUE 03 2023

PROCEEDINGS

OF THE INTERNATIONAL RESEARCH, EDUCATION & TRAINING CENTER

JOURNAL OF SOCIAL RESEARCH & BEHAVIORAL SCIENCES
REFERRED & REVIEWED JOURNAL

Heyder Guliyev
Editors-in-chief

Platform &
workflow by
OJS/PKP

https://bsj.fisdd.org/index.php/piretc