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AVADANLIQLAR, TEXNOLOGİYALAR, MATERİALLAR

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SENTIMENT ANALYSIS IN TEXT BASED SYSTEMS USING MACHINE LEARNING TECHNIQUES

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ABSTRACT

The goal of this work is to apply machine learning based models in order to understand text based inputs. The project's purpose is to use machine learning based models in real world applications such as chatbots. Using artificial intelligence based machine learning models leads significant improvement in real world applications, reducing human labor costs.
Keywords: artificial intelligence, machine learning, intelligent systems, nlp, chatbots, nlu, sentiment analysis, text-based systems, supervised learning, classification, deep learning, text preprocessing, sentiment classification.

Introduction

Machine learning is a branch of artificial intelligence that involves the creation of models and algorithms that can use data to learn and make decisions or predictions. [1] The purpose of machine learning algorithms is to recognize patterns and connections within data, and subsequently use this knowledge to make decisions or forecasts regarding new data. [2] An important benefit of machine learning is its capability to automatically learn from data, without the need for explicitly programmed rules. This quality makes it particularly suitable for applications where rules are ambiguous or undergo frequent modifications.

Chatbots, which are also referred to as virtual assistants or conversational agents, are a form of artificial intelligence (AI) technology capable of emulating human conversation. Within Industry 4.0, chatbots are being utilized across several applications to enhance customer service, automate mundane tasks, and increase employee efficiency. This paper provides an overview of the role of chatbots in Industry 4.0, focusing on their benefits, challenges, and future directions. Chatbot systems are software applications that employ natural language processing (NLP) and machine learning methods to imitate human conversation. These chatbots can be created to engage with users in diverse ways, such as answering queries, offering customer assistance, or facilitating online purchases. [4]

One of the main benefits of chatbots in Industry 4.0 is their ability to improve customer service. Chatbots have various applications, including addressing common queries, suggesting products, and aiding in purchases. They can also provide individualized recommendations based on the customer's past preferences and interactions, elevating the customer experience. Furthermore, chatbots can perform automated routine duties, such as scheduling appointments, managing invoices, and processing orders, freeing up staff to handle more intricate responsibilities [5].

Nonetheless, there exist numerous difficulties related to the implementation of chatbots within Industry 4.0. A primary obstacle involves guaranteeing that the chatbots are dependable and precise. Chatbots must be trained using high-quality data to ensure that they provide accurate responses and recommendations. Furthermore, it is crucial to develop chatbots that can effectively

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manage intricate inquiries and adjust to novel circumstances. Another challenge is ensuring that the chatbots are secure and protect the privacy of customer data. It is necessary to create chatbots that adhere to data privacy regulations and prevent unauthorized access to sensitive data.

Preliminaries

Sentiment analysis entails detecting and extracting subjective information from textual data, including emotions, opinions, and attitudes. In text-based systems like chatbots, sentiment analysis can be used to understand the sentiment of the user's message and provide appropriate responses. However, before applying machine learning techniques for sentiment analysis in chatbots, certain preliminaries need to be taken care of. Some of the important preliminaries for sentiment analysis in text-based systems are:

1. Data Collection: The first step in sentiment analysis is to collect data for training the machine learning model. This data should be representative of the domain and context in which the chatbot will be used. [6] The data should also be labeled with sentiment polarity (positive, negative, or neutral) to train the machine learning model. [7]
2. Data Preprocessing: The quality of the data is crucial for the accuracy of the sentiment analysis model. [8] The data should be preprocessed to remove noise, stop words, and irrelevant information. This helps to reduce the dimensionality of the data and improve the accuracy of the sentiment analysis model.
3. Feature Extraction: The next step is to extract features from the preprocessed data. Feature extraction involves converting text data into numerical features that can be used for training the machine learning model. Some of the common feature extraction techniques used for sentiment analysis include bag-of-words, word embeddings, and n-grams. [10]
4. Machine Learning Model Selection: After feature extraction, a suitable machine learning model should be selected for sentiment analysis. Some of the popular machine learning algorithms used for sentiment analysis include Support Vector Machines (SVM), Naive Bayes, and Convolutional Neural Networks (CNN). [11]
5. Model Evaluation: Once the machine learning model is trained, it should be evaluated to assess its accuracy and performance. The model should be tested on a separate dataset to ensure that it generalizes well to new data. [12]

Statement of the problem and a solution method

Chatbots are becoming increasingly popular as a means of communicating with customers in various industries. [13] However, chatbots that use sentiment analysis to understand the emotions and attitudes of customers may not always provide accurate or appropriate responses. [6] This can result in a negative customer experience and a potential loss of business. Therefore, there is a need for a more accurate and effective sentiment analysis system for chatbots.

One potential solution is to incorporate a combination of machine learning and rule-based techniques for sentiment analysis. [8] Machine learning algorithms, such as deep learning models, can be trained on large datasets to recognize patterns in text that correspond to specific emotions or sentiments. Rule-based techniques, such as lexicons or dictionaries, can be used to identify words or phrases that are commonly associated with certain emotions or sentiments. [13] By combining these approaches, the sentiment analysis system can achieve higher accuracy and adaptability to different contexts.

Furthermore, to improve the accuracy of the sentiment analysis system, it is important to use high-quality data for training and testing the machine learning models. The data should be diverse and representative of the target population to avoid bias. In addition, the system should be regularly updated and monitored to ensure that it continues to perform well and adapt to changing customer needs and preferences.

Overall, the proposed solution method of combining machine learning and rule-based techniques, along with the use of high-quality data and regular monitoring and updating, can help to improve the accuracy and effectiveness of sentiment analysis in chatbots.

Today there are a lot of platforms that serve as a tool in order to build, deploy and use chatbots in the everywhere. These platforms are often called chatbot frameworks. Chatbot frameworks are software development tools that provide a set of pre-built components, libraries, and APIs to facilitate the creation of chatbots. These frameworks typically provide a range of features and functionalities, such as natural language processing, dialogue management, intent recognition, and integration with various messaging channels. In order to combine machine learning and rule-based techniques. Chatbot frameworks can be used to build chatbots that incorporate sentiment analysis using machine learning techniques. Here are some popular chatbot frameworks that support sentiment analysis:

1. Dialogflow: Dialogflow is a natural language processing platform that offers sentiment analysis as one of its features. It uses machine learning algorithms to analyze the sentiment of user input and can be trained on custom datasets to improve accuracy. [16]
2. Rasa: Rasa is an open-source chatbot framework that also supports sentiment analysis using machine learning techniques. It provides pre-built sentiment analysis models that can be customized for specific use cases. [15]
3. Microsoft Bot Framework: Microsoft Bot Framework is a platform for building and deploying chatbots that can integrate with various channels, such as Facebook Messenger and Slack. It provides sentiment analysis as one of its cognitive services, using machine learning algorithms to analyze text sentiment. [17]
4. IBM Watson Assistant: IBM Watson Assistant is a chatbot framework that uses natural language processing and machine learning to understand and respond to user input. It also includes sentiment analysis as one of its features, allowing chatbots built with Watson Assistant to analyze the sentiment of user input. [18]

These frameworks provide pre-built sentiment analysis models that can be customized and trained on specific datasets to improve accuracy. They also offer various tools and features for building and deploying chatbots, such as natural language processing, intent recognition, and dialogue management.

Conclusion

In conclusion, chatbot frameworks are a useful tool for incorporating sentiment analysis into chatbots using machine learning techniques. These frameworks provide pre-built models and tools for sentiment analysis, making it easier for developers to create chatbots that can understand and respond to user emotions.

Machine learning techniques, such as deep learning and natural language processing, are commonly used for sentiment analysis in chatbots. These techniques enable chatbots to analyze

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user input and classify it as positive, negative, or neutral, allowing them to provide appropriate responses that match the user's emotions.

The use of chatbot frameworks for sentiment analysis offers several benefits, including increased accuracy and efficiency. Chatbot frameworks provide a user-friendly interface for developers to train and deploy sentiment analysis models, making it easier to create chatbots that can understand and respond to user emotions.

Furthermore, the combination of sentiment analysis and chatbot frameworks using machine learning techniques provides a powerful tool for creating chatbots that can interact with users in a more natural and engaging way. This is especially important in customer service and other areas where user experience and engagement are crucial.

In summary, chatbot frameworks have become an essential tool for developers to create chatbots that incorporate sentiment analysis using machine learning techniques. As the demand for chatbots continues to grow, the use of chatbot frameworks in sentiment analysis is expected to become more prevalent in the future.

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THE BENEFITS OF DATA MINING IN FLIGHT DATA MONITORING

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ABSTRACT

Recording and processing flight data (FD) ensures the safety of modern civil aviation. By processing and analyzing of flight data, the causes of aviation incidents are revealed. The accuracy of data processing in this field is of great importance. Flight data monitoring (FDM) is a crucial process in the aviation industry that involves the collection, analysis, and interpretation of FD to improve safety and efficiency. The system monitors a wide range of flight parameters. However, analyzing large amounts of FD manually can be a time-consuming and daunting task. By using advanced data analysis techniques such as data mining, FDM systems can provide detailed insights into aircraft operations, allowing airlines and operators to identify areas for improvement and take proactive measures to prevent incidents or accidents. In the context of FDM, data mining can help analyze FD more efficiently and identify patterns that may not be apparent through manual analysis.
The article discusses the issues of recording and processing of FD, which play an important role in ensuring the safety of civil aviation in modern times, including the analysis of that data with the help of data mining technology, were examined, and various algorithms of data mining were investigated.
Keywords: flight data, flight data monitoring, flight safety, aircraft, artificial intelligence, data mining.

Introduction

The safety of civil aviation is the main goal of the International Civil Aviation Organization (ICAO) and significant progress has been made in this area in recent years. However, there is still a need for further improvement of the measures taken, since any progress in this area has a significant impact on the improvement of aviation security. Situational awareness is an important component of human information processing and is of great importance in pilot decision-making processes.
The comfort and reliability of aircraft is growing each year, while many flight stages are performed automatically under strict control by the pilot. However, the ICAO reports that every three out of four aviation accidents have been occurring due to the pilot fault for many years up to now. The measures taken and being taken by ICAO contributed to a reduction in the total number of aviation accidents, nonetheless their causality remains the same, i.e., at least 80% of all aviation incidents, accidents and catastrophes still occur due to erroneous and incorrect actions of aviation personnel, both in the air and on the ground [1,2].
Data monitoring is a critical function for organizations in various industries. By monitoring data, organizations can identify potential risks, anomalies, and patterns that may require further.
An operator can use a Flight Data Monitoring Program to identify, assess, quantify, and address operational risks. Additionally, this tool is versatile and can be utilized to support various safety

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tasks related to airworthiness and operations. Numerous clients face comparable challenges when it comes to adjusting their procedures, defining or fine-tuning the software provided by the supplier to meet the requirements of turbo-prop operations.

Flight Data Monitoring (FDM) is a proactive and non-punitive program that involves the collection, analysis, and interpretation of flight data from routine flights to improve flight crew performance, operating procedures, flight training, air traffic control procedures, air navigation services, and aircraft maintenance and design [3].

Figure 1 explains that FDM is a comprehensive process that involves tracking statistics and monitoring the evolution of events such as identifying network difficulties, trends, and safety indicators. In contrast, Flight Data Analysis (FDA) refers to the detailed investigation of a single event, which may include a single occurrence investigation, a practical flight investigation, or a detailed investigation.

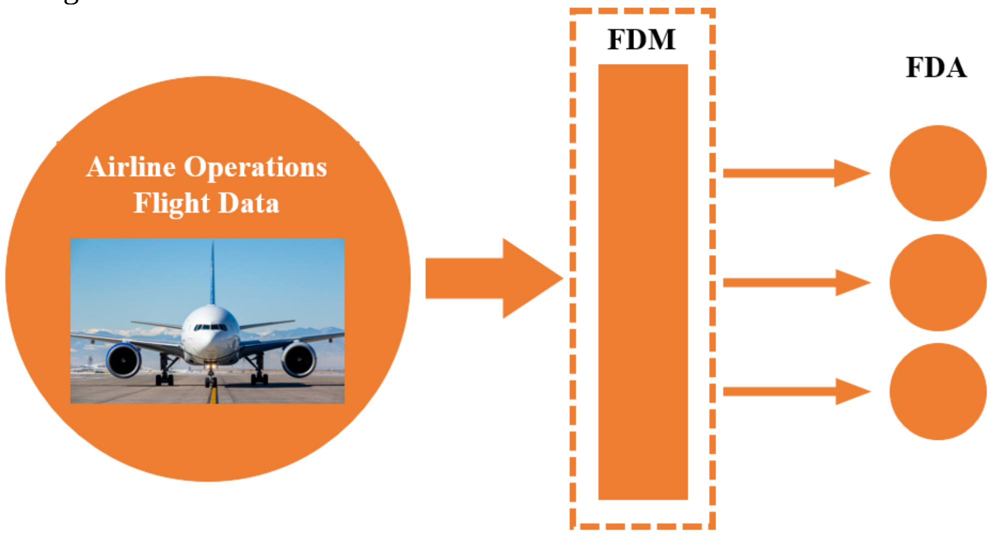

Figure 1: FDM a broad process that includes FDA.

The FDM procedure is an integral part of an airline's Safety Management System (SMS), which is compulsory in many countries. While FDM is not mandatory for aircraft with a MTOW less than 27 tons under FAA and EASA regulations, it can provide valuable input to SMS for flight operations.

The figure shows the life cycle of flight data in FDM (Figure 2) [4].

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Figure 2: The life cycle of flight data in FDM.

Problem statement

However, with the increasing volume of flight data being generated, traditional manual analysis methods are becoming less effective. Data mining can help analyze this "big data" and extract valuable insights that may not be apparent through manual analysis. The process of data mining involves utilizing machine learning algorithms and statistical techniques to extract valuable insights from extensive datasets. When applied in the context of FDM, data mining can help enhance the efficiency of flight data analysis and uncover patterns that might not be easily noticeable through manual examination. Here are some ways in which data mining can be used in FDM [5]:

Identify Anomalies: Data mining algorithms can help detect anomalies in flight data that may indicate potential safety issues. For example, if an aircraft is consistently consuming more fuel than expected or is experiencing more turbulence than usual, it may be a sign of an underlying problem that needs to be addressed.

Predictive Maintenance: Data mining can be used to predict when aircraft components may fail based on historical data. By analyzing patterns in the data, FDM systems can identify when parts are likely to need maintenance or replacement, helping to reduce downtime and increase aircraft availability.

Root Cause Analysis: When an incident or accident occurs, data mining can be used to identify the root cause. By analyzing data from multiple sources, including flight data, maintenance records, and crew reports, FDM systems can identify underlying factors that may have contributed to the event.

Improve Operational Efficiency: Data mining can help identify inefficiencies in aircraft operations, such as unnecessary fuel consumption or inefficient flight paths. By analyzing flight data, FDM systems can provide insights into how aircraft operations can be optimized to reduce costs and improve efficiency.
Crew Performance Analysis: Data mining algorithms can be used to analyze pilot and crew performance data, such as response times, decision-making processes, and situational awareness. By identifying areas where crews may need additional training or support, FDM systems can help improve overall safety and reduce the risk of accidents.
Weather Analysis: Weather conditions can have a significant impact on aircraft operations, and data mining can help identify patterns in weather data that may affect flights. For example, by analyzing historical weather data, FDM systems can help airlines plan more efficient flight routes and reduce the risk of weather-related delays.
Aircraft Design and Performance: Data mining can also be used to analyze aircraft design and performance data, such as aerodynamic performance, structural integrity, and engine efficiency. By identifying areas where aircraft may be underperforming or experiencing issues, FDM systems can help improve aircraft safety and reliability.
Predictive Analytics: Data mining algorithms can be used to predict future trends and events based on historical data. For example, FDM systems can use predictive analytics to identify patterns in flight data that may indicate future safety hazards or maintenance issues, allowing airlines to take proactive measures to address these concerns before they become more significant problems.

Problem solution

Data mining is a broad field of data science designed to make future predictions based on patterns found in collected FD. Due to the large amount of data collected every day, it is impossible to manually find events in FD. Data mining has been able to start addressing this problem. There are various methods and algorithms of data mining. Although they are not yet optimized for mining of aviation data in their current state, some common data mining methods, such as Clustering Analysis, Association Rule Mining, Classification Analysis and Predictive Modeling are being explored [5].

1. Clustering Analysis

Clustering analysis is a data mining technique that can be used for event detection in flight data. Clustering algorithms group similar flights together based on specific criteria, such as aircraft type, route, or weather conditions. This can help identify patterns and anomalies that may indicate potential safety hazards, such as abnormal flight parameters or deviations from normal flight paths. By analyzing these clusters, airlines can develop proactive safety measures that prevent accidents and improve overall aircraft safety.

2. Association Rule Mining

Another technique of data mining called association rule mining can be utilized for detecting events in flight data. This technique identifies relationships and patterns between different variables in the dataset. For example, association rule mining can be used to identify correlations between specific weather conditions and changes in aircraft performance. By analyzing these relationships, airlines can develop proactive measures to prevent safety hazards and improve overall aircraft performance.

3. Classification Analysis

Classification analysis is a data mining technique that can be used to identify specific events or conditions in flight data. Trained on previous flight data, classification algorithms are utilized to detect particular patterns or abnormalities that could potentially indicate a safety risk. For example, classification analysis can be used to identify abnormal flight parameters or deviations from normal flight paths that may indicate a potential safety issue. By using classification analysis, airlines can develop proactive measures to prevent accidents and improve overall aircraft safety.a

4. Predictive Modeling

Predictive modeling is a data mining technique that can be used to predict future events or conditions based on historical data. Through the analysis of past flight data, predictive modeling algorithms have the capability to recognize trends and patterns that might indicate possible safety risks or other concerns. For example, predictive modeling can be utilized to identify components that may be more likely to fail, enabling airlines to replace these components before they cause a safety hazard. Predictive modeling can also be used to forecast future aircraft performance based on historical data, enabling airlines to take preventative actions to improve overall aircraft performance and reliability.

Conclusion

In conclusion, extracting valuable insights from extensive datasets is made possible through the implementation of data mining techniques, and it can help improve safety and efficiency in the aviation industry. There is no single "best" data mining method for flight data monitoring, as the choice of method will depend on the specific goals and objectives of the analysis, as well as the characteristics of the dataset being analyzed. However, here are some commonly used data mining methods in flight data monitoring. A combination of different methods may be needed to achieve the desired results. FDM systems can analyze vast quantities of flight data more efficiently and identify patterns that may not be discernible through manual analysis by leveraging machine learning algorithms and statistical techniques. As the aviation industry continues to evolve, data mining will likely play an increasingly important role in FDM and other critical aviation processes.

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BASIC PRINCIPLES OF BUILDING INTELLIGENT SYSTEMS FLIGHT CONTROL

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ABSTRACT

The issues of creating intelligent control systems in a dynamically changing flight environment are considered and the principle of constructing an onboard intelligent flight control system is proposed. The implementation of the proposed system is based on the pilot's situational awareness of the flight progress in real time, which allows avoiding errors and maintaining enhanced synergy between human and avionics systems. Constant adaptation of the cockpit, as well as onboard. automation successfully maintains the pilot's workload within an optimal range, mitigating the occurrence of dangerous levels of fatigue. Methods for assessing and predicting the threat of an aviation accident based on direct control of the variation in the values of characteristics that affect flight safety, using methods and tools of artificial intelligence, are proposed.
Keywords: flight safety, aircraft, intelligent aviation system, accident threat, prevention, control system, artificial intelligence, aircraft control systems

Introduction

Currently, there are various systems for ensuring aircraft flight safety, the action of which is aimed at detecting, predicting and parrying the threat of an aviation accident. However, these systems, as a rule, make it possible to identify the threat of a catastrophic situation under the influence of individual influencing factors and do not take into account the change in aircraft flight conditions from a difficult state to a catastrophic one. Therefore, the creation of methods for assessing and predicting the threat of an aviation accident based on direct control of the variation in the values of characteristics that affect flight safety, using the methods and means of artificial intelligence, is an urgent scientific problem, the solution of which will make it possible to identify the immediate causes of an aviation accident and parry them using a safety management system [1-3]. Flights To solve this problem, it is necessary to create a set of principles, methods and algorithms, the action of which is aimed at identifying the threat of an aviation accident, its prediction and countering. At the same time, in order to implement methods and algorithms for improving aircraft flight safety, it is necessary to explore a new class of organizational and technical systems - intelligent aviation systems.
Intelligent Flight Control (IFC) is defined as autonomous adaptive control algorithms that can find non-trivial solutions to control problems using trivial strategies [4]/ There has been a rise in drones around the world, but integrating drones into current airspace is difficult due to safety regulations. While conventional civil and commercial aviation autopilots are not adaptive (a human pilot must act if something unexpected happens), autonomous systems must be able to adapt themselves to changing circumstances. This is where intelligent flight control systems come in.

The effectiveness of the system is determined by the degree of reliability and non-failure operation of technical means, as well as the professional training of dispatchers and maintenance personnel. Therefore, to support the actions of the crew when controlling the aircraft, it is necessary to use an intelligent decision-making system (DSS) as part of the aviation transport complexes, which allows us to introduce the concept of an intelligent aviation system (IAS). A distinctive feature of such a DSS, in comparison with the aviation technical system (ATS), is the presence in it of a control and management complex, the functioning of which is associated with the detection and elimination of flight accidents that occur under the influence of internal and external factors on the ground and in the air - the system aircraft safety management.

Statement of a question

The experience of aviation accidents shows that a large number of piloting errors are associated primarily with situational uncertainty, when the pilot does not understand what actions the onboard automation systems perform. In this case, intelligent systems come to the aid of the pilot, in which the term "on-board intelligence" is more used [2]. Onboard intelligence includes the totality of knowledge used in flight in order to perform a flight task; mathematical, information and software of the onboard computer; model of crew activity in various (regular and abnormal) situations. Thus, the active introduction of onboard intelligent systems helps to reduce situational uncertainty in a dynamically changing flight environment. In addition, in intelligent control systems (IMS), logical (semantic) information processing prevails over computational, which is expedient, for example, when analyzing situations and making decisions/

In the process of aircraft (AC) control, the crew performs various functions, which consist in promptly detecting and understanding the problem that has arisen, identifying rational ways to resolve it, implementing the chosen method, and monitoring the results of their activities. At the same time, the lack of the necessary information and the lack of time for its analysis are not the reason for the pilot to make a certain decision by a certain point in time. The reason for this is that a person does not have a high speed of perception and processing of information. In addition, it has a low throughput, a limited reaction rate, a large dependence of functioning on external conditions and a psychophysiological state, and fatigue during intense and prolonged work [5].

The solution of the problem

Here are just some of the problems that need to be addressed when replacing a pilot with artificial intelligence:

A large number of emergency situations that cannot be foreseen and described in the algorithm;

The transfer of a person to the status of an operator is dangerous because it is difficult to determine when to intervene: if artificial intelligence can do routine operations better than a person, then when faced with an emergency situation, a creative component is needed, which AI is deprived of;

Significant increase in the cost of infrastructure; it is necessary to increase the number of information sensors in the operation of systems in the air and on the ground in order to give artificial intelligence detailed data for making the right decision;

The capabilities of flight control systems can be extended by designing them to mimic the functions of natural intelligence. Intelligent control functions fall into three categories [6]:

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Declarative actions involve making decisions, providing models for system monitoring, target planning, system/scenario identification.

Proceedings refer to skillful behavior and have parallels in leadership, navigation and adaptation.

Reflexive actions are spontaneous internal reactions to control and evaluation.

Intelligent flight control systems learn the aircraft and its mission and adapt to changes in the flight environment. Cognitive models form an effective framework for integrating outer/inner loop control functions and for developing robust parallel processing algorithms.

To develop an intelligent flight control algorithm, first of all, it is necessary to determine the main functions of the aircraft performed during the flight [7].. The aircraft is required to fulfill its mission, which consists of guidance, navigation and flight control. As follows from Fig. 1, the human pilot can interact with the aircraft at several levels, or its functions can be replaced by electromechanical equipment.

The aircraft is required to fulfill its mission, which consists of guidance, navigation and flight control. As follows from Fig. 1, the human pilot can interact with the aircraft at several levels, or its functions can be replaced by electromechanical equipment.

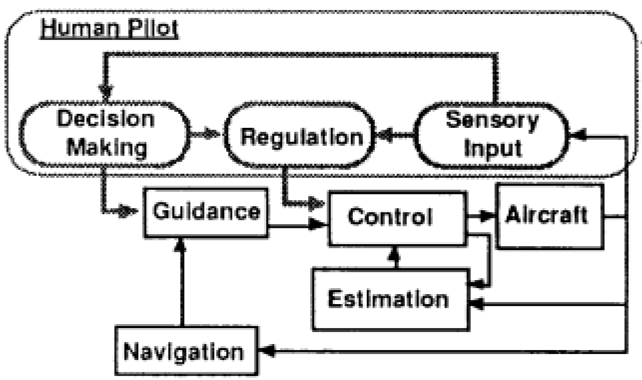

Figure 1. Guidance, Navigation and Control Structure.

During the flight, the pilot performs three different functions:

Perception, regulation and decision making. The accomplishment of these tasks requires various human qualities from the pilot - the ability to see and feel, the ability to identify and correct errors between the desired and actual state, and the ability to decide what needs to be done next. The first one depends on the organism, that is, on the sensors that perceive information, neural networks, which together connect them in the human brain.

The second function is based on motor functions, which are based on neuromuscular system to perform certain actions learned during the operation of the object, between stimuli and desired actions.

The third function requires more formal, introspective thinking about the reasons for taking an action, drawing on the deep memory of the brain to recall the most important procedures or data.

Perception and regulation are high-throughput tasks that leave little time for deep thinking.

Decision making is a low-throughput task that requires concentration.

Each of these tasks requires a certain workload on the pilot. Pilot workload has become a critical issue as system complexity has grown, aircraft cockpit design has become ideal, and aircraft performance over the entire flight range has become imperative. It was necessary. broadband, automatic functions, giving the pilot time to deal with unexpected or unlikely events.

On fig. 1 also shows the hierarchical structure for implementing the stability enhancement, command augmentation, autopilot, and flight control system functions. These functions can be broken down into reflexive and declarative parts.

The increase in stability is reflexive control provided by the innermost loop, usually implemented as linear feedback.

Control law that ensures stability and improves transient processes through the Estimation Compensation block.

The direct control loop provides inputs for a satisfactory response to the command through the control/compensation block, again using linear models.

A combination of monitoring and evaluation can be used to change the pilot's perceived quality. Figure 2 shows the flight control block diagram with the addition of new functions. The proposed structure has subblocks that define declarative, procedural and reflexive functions. They contain classic GNC (Guidance, Navigation and Control) features plus new features related to decision making, prediction and learning. The black arrows represent the flow of information for the main functions of the GNC, while the gray arrows illustrate the flow of data supporting further adjustments to goals, rules, and laws. Within sub-blocks, higher-level functions distinguish between conscious, preconscious, and subconscious attributes, not in spite of the philosophical objections raised earlier, but as a working analog for establishing a computational hierarchy. New features relate to setting or revising aircraft flight objectives, monitoring and adjusting aircraft systems and subsystems, identifying changing aircraft characteristics and its environment, and applying this knowledge to modify the structure and parameters of GNC functions.

The proposed structure has implications for both hardware and software.

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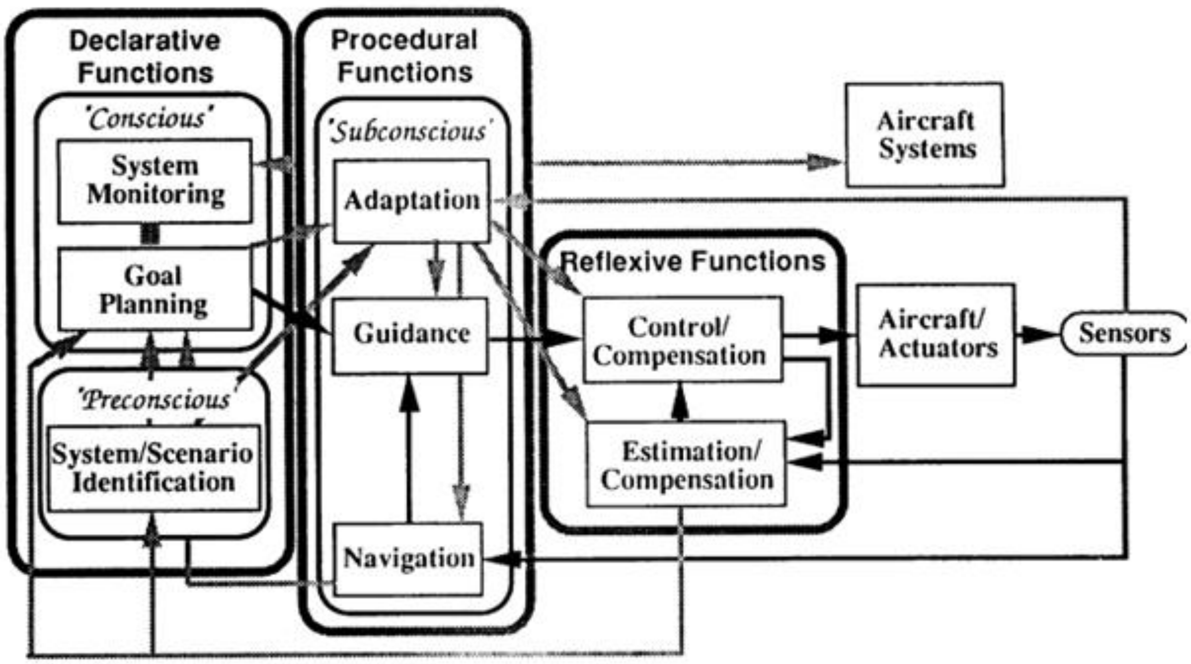

Figure 2. Intelligent Flight Control System Structure.

Monitoring and evaluation

It is assumed that the nominal (desired) flight path Δ is generated by a higher level intelligence, such as human intelligence. The process system must follow the path, x*(t) in to < t < tf t.) The control is carried out by means of a computer at intervals of time (Δ t.). The perturbation of the n-dimensional state vector at time t_k is x_k, and the perturbation of the m-separate control vector is u_k..

Linear Quadratic Gaussian (LQG) Discrete Time Control is formed as [8],

$$u_k = u^*k .C_B [\widehat{x_k} - x^* k] = C_F y^*_k - C_B \widehat{x_k} \qquad (1)$$

where y*k is the desired value of the output vector (defined as H_x x_k + H_u u_k) and x_k, is the Kalman filter estimate expressed in two steps:

$\widehat{x_k}$ (-) = Φ $\widehat{x_k}$ -1 (+) + Γu_{k-1}

$$\widehat{x_k}\,(..) \triangleq \widehat{x_k}\,(+) = \widehat{x_k}\,(-) + K[z_k - H_{obs}\widehat{x_k}\,(-) \qquad (2)$$

The forward and reverse control gain matrices are CF and CB,F and Γ- are matrices describing the system state transition, control effect, and predicted aircraft dynamics, The control estimation gain matrix is K and the measurement vector Z_k is the state transformation via Hobs The gains C_B and K are the result of solving two Riccati equations that introduce trade-offs between control use and state perturbation, and between the strength of random perturbations and measurement errors . CF, which provides the correct steady-state command response. This command is an algebraic function of CB, F, and Hobs. All matrices may change over time and K may need to be calculated

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online. Otherwise, it is not necessary that CB and K be optimal (i.e., they can be obtained from the designation of own structure, the formation of a loop, etc.), although the increase in LQR guarantees the useful properties of a nominal closed system [8].
Integral compensation, low-pass filtering, and explicit model following can be obtained by augmenting the system model during the design process. The order of compensation and the creation of control structures are shown in Fig. 3

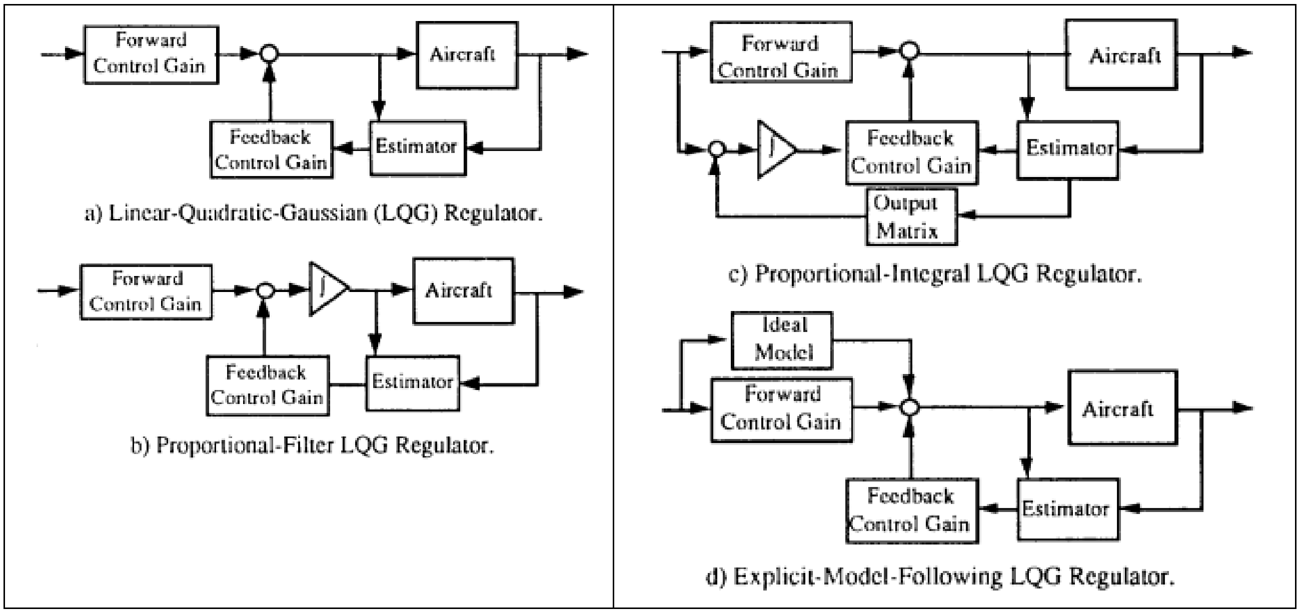

Figure 4. Structured Linear-Quadratic-Gaussian Regulators.

Conclusion

The principles of building an intelligent aircraft control system are considered, which increases the functionality of the system for its adaptation to a controlled object and helps pilots make the right decisions when performing important and critical tasks from the point of view of flight safety in modern aircraft. The work uses methods and tools of artificial intelligence, as well as autonomous adaptive control algorithms that can find non-trivial solutions to control problems using trivial strategies.

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METHODS OF TASK AND MOTION PLANNING FOR ROBOTS: APPLICATIONS AND LIMITATIONS

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ABSTRACT

Robots are increasingly required to perform more complex tasks, which in turn demand advanced planning algorithms. Task and Motion Planning (TAMP) methods, studied for decades, have made significant progress but still face various challenges. This document provides an overview of TAMP's development, encompassing problem-solving, simulation environments, methods, and remaining limitations. It particularly compares different simulation environments and methods used in various tasks, offering a practical guide and overview for beginners. Task planning is typically seen as planning in discrete spaces, while motion planning deals with continuous spaces. Significant progress has been made in integrating discrete and continuous planning methods to address TAMP problems. A recent survey has focused on TAMP integration, summarizing various methods for solving multimodal motion planning and TAMP problems. It introduces general concepts but primarily focuses on methods that operate in fully observable environments, which are far from real-world applications. Additionally, it demonstrates TAMP problem-solving in a theoretical manner that may not be user-friendly for beginners looking to apply these methods in practice. Therefore, this article aims to provide a practical and broader overview to readers, facilitating an easy entry into the field of TAMP for solving various tasks.
Keywords: task and motion planning, simulation environment, learning methods, TAMP.

Introduction

With the advancement of manufacturing and software technologies, robots are playing an increasingly vital role in our society. For example, we can find them in factories to assist or replace humans in dangerous and repetitive tasks. To enhance our daily lives, they are entering our homes as autonomous cars, housekeepers, and more. However, their competence in these tasks is not always convincing because they are not as intelligent as expected. A significant reason for this is that the human environment is unstructured and dynamic, more complex than the structured environment of a factory. Consequently, tasks for robots are more challenging in human environments, such as household chores.

When a robot performs a task, it must first find feasible plans to achieve its goal. Then, while executing the plan, it must consider the complex and ever-changing surroundings before taking each step. This process can be generalized into two steps: task planning and motion planning. Task planning is aimed at computing solvable plans to accomplish a long-term task. It typically decomposes a long-horizon task into a shorter horizon and elementary subtasks. For example, when instructing a robot to fetch an item in a room with a closed door, after decomposition, it can complete the task by solving several simple subtasks, including opening the door, locating the object, and returning. Therefore, the challenge at this stage is to decompose a complex task into several simpler subtasks.

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Motion planning, on the other hand, focuses on transforming subgoals into a sequence of parameters that the robot's software can use to control hardware components to achieve the subgoal. For example, the task "open the door" is transformed into specific parameters to control the robot's arm joints in a way that the end effector can touch and push the door. Due to the constraints of the surrounding environment, it is often challenging to create applicable control parameters that allow the robot to avoid collisions with other objects.

Although task planning and motion planning may seem to have some similarities in their structure, they operate in different spaces.

First, let's discuss task planning and motion planning separately. Task planning typically operates at a higher-level discrete level—state space that provides a global plan, while motion planning aims to follow this guidance at a lower-level action space.

Task Planning: Given an initial state and a global task, task planning is directed at creating a sequence of intermediate elementary tasks or abstract actions to assist the agent in accomplishing the initial complex task. Depending on the nature of the tasks, robot actions can be discrete or continuous. Discrete actions consist of a finite set of options that the agent can choose to apply, such as moving left or right. Continuous actions are parameterized with values, such as rotating the robot's base, where there is an infinite range of possible actions. For instance, rotating by 60 degrees clockwise differs from 60.1 degrees clockwise, making the search space much larger in the latter case.

Researchers in robotics have put in significant effort, and several planning methods have been proposed, including hierarchical methods, heuristic search methods, operator planning methods, and more. For a more detailed overview and discussion, you can refer to the introduction of relevant books. Due to their simplicity and efficiency, these methods are widely used in decision-making tasks like chess, the Tower of Hanoi, and so on. Instead of manual methods, Reinforcement Learning (RL) methods learn policies that map observations to subgoals, maximizing numerical reward signals. By default, these methods learn solutions to individual tasks, so they do not address the complete planning problem.

Motion Planning: Motion planning can be considered a way to bridge the gap between low-level control parameters and high-level tasks. Given a solvable task, a motion planning algorithm will generate specific parameters to achieve the given task. For example, in a navigation task, considering the position of the goal, a motion planning algorithm will create a trajectory for the robot to follow, enabling it to reach the goal without collisions. Several motion planning algorithms have been proposed, such as shortest path search methods in navigation tasks or inverse kinematics methods in manipulation tasks. For a more detailed introduction, you can find it in planning books by Gallab.

Furthermore, learning methods, especially RL methods, have garnered significant attention for intelligent motion planning. Some examples can be found in addition to traditional passive motion planning algorithms. Active motion planners take into account the context of the local environment before making a plan. For instance, context-dependent cost maps are generated by integrating several semantic layers, each describing a type of obstacle or constraint, including moving and static obstacles or hazardous zones. Context-dependent cost map planning can provide a practical and intelligent trajectory. Moreover, an active obstacle avoidance method is introduced, where the robot intends to avoid people from its rearward region.

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Task and Motion Planning (TAMP) is the integration of task planning and motion planning. In other words, it bridges planning in discrete spaces and continuous spaces. We will outline common issues, and TAMP methods are classified based on whether they utilize deep learning methods. In this context, where the main focus is on planning methods based on symbolic operators, we expand its scope to include integrated learning methods for TAMP. Additionally, we provide a comparison of related global tasks and experimental environments.

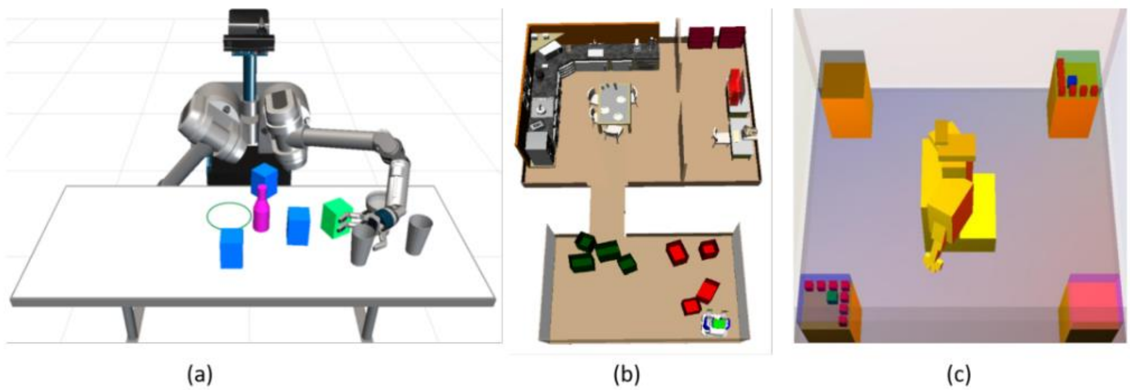

Figure 1. Demonstration of Tasks.

(a) Permutation Task: The robot needs to move the green box from the initial pose to the target area marked by a green circle.
(b) Navigation Amidst Moving Obstacles: The robot must clear the green obstacles before moving the red boxes into the kitchen area.
(c) Pick-Place-Move Task: The robot needs to select the blue cube and place it into the box with the green cube.

There are various global tasks for TAMP in human environments, but most of them can be considered combinations of fundamental tasks. We believe that if TAMP methods can perform well on these fundamental tasks, they could be generalized to solve more complex global tasks. The three fundamental tasks are described as follows:

- Permutation (Re): As shown in Figure 1(a), the robot needs to manipulate multiple objects, enabling it to reach the target object without collisions. Permutation tasks for multiple robots require collaboration among the robots, which typically occurs when a robot's arm cannot reach certain regions of the environment due to physical limitations.
- Navigation Amidst Moving Obstacles (NAMO): Unlike a pure navigation task, NAMO requires the robot to interact with the surrounding environment while navigating to reach a target location. The interaction aims to actively overcome obstacles, making previously blocked trajectories possible. An example can be found in Figure 1(b), where the robot must clear obstacles before entering the kitchen.
- Pick-Place-Move Task (PPM): As depicted in Figure 1(c), the robot's primitive operations involve picking up an object, moving it, and placing it into a box. Additionally, the PPM task can serve for assembly and/or disassembly tasks where the order of object manipulation needs to be considered.

After introducing the global tasks, we will describe TAMP methods aligned with these objectives in three categories: classical methods, learning-based methods, and hybrid methods that combine the previous two categories.
Classical Methods mainly encompass two types of methods: sampling-based methods and optimization-based methods. Given a long-term task with descriptions of the initial and final states, sampling-based methods may sample several useful intermediate states from the continuous infinite state space. Afterward, search methods are used to find a sequence of valid operator transitions between these intermediate states. Commonly used search-based sampling methods include heuristic search, forward search, or backward search. With the sequence of operators, classical motion planning methods, including RRT-Connect for the robot base and inverse kinematics for the robot arm, are applied to move the robot from one state to another. However, sampling methods usually are not complete for all problem instances. Firstly, they cannot typically identify and terminate infeasible instances. Secondly, the sampling process can only be applied to the explored space, thus failing to find solutions to instances that require identifying values from an unknown space. For example, in cases of partial observability, a robot can only find a path to a way-point within its sensing range. Thirdly, when the task description is vague (for example, the pouring task, where the goal is to pour as much milk as possible), sampling-based methods typically fail. As a result, optimization-based methods are proposed to complement sampling methods. The objective is primarily given in terms of a cost function over time. An optimization strategy is employed to minimize the cost subject to constraints and eventually derive feasible solutions. The optimization method is particularly suitable for solving problems with continuous solutions, as the time axis is directly integrated into the objective function. This approach is used in manipulation tasks, where the robot selects and places cylinders and plates on a table to assemble the tallest tower possible. Action sequences are generated using a straightforward symbolic planning approach, but optimal final and intermediate object positions are found through optimization. A comprehensive review of sampling methods and optimization methods for TAMP problems can be found. Additionally, there are some TAMP methods with a manual strategy component. For example, an active path-clearing algorithm for the NAMO task is presented. The proposed system combines obstacle classification, collision detection, local environment reconstruction, and obstacle interaction. To address situations where the obstacle is unknown, an affordance-based method is developed to help the robot determine whether the obstacle is movable by interacting with it.
In **learning-based methods**, the robot acquires skills from experience. The most common framework is Reinforcement Learning (RL), which learns a policy mapping the state of the environment to actions by maximizing a reward and penalty signal. TAMP problems typically involve long-term tasks that can be transformed into sparse rewards when the task is completed. However, exploring the environment by taking random actions requires an excessively large number of samples until a solution is found. Hence, Hierarchical RL (HRL) has been proposed to address the sparse reward problem by creating sub-tasks to guide the robot toward achieving the ultimate task.
The intuitive idea behind **HRL (Hierarchical Reinforcement Learning)** involves developing and training two networks: one for generating high-level tasks and another for low-level motion control. The high-level module learns policies over sub-goals, while the lower-level module learns actions to achieve each sub-goal. Given the task dependency and generalization issues of

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previous methods, an agnostic approach is developed by reformulating the task description. Instead of using observations from the robot, they use observations from the environment, such as positions and distances, to reduce task dependency. Training high-level policies and low-level actions separately lacks the opportunity for joint optimization. Therefore, they describe a joint training strategy for learning policies at three levels for the navigation task. The top level takes the current state and generates sub-goals, the middle level decomposes the sub-goal into visible targets, and the lowest level generates action parameters to reach the targets. However, in the NAMO task, considering the final position, the high-level network creating sub-goals must not only generate sub-goals for the robot base but also interaction positions for the arms. Consequently, an HRL method is proposed to obtain diverse sub-goals so that the robot can interact with obstacles during navigation. To find the corresponding action for interacting with different obstacles, a neural interaction mechanism that predicts the action's effect is integrated into the policy network generation. Although learning methods have achieved satisfactory results in simulated environments, transferring from simulation to real-world applications is challenging because the trained models cannot be directly used in real scenarios, and in most cases, they need retraining in the application environment. For example, in the solution proposed, a trained model maps sensor data to actions. However, due to the significant differences between environments, changing sensor data can lead to strange actions. Furthermore, collecting training data in a real-world environment is costly, so we see few real-world applications based on pure learning methods.
Hybrid methods - While both classical and learning-based methods can solve several TAMP tasks, they suffer from some limitations. For instance, operators used in sampling methods are usually manually crafted, which consumes a lot of time and is often highly task-specific. Learning-based methods avoid manual guidance but offer less flexibility for adding additional constraints, such as collision avoidance. Additionally, the ability to transfer learning methods from simulation to the real environment has proven to be challenging, due to the high cost of building a training dataset and the imprecise representation of the environment, which can be caused by sensor noise, lighting, occlusions, etc.

Table 1. List of TAMP Methods for Three Tasks.

	Classical methods	Learning based methods	Hybrid methods
Re	[Toussaint, 2015] [Garrett et al., 2020b]	[Driess et al., 2020]	[Chitnis et al., 2016] [Wang et al., 2021]
NAMO	[Meng et al., 2018] [Wang et al., 2020]	[Li et al., 2020] [Zeng et al., 2021]	[Kim and Shimanuki, 2020] [Xia et al., 2021]
PPM	[Kaelbling and Lozano-Pérez, 2013] [Garrett et al., 2015]		[Kim et al., 2019] [Konidaris et al., 2018] [Garrett et al., 2018]

Therefore, some researchers employ hybrid strategies, such as learning symbolic operators from a dataset, learning to guide operator search, or learning to create executable sub-goals. Learning symbolic operators from a dataset provides primitive task planning skills. With these operators, a common tool like PDDL or its extensions is applied to search for possible plans. Subsequently, motion planning algorithms can directly transform primitive operators into executable control

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parameters. A controlled learning strategy is introduced to learn symbolic operators from the training dataset. Each training example contains the current state, action, and the state after applying the action. The action model is learned by maximizing the probability of the action's consequences while considering a complexity penalty. To reduce the need for expensive training datasets, an experiential learning method applies actions to an agent and obtains states through experience. It then converts continuous states into a decision tree and, finally, into symbolic operators. Given the immense problem space that encompasses numerous actions and states, classical search methods are less efficient because the search space is too vast. Instead of traversing the entire space to find a solution, reinforcement learning methods provide an efficient way to learn a search strategy through self-experience. A graph is taken as the search space due to its scalability. Nodes represent abstract actions, and edges represent transition priorities. The Q-value function is learned from the training dataset to calculate action priorities, which guide efficient search. In addition to guiding discrete search, in continuous action spaces, a generative model is applied to generate multiple possible candidates to avoid getting stuck in infeasible solutions. Similarly, the model is applied to the dataset to learn the success probability. Then, in the same domain but a new scenario, given an action, the model predicts the success probability. By choosing actions with higher success rates, the search space is significantly reduced. In addition to operator-based methods, several methods are proposed for directly creating sub-goals based on RL methods. With an executable sub-goal in hand, classical motion planning methods are employed to control the robots. In the NAMO task, the Soft Actor-Critic Algorithm is applied to generate sub-goals for the arm and the robot base through environmental observation. Subsequently, RRT Connect and inverse kinematics methods are used to achieve the sub-goals. Thus, hybrid methods typically apply learning to task planning or part of the task planning process, with classical motion control algorithms adopted to generate control parameters. This strategy benefits from better portability to real-world applications than pure learning algorithms and provides more efficient strategies than classical methods. An overview of the presented methods for the main tasks is presented in Table 1.

When developing robotic algorithms, validating the results of interactions is an important step. Testing interaction effects in a real environment is a straightforward approach, but it can be labor-intensive, expensive, unstable, and potentially hazardous. Therefore, several interactive simulation environments have been proposed recently to advance robotic research and facilitate experiments. In this subsection, we compare several interactive simulation environments designed for navigation and manipulation tasks, including iGibson2 and VirtualHome. We focus on the type of rendering they use, their suitability for TAMP tasks, and their transferability to a real environment. The results of the comparison can be found in Table 2.

Table 2: Comparison of Various Interactive Simulation Environments.

		iGibson2	AI2THOR	TDW	Sapien	Habitat2	VirtualHome
Provided environment		15 homes (108 rooms)	120 rooms	-	-	-	build from 8 rooms
Interactive objects		1217	609	200	2346	-	308
ROS support		✓	×	×	✓	✓	×
Uncertainty support		✓	×	×	×	✓	×
Supported tasks	Re	+	+++++	++++	++++	++++	++++
	NAMO	+++++	++	+++	+++	++	++++
	PPM	+++++	+++++	++++	++++	+++++	+++++
Speed		GPU ++	++	++	+++	++++	++
Sensors		RGBD, Lidar	RGBD	RGBD	RGBD	RGBD	RGBD

Issues - Although TAMP methods have been studied for decades, they are still unreliable and face limitations in practical applications. In this section, we present several possible directions for improvement.

Observation Uncertainty - Typically caused by sensor noise, which is inevitable in real-world applications. There are mainly two types of solutions: (a) modeling the noise and reducing it through repeated observations, and (b) using learning methods to directly map noisy data to actions. An operator-based TAMP method is introduced to address observation uncertainty in the PPM task. Uncertainty arises in the robot's localization and the target object's location. They ask the robot to observe the object multiple times and use a Gaussian model to approximate localization noise. Raw sensor data is directly fed into a neural network, aiming to match raw observation data with action sequences through reward optimization. The approach is straightforward as it does not require complex process modeling but demands a large number of training scenes, 30,000 in their experiment. Thus, while previous methods deal with observation uncertainty, their experimental environment is relatively simple, allowing the robot ample maneuvering space. This raises questions about their practical implementation in confined conditions and complex environments for household tasks and their efficiency in finding feasible solutions.

Action Uncertainty - Under the same initial conditions and symbolic operator, an action can lead to different outcomes. For example, a grasping action may specify grasping an object from the top or from the side. This ambiguity can result in failure when attempting to place an object stably. In the PPM task, the robot needs to pick up an item and place it on a shelf, which requires the robot to choose an appropriate assembly action, as the shelves are closely spaced. They collect a dataset from which they obtain several types of assembly actions, such as from the side and from the top. The solution is found through backtracking because the robot could derive the appropriate assembly action from the target state. However, backtracking requires a complete observation of the surrounding environment, which is usually not feasible in real-world applications.

Contextual Mapping - Real-world tasks tend to be more complex, requiring the robot to make decisions considering the semantic information about the environment. For example, consider the task of building blocks, with various types of blocks and the goal of assembling a model car. Without considering information about the type or shape of each block and the model car, the task is impossible to complete. Contextual analysis and mapping can benefit various domains, including safe navigation, action verification, understanding ambiguous tasks, etc. For instance, to ensure safe navigation, situational mapping allows the robot to build an appropriate danger zone based on obstacle characteristics. The danger zone is relatively small for static obstacles like walls and tables, but it is larger for mobile obstacles like people and vehicles. In particular, the shape of the danger zone depends on the direction of motion and the speed of mobile obstacles.

CONCLUSION - This article discusses recent developments in TAMP, including popular tasks, practical simulation environments, methods, and existing issues. Three fundamental tasks, including rearrangement, navigation among moving obstacles, and the Pick-Place-Move task, are described. Furthermore, some popular environment simulators are listed and compared to facilitate the selection of an experimental environment. Additionally, some TAMP methods are classified based on whether they use deep learning methods and their tasks, helping readers start from the ground up according to the arising problems and their foundational knowledge. Finally, we describe existing issues with the aim of indicating possible directions for exploration.

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4TH INDUSTRIAL REVOLUTION AND ARTIFICIAL INTELLIGENCE

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ABSTRACT

An overview of industrial revolutions is made. Then the analysis of the fourth industrial revolution. The main major components of Industry 4.0 are identified, and their essence is revealed. The tasks of artificial intelligence within Industry 4.0 are also considered. Developed software in Python language about data and machine learning (ML) to visualize objects and table data. In order to use the capabilities of AI to the maximum benefit for business, it is necessary to hire data scientists. Data science combines statistics, computer science and business knowledge to extract value from various data sources. Developers use artificial intelligence to more effectively perform tasks that would otherwise have to be done manually, interact with customers, identify patterns and solve problems. To start working with AI, developers will need mathematical knowledge and the ability to use algorithms. There are several stages in the development and deployment of machine learning models, including training and inference. AI learning and inference refers to the process of experimenting with machine learning models to solve a problem. For example, a machine learning engineer can experiment with various candidate models to solve a computer vision problem, such as detecting bone fractures in X-ray images.
Keywords: fourth industrial revolution, artificial intelligence.

Introduction

Much of the world today depends on information. Since without current information it is impossible to make high-quality management decisions. But the creation of new knowledge from which information is obtained is still controlled by individuals. So far, there have been several industrial revolutions (Fig. 1). Industry 1.0 began in Great Britain in the middle of the 18th century, which is associated with the use of steam energy, the mechanization of the textile industry and the development of energy technologies [9, 11].

Industry 2.0 began in 1870 and is associated with the application of the principles of the division of labor, the development of mass production and electricity.

Industry 3.0 began in 1969 with the advent of the first programmable logic controllers and the development of information technology (IT) and IT systems, computer networks, information retrieval systems, with the help of which automation and robotization processes began.

The fourth industrial revolution, known as Industry 4.0, will lead to the digital transformation of the economy, society and the future of humanity in the future. Here, an important role is played by the massive use of cyber-physical systems in production, the industrial Internet of things (IIoT), three-dimensional printing, nanotechnology, biotechnology, artificial intelligence, and much more [1, 10].

Naturally, specific technologies and processes may be different. The fifth industrial revolution (or Industry 5.0) is also emerging, where it will represent a new direction in the development of

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production and society [6, 8]. At the same time, Industry 5.0, based on the bioeconomy, will be a friendly cooperation between people and intelligent systems such as robots.

Methods. The structure of Industry 4.0 - digital technologies can be given in the form shown in Figure 2. The main components are: SMART sensors, big data analysis, cloud technologies and computing, additive technologies (3D Printing), robotics, simulation, augmented reality, cybersecurity, Internet of Things (IoT) [2, 3]. The development of society has a spasmodic character [5, 7].

SMART (Standards Machine Applicable, Readable and Transferable) sensors provide all the conditions for successful use in Industry 4.0 applications.

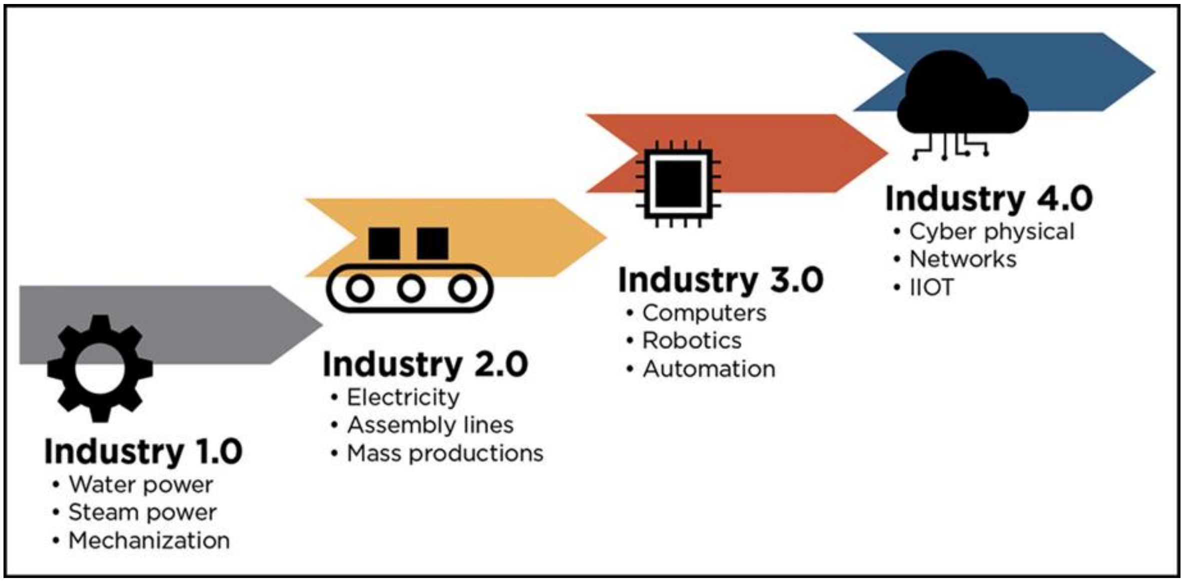

Figure 1. Industrial revolutions.

Big data analysis - used for advanced analytics tasks, including in artificial intelligence. There are various tools for this (special software such as NoSQL, MapReduce, Hadoop, R, etc.), technologies (Data mining), visualization of analytical data, artificial intelligence and neural networks.

Cloud computing and computing is the provision of resources from any computer at the request of a user connected to the Internet.

Additive manufacturing or 3D printing is a method of creating three-dimensional objects.

Robotics or robotics is the automation of production or other processes with the help of robots.

Simulation is an imitation ("simulation modeling") of any physical process, phenomenon, event using an artificial mechanical or computer system.

Augmented reality is a human-computer interaction technology designed to add digital elements to objects from a real external environment.

Cybersecurity is methods and measures to protect against intruder attacks on computer and mobile device resources.

The Internet of Things is the concept of a network of information transfer between computers.

To implement the concept of Industry 4.0, it is necessary to organize that individual business processes go digital [4].
The development of society is spasmodic, which is strongly influenced by the fourth industrial revolution and the labor market [5]. And in the picture of a colorful future, most of the business processes will be digitalized and automated, and many processes will be carried out by machines without human intervention

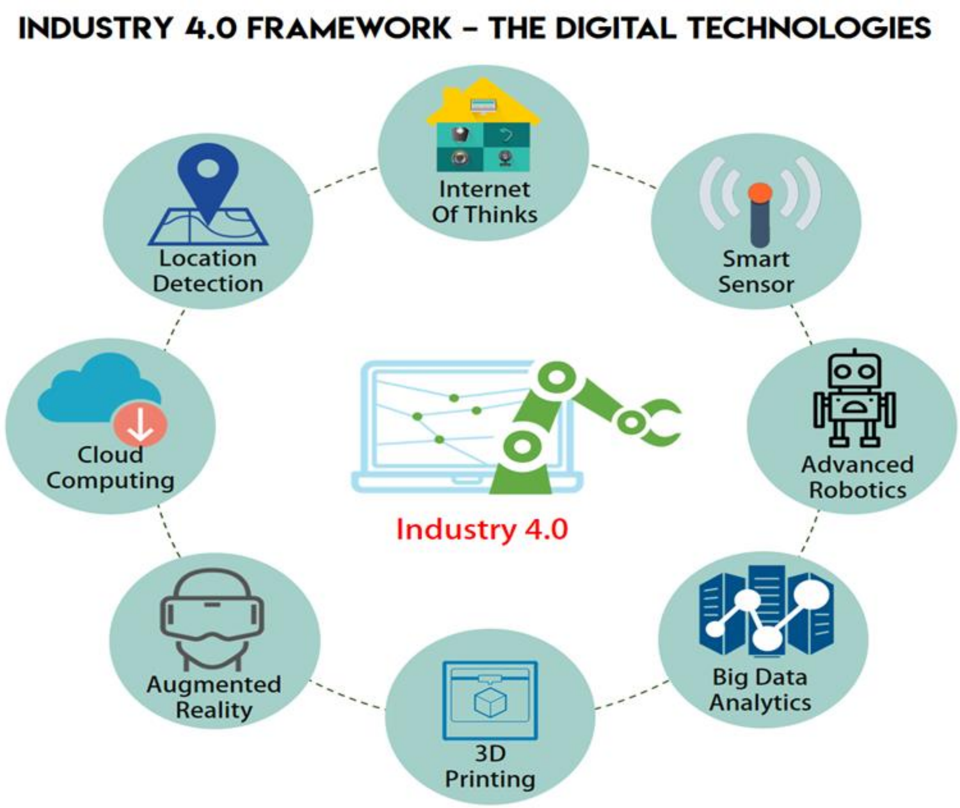

Figure 2. Structure of Industry 4.0 - digital technologies.

In the fourth industrial revolution, artificial intelligence plays a special role, which can be considered its foundation. There are three types of AI:
• Artificial Narrow Intelligence (ANI);
• Artificial General Intelligence;
• Artificial Superintelligence.
An example of an ANI system is a spam filter on an e-mail box.
We have developed software in Python about data and machine learning (ML) to visualize objects and table data. To run the codes, download the *jupyternotebook* program. After that, we create new files and start executing them.
Example. Create a visualization for the color and size of an array organized from 100 random table values.
Solution. The code and graph, using AI, will be like in Fig. 3 and 4, respectively.

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```
import matplotlib.pyplot as plt
import numpy as np

x = np.random.randint(100, size=(100))
y = np.random.randint(100, size=(100))
colors = np.random.randint(100, size=(100))
sizes = 10 * np.random.randint(100, size=(100))

plt.scatter(x, y, c=colors, s=sizes, alpha=0.5, cmap='nipy_spectral')

plt.colorbar()

plt.show()
```

Figure 3. Visualization code for array color and size.

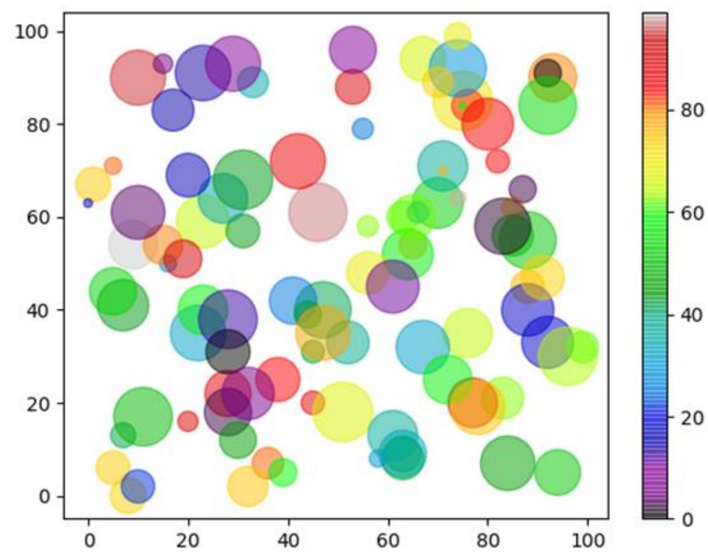

Figure 4. Render Graph for Array Color and Size.

Another important part of the new - the fourth industrial revolution, i.e. Industry 4.0 can be called the "Internet of Things". This term was proposed in 1999 by the British scientist C. Ashton. IoT can be characterized as a convergence of the virtual and real worlds: material objects (i.e. things), interacting with each other, organize a kind of network.

Conclusion

On the threshold of a new era, when AI and Industry 4.0 will change our future life, where many traditional jobs will be replaced by robots and automation, there will have to be a transition to new types of human employment. Also, with the development of innovative information technologies, automation, robotization, and at the same time the emergence of new forms of management, it is necessary to effectively plan and take into account the social, economic and environmental aspects of the country's development. It is becoming increasingly difficult for companies to attract and retain a skilled workforce. Filling positions that require digital and/or interdisciplinary skills seems especially challenging. And so, we need to consider the consequences of these things both in business and in human resource management.

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DESIGNING THE CONTROL SYSTEM OF THBIP-I HUMANOID ROBOT

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ABSTRACT

This article presents a method for planning the static position of THBIP-I (Tsinghua Biped Humanoid Robot) and a control strategy for its execution. The robot includes a head, torso, two arms, and two legs, with a total of 32 degrees of freedom. This project aims to enable the robot to perform static walking in various environments as an independent humanoid robot. Firstly, the mechanical structure and control architecture of the robot are determined. Secondly, a method for creating a static position based on the optimization of the supporting foot is presented, and a control strategy consisting of a combined controller and sensor feedback regulator is described. Navigation experiments demonstrate the robot's ability to maintain a static position, perform desired directional motions, and ascend/descend stairs.
Keywords: humanoid robot, control system, regulator, THBIP-II robot, Humanoid Walker Training model

The purpose of the work

The main goal in the development of humanoid robots is to replace humans in tasks that are dangerous or repetitive. There are several powerful bipedal humanoid robots created by various research groups worldwide [1,2]. Researchers at Waseda University have a long history of working on bipedal humanoid robots since 1969 and have created the anthropomorphic robot Wabian. This robot has 35 degrees of freedom and the ability to reuse pre-recorded trajectories [3,4]. After 10 years of research, Honda Corporation created humanoid robots P2, P3, and Asimo. These robots can perform complex tasks such as walking on a flat surface, turning, ascending/descending stairs, maintaining balance, and pushing objects in three-dimensional space. The control method of Honda's robot involves planning pre-recorded trajectories using Zero Moment Point (ZMP) and executing them with sensor-based feedback control [1,2]. In the year 2000, a French group developed the BIP-2000 robot, which has 15 degrees of freedom.
From an engineering perspective, the integration of the computer system, the design of sensor systems, and the mechanical design of the humanoid robot involve several aspects. Building upon the aforementioned robots, our research combines three main components [5,6]: analysis of human locomotion through energy analysis, preparation of an experimental humanoid robot platform, and the study of natural dynamic locomotion and balance control.
In Fig.1 shows prototypes of the robot with 32 degrees of freedom. The robot has a height of 170cm, weighs 140kg, and has 6 degrees of freedom in its legs, 7 in its arms, and 2 in its hands and neck. With these configurations, the robot is capable of maintaining stability on a flat surface, ascending/descending stairs, and grasping small objects. The robot with these configurations is shown in Fig.2. Each joint of the robot is actuated by Maxon Electronics' DC motors. To perceive

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the surrounding environment, two CCD cameras are installed on the robot's head [7,8]. To measure ground reaction forces and calculate the Zero Moment Point (ZMP) position, six-axis force and moment sensors are placed on the feet. To implement feedback control, a gyrometer and an accelerometer are installed on the robot's body to measure its posture and body position. The control of the robot in uneven terrain conditions is necessary [9-12].

Figure 1: THBIP-I humanoid robot [1,8]

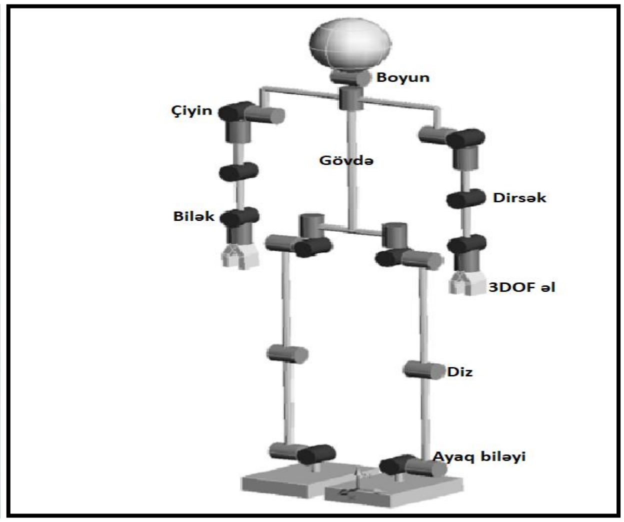

Figure 2: THBIP-I robot with DOF configuration [1,8]

Technical Architecture of the Control System

The control system of the THBIP-I humanoid robot is based on a parallel multi-computer architecture and is divided into four components: Remote Brain Work Station (RBW), Mobile Controller (MC), Distributed Control Units (DCU), and Sensor Processing Unit (SPU). The RBW subsystem is responsible for path planning and teleoperation of certain complex motions that cannot be autonomously controlled by the robot body. The Mobile Controller (MC) is a laptop computer mounted on the robot, serving as the decision-making unit for the robot. The MC collects environmental information through sensors and generates compensatory trajectories based on pre-recorded trajectory data. As shown in Figure 3, the RBW and MC are connected via wireless Ethernet, while the CCD (charged-coupled device) cameras are connected to the MC via a USB cable.

The Distributed Control System is divided into two levels: high-level control and low-level control. The High-Level Control consists of two PC104 embedded computers, responsible for the upper and lower body respectively. The Low-Level Control consists of 11 PID servo control systems. Each servo control system is a dual-CPU computer system and is dedicated to controlling approximately three or four joints. The PC104 and servo control systems are connected through a Controller Area Network (CAN) cable, and the two PC104 systems are connected to the MC via a 10M Ethernet cable.

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In addition to these four subsystems, the power management subsystem controls the power supply from the battery to the control system and electronic devices. In Fig.3, we use a yellow line to represent power and a blue line to represent signals.

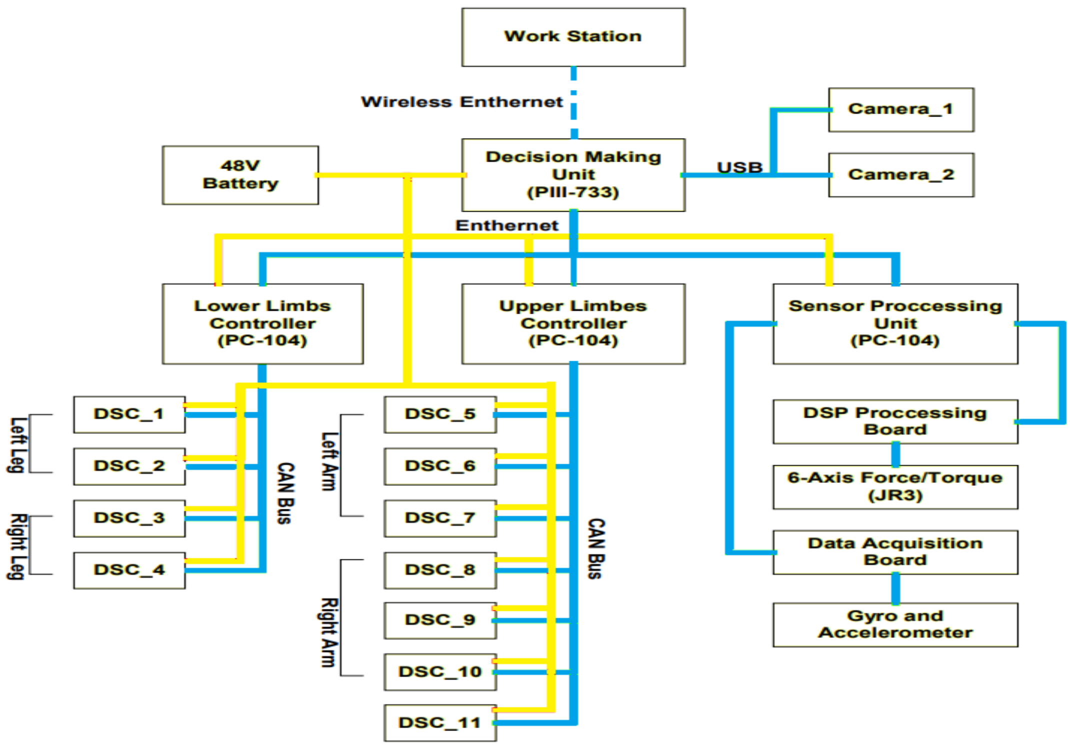

Figure 3: Control system diagram [6].

The configuration of the servo control system is shown in Fig.4. It consists of CPU1 connected to the PC104, which generates data signals for the four integrated PID controllers.

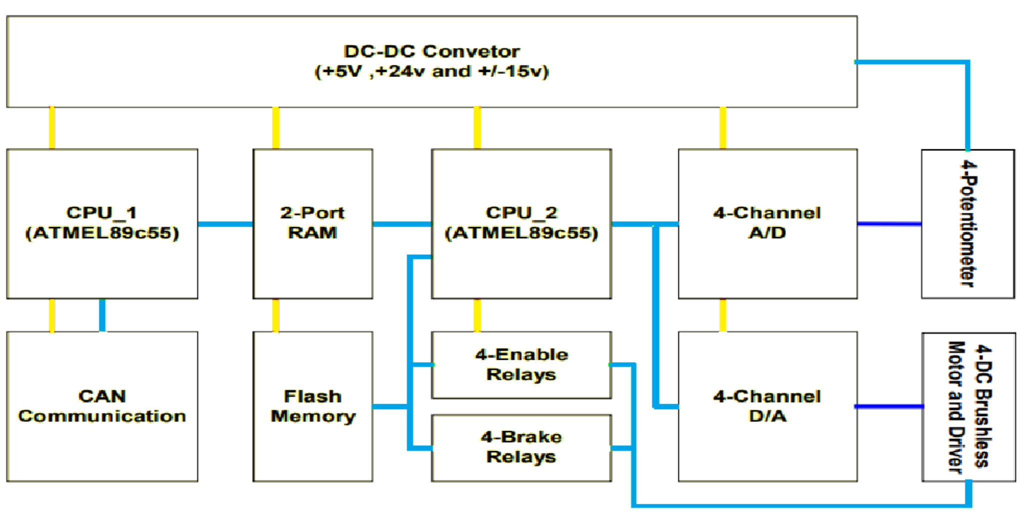

Figure 4. Servo control system [11-13].

Due to the wide bandwidth, the high-level control generates a group of trajectory data at 50 Hz, while the low-level PID control by CPU2 operates at a frequency of 500 Hz. To store the interpolated data, a dual-ported RAM is used between CPU1 and CPU2. Flash memory is utilized to store the PID schemes, and resident programs running on CPU1 and CPU2 can modify control parameters in the RBW without moving any actuators or loading the servo control system. Currently, the CPUs in the Servo Control Section are ATMEL 89c55, and a BIOS program is being developed for the servo control system based on DSP (Digital Signal Processor) for complex control schemes.

Designing the Lower Body of the Robot

Controlling the walking and stability of a humanoid robot is crucial. Within our knowledge, they can be categorized into two main approaches. Many of them utilize pre-recorded joint trajectories and sensor data for online control strategies. Others employ heuristic control schemes. Initially, we follow the first approach in our robot, where we use the same methodology and incorporate it into our control system for dynamic walking in the future. Initially, we employ the same approach in our robot, without considering the motion of the upper body. In Figure 5, the model of our robot is shown in the sagittal and lateral views. Assuming that the time period for a step is T_c, the k-th step occurs between kT_c- and t=kT_c-, where k = 1,2,... For simplicity, we assume that the step at position k starts with the left foot lifting off the ground at $(k+1)T_c$, k=1,2,...-and ends with the left foot touching the ground at $t=(k+1)T_c$ D_step represents the length of one step. H_a, $T_a$represents the Z coordinate of the highest point of the swinging foot at time, T_a . X_{hd}indicates the body position at the end of the double support phase. X_{hs} period represents the angle θ_{al} of the ankle joint.

To control balance, we utilize the ZMP (Zero Moment Point) Critic method proposed by Vukobratovic.

$$X_{ZMP}=\frac{\sum_{i=0}^{n}m_i(\ddot{z}_i+g_z)x_i-\sum_{i=0}^{n}m_i(\ddot{x}_i+g_x)z_i-\sum_{i=0}^{n}I_{iy}\dot{\omega}_{iy}}{\sum_{i=0}^{n}m_i(\ddot{z}_i+g_z)}$$

$$Y_{ZMP}=\frac{\sum_{i=0}^{n}m_i(\ddot{z}_i+g_z)y_i-\sum_{i=0}^{n}m_i(\ddot{y}_i+g_y)z_i+\sum_{i=0}^{n}I_{ix}\dot{\omega}_{ix}}{\sum_{i=0}^{n}m_i(\ddot{z}_i+g_z)}$$

Firstly, the foot trajectories are generated based on the study of human posture. Then, the parameters of the foot are adjusted to bring the ZMP closer to the center of the support polygon. Finally, the inclination angle between the floor and the support surface can be modified to reduce the velocities of the contacts, resulting in a significant reduction of the pitching moment. In addition, we plan the 3D smooth trajectory separately in the horizontal and vertical planes, and

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the horizontal motion occurs only during the double support phase. The implementation of the static posture model of the humanoid robot is carried out in Simulink (Fig.5).

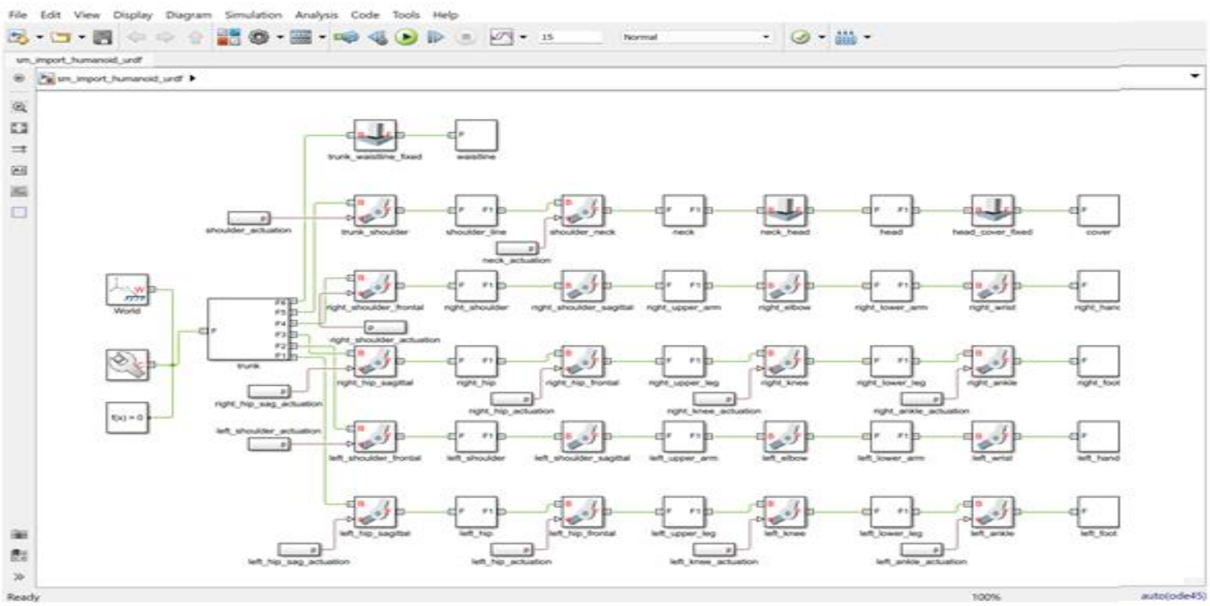
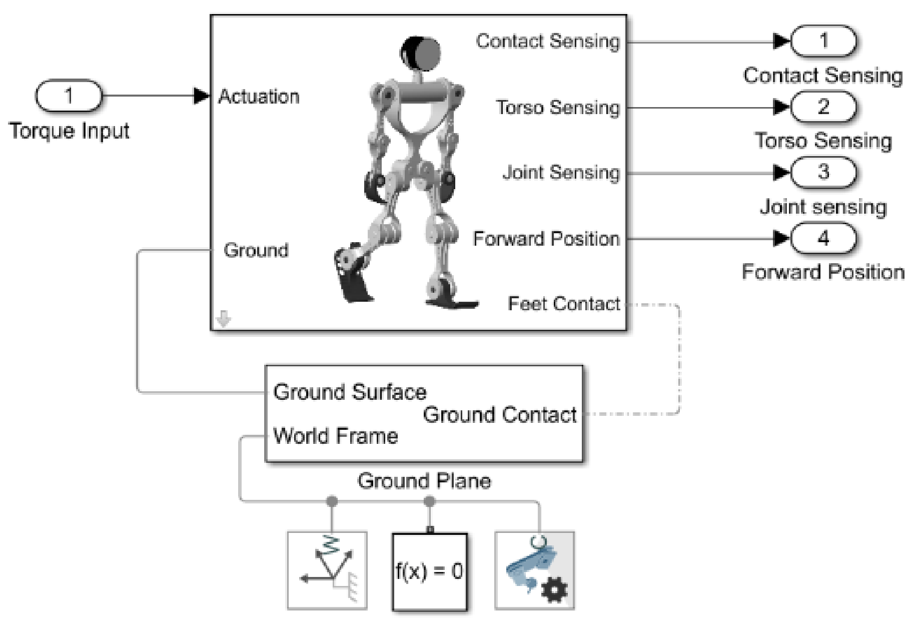


Figure 5. Realization of the static walking model in Simulink

The example in Figure 6 is based on a model of a humanoid robot (Fig.6).



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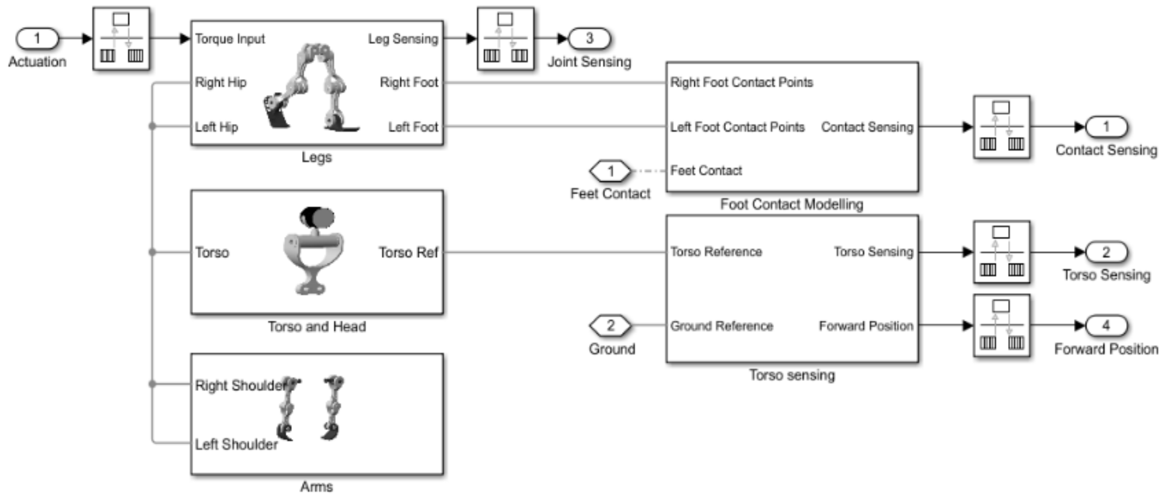

Figure 6. Computer model of a humanoid robot.

The unified control model utilizes a stiffness-based proportional-derivative control system for each joint. In this system, the stiffness (K) and damping (B) coefficients are employed. The torque is applied when the deviation (θ - θ_0) of the current joint position from the desired position exceeds a certain threshold.

$T = B\theta + K(\theta_0 - \theta)$.

The adjustment point θ_0 can be modified to control the movement of the legs and create a coordinated response in a unified manner. The Simulink model of the control system is illustrated in Fig.7.

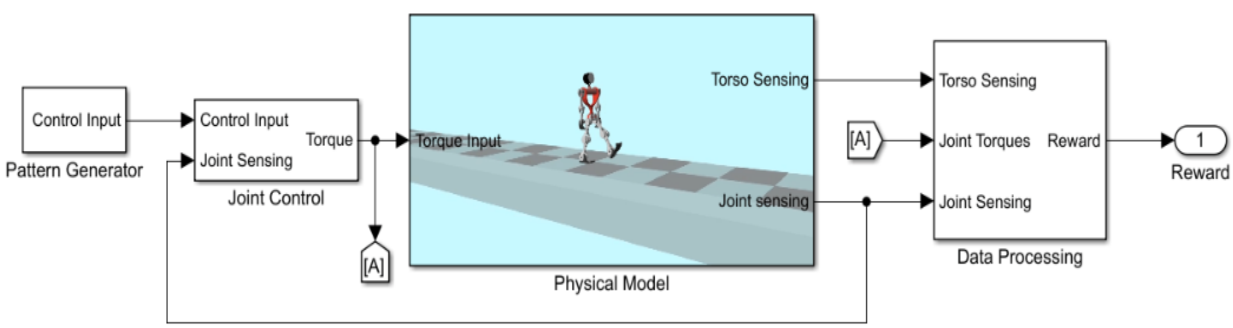

Figure 7. Feedback control circuit.

The purpose of the example "Humanoid Walker Training" is to teach a humanoid robot to walk, and various methods can be used to train the robot. In the example, a walker training model for a humanoid robot using a genetic algorithm is shown (Fig.8).

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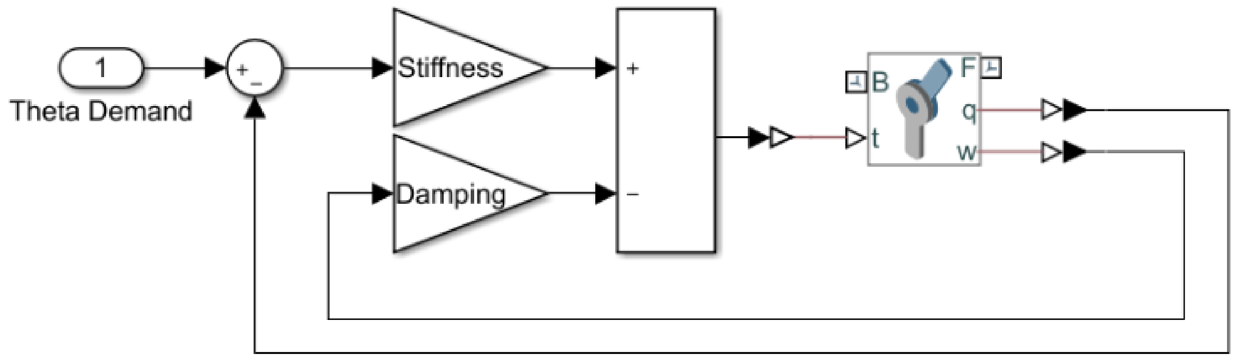

Figure 8. Humanoid Walker Training model

The objective function of motion is used in this example to evaluate different styles of motion.

$r_t = w1\,v_y + w2t_s - w3p - w4\,\Delta z - w5\,\Delta x$

v_y represents forward velocity; p represents energy consumption; Δz represents vertical displacement; Δx represents horizontal displacement; $w_{1,...,5}$ represents weights that represent the relative importance of each term participating in the objective function r_t.

Therefore, the overall result (R) of the motion can be expressed as:

$$R = \sum_{t=0}^{T} r_t$$

Here, T represents the time at which the simulation ends. We can modify the weights of the objective function in the sm_humanoid_walker_rl_parameters script. The simulation is stopped when the simulation time is reached or when the robot falls. Falling is determined as follows:

- The robot falls below 0.5 m.
- The robot moves more than 1 m sideways.
- The robot's body tilts more than 30 degrees.

Genetic Algorithm Training - Genetic algorithms can be used to optimize the robot's gait. Genetic algorithms solve optimization problems based on the imitation of biological evolution and natural selection processes.

Overall, the goal is to use genetic algorithms to find the optimal gait for the robot.

The model determines the cyclic demand of each component in a circular manner [2]. This type of allocation represents a cyclical control. The periodicity of the signals is the step period, which indicates the time required to complete one full step. In the best case scenario, the humanoid robot is symmetrically positioned (Fig.9). The control pattern of each component of the right leg is transferred to the corresponding component of the left leg with a delay of half of the step period.

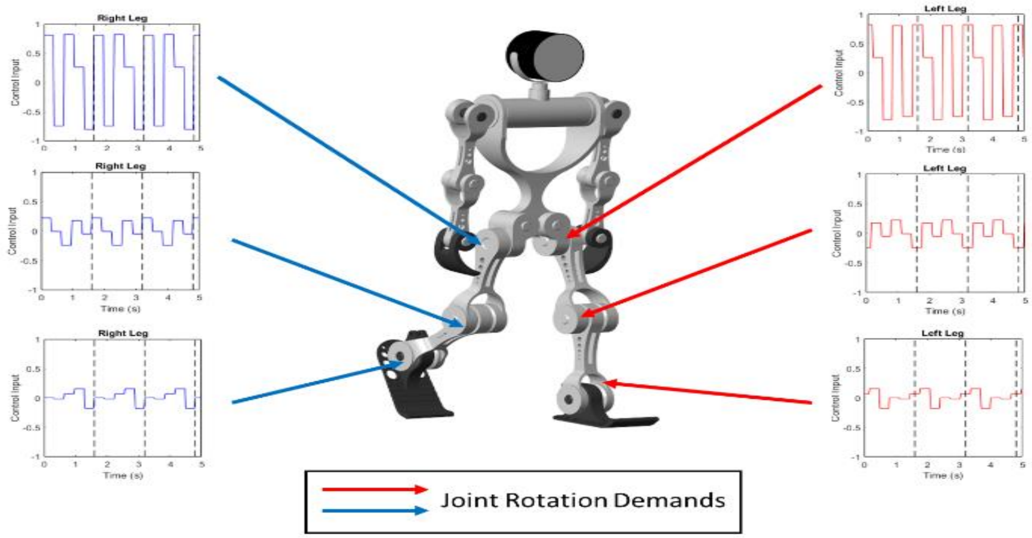

Figure 9. Humanoid robot model

To train the robot using genetic algorithms, we open the sm_humanoid_walker_ga_train script (Fig.10). In this example, a pre-trained humanoid walker is used. To train the humanoid walker, we set the value of the trainWalker variable to true.

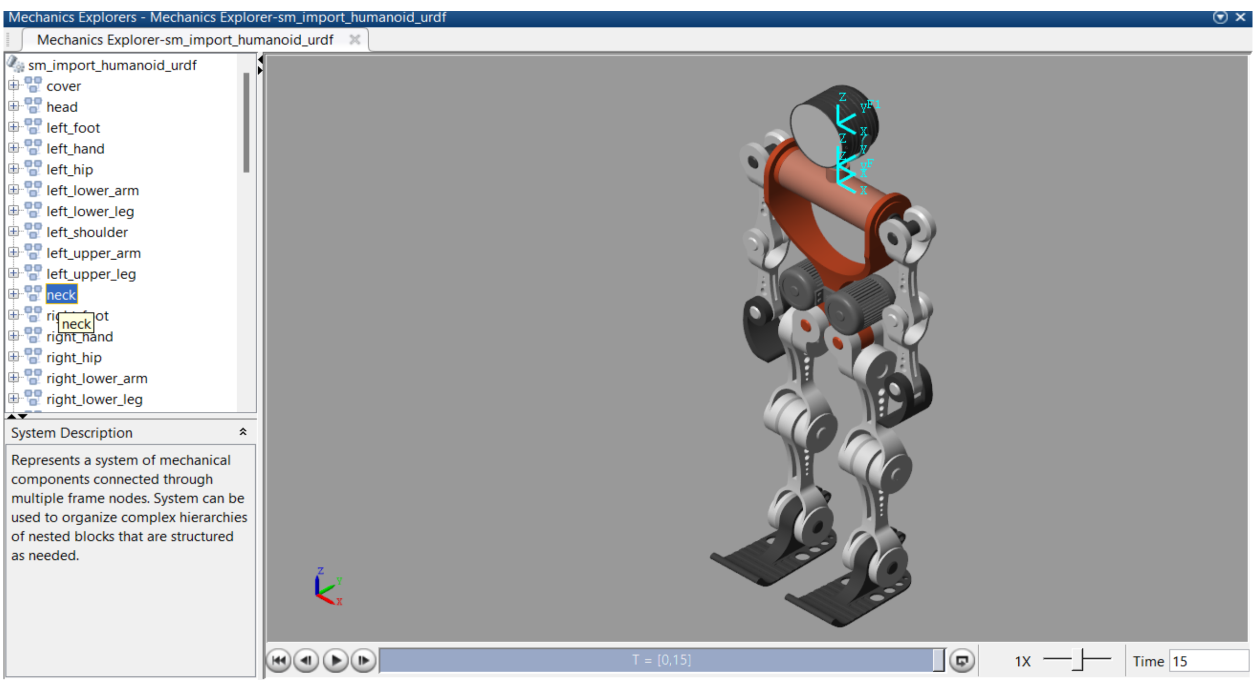

Figure 10. sm_humanoid_walker_ga_train script.

Conclusion

In simulations, the vibration of the body is affected by the ground speed. Therefore, the robot can only achieve slow-speed static walking. We are working on a robust control scheme and using a tethered platform to control the upward and downward contraction forces of the leg.

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CREATING A HIGH-PERFORMANCE HADOOP CLUSTER CONSIST OF WEAK COMPUTERS WITHIN THE ORGANIZATION

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ABSTRACT

Knowledge of practical methods of processing large amounts of data is akin to black magic. There are many tools and techniques for scalable data processing, in particular, caching (for example, using the mem cached program), replication, partitioning and, of course, Map Reduce/Hadoop. Hadoop is an open source framework that implements the Map Reduce distribution and reduction algorithm, which underlies Google's approach to organizing queries to distributed datasets that make up the Internet. This article is intended for programmers,
architects and project managers involved in processing large amounts of data offline. It will describe how to get a copy of Hadoop, how to organize a cluster and how to write analysis programs. We will start by applying Hadoop in the default configuration to solving a few simple tasks, for example, analyzing changes in the frequency of occurrence of words in the corpus of documents; this will help to understand the basic ideas of Hadoop and MapReduce. Next, we will move on to the basic concepts of MapReduce applications developed using Hadoop, and along the way we will study the components of the framework, the application of Hadoop to a wide range of data analysis tasks and numerous examples of Hadoop in action.
Keywords: big data, cluster, Hadoop.

Introduction

It is well known that not every employee in the company has a robust computer. After a while, the number of underutilized and unreliable computers starts to rise. Weak PCs can be connected over a network to address this issue. A cluster is a collection of servers and other resources that work together as one system in a computer system to provide high availability, load balancing, and parallel processing. It is a cluster-based system that can be as small as two personal computers (PCs) or as large as a supercomputer. Target devices are first chosen and linked to the same network for this. One of the machines is designated as the administrator at this point. The development of a central command structure that offers.

Hardware and software to set up the cluster

Having computers and a network infrastructure to connect them is essential in the initial stage. For this, a hub and LAN cables with at least as many ports as the number of devices are required.
It's crucial to be able to manage the computers from a central location using SSH after installing any Linux-based operating system on the computers (the cluster in use at the time used Ubuntu).
Hadoop It is a Java platform used in servers that hold enormous amounts of data.
MapReduce is a programming algorithm used by Hadoop that is offered by Google. Hadoop is now widely used by large brands to process their massive data. For instance, consider Facebook, Yahoo, Netflix, and eBay. Architecturally, it is made up of 4 main parts.

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•MapReduce
•HDFS (Hadoop Distributed File System)
•YARN (Yet Another Resource Negotiator)
•Common Utilities və ya Hadoop Common

1. MapReduce

An algorithm or data structure based on the YARN platform is called MapReduce. Hadoop runs incredibly quickly because to MapReduce's parallel implementation of distributed processing on a Hadoop cluster. With huge data, sequential processing is no longer used. MapReduce is a combination of the words "map" and "reduce,".

The input data is supplied to the Map() function, as seen in the picture. Here, data blocks are divided into lists of index-value pairs using the Map() method. The Reduce() method is then given its output as input. These dispersed lists are combined by index using the reduce() function. Following that, it carries out specific operations like sorting and aggregation and outputs the outcome. Depending on company needs, data processing is always done in Reduce.

2. HDFS(Hadoop Distributed File System)

Based on a shared file system, HDFS is made to function with cheap device clusters. A file system called HDFS gives data precedence over bigger blocks. The issue is that whereas a file block in Linux OS is 4KB in size, it is 128MB in HDFS. The DataNodes contain these. Information (metadata) about the data in all DataNodes is stored on the host called NameNode.No matter the size, Hadoop divides a file into 128 MB pieces. A 500 MB file, for instance, is split up into 4 pieces. The last block has 116 MB, whereas the first three blocks each contain 128 MB.

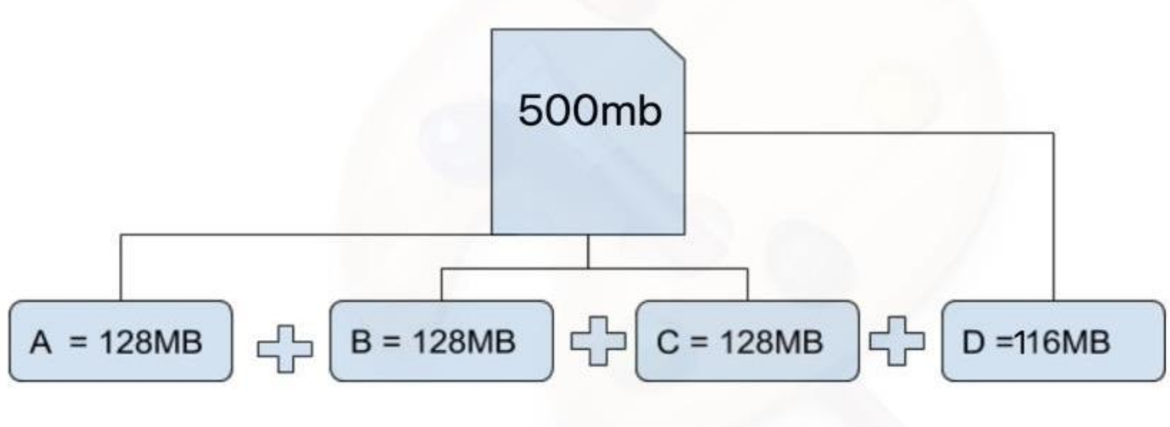

Figure 3.

3. YARN(Yet Another Resource Negotiator)

YARN is the framework for running MapReduce. YARN manages task allocation and resource management.

4. Common Utilities və ya Hadoop Common.

Hadoop common or Common utilities are Java libraries and Java files. Scripts written in Java and used by HDFS, YARN, and MapReduce to run the cluster.

Setting up the cluster

We performed the following steps to install the Hadoop system.

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1. Ubuntu operating system installed on all computers.
2. Computers are assigned a static IP address and then an ssh connection is established between them.
3. Hadoop platform installed and tested on all computers

Node	Http Address	Last contact	Last Block Report	Capacity	Blocks	Block pool used	Version
✔node1:9866 (172.17.64.54:9866)	http://node1:9864	2s	30m	227.68 GB	5	569.4 MB (0.24%)	3.2.1
✔node2:9866 (172.17.64.236:9866)	http://node2:9864	35s	30m	227.68 GB	5	569.4 MB (0.24%)	3.2.1

Figure 4. Hadoop interface.

As you can see from Figure 4, in the first stage we connected two computers to the network and made them members of the Hadoop platform. With this, our data is placed on all nodes with the help of a distributed file system. As a result, we keep a true copy of our data and can more optimally respond to incoming requests. As can be seen from the picture, there is currently 569.4 MB of data in the system. Analysis of this data and the performance difference with traditional databases will be discussed in the next section.

Conclusion

We implemented the Hadoop system by connecting computers with small resources within the organization over a local network. As a result, we built a high-performance cluster using the resources we had instead of buying huge supercomputers. We are currently conducting data processing processes on this cluster with a group of colleagues. Considering that the number of devices may increase, we can say that the stability and reliability of the system may increase. In the next step, for security reasons, we plan to interconnect these devices in a closed network in a room and localize the data processing.

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IRRIGATION SYSTEM PROBLEM BASED ON Z-INFORMATION

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ABSTRACT

In this paper an automatic intelligent irrigation system is considered. Irrigation regimes for agricultural crops provide the determination of scientifically based norms of irrigation, depending on the soil, physiological, climatic and technical characteristics of the irrigated array. In modern irrigation systems, the parameters of irrigation regimes are calculated similarly to traditional methods. But to solve the problem of efficient irrigation, it is necessary to take into account the weak formalizability, which makes it difficult to use accurate mathematical models to describe the control system. The solution of this problem would be partially possible if there were a large number of qualified experts who, taking into account the linguistic nature of the variables, are able, using their experience without constructing any dependencies, to determine the optimal irrigation rates. In the absence to date of such reference experts in intelligent irrigation planning systems, mathematical models based on Soft Computing should come forward. Our model is based on Z-information as an important qualitative attribute of information on which decisions are based is its reliability. The concept of Z-number relates to the issue of reliability of information, especially in the realms of decision analysis. Z-number valuations, take into account the uncertainty of the experts` opinion in estimation of the options.
Keywords: Z-numbers, uncertainty, reliability.

The purpose of the work. The solution of the problem of irrigation based on Z-information.

Introduction

In the last century, water infrastructure has been developed taking into account the growing demand for agricultural products in Azerbaijan Republic. International experience shows that the priorities for achieving efficiency in irrigation agriculture depend on the level of economic development of the country, the degree of development of science, the existing potential of highly qualified personnel. Methodical approaches and problem solving methods for systematic evaluation of irrigation and melioration systems should be adapted to the current situation. The main characteristics of the measurement quality are accuracy and reliability. Increasing the accuracy of the measurement due to the reduction of its error is technically difficult, expensive and laborious. Therefore, the level of accuracy to which one should strive is determined by the criterion of expediency, which depends on specific conditions and the purpose of measurements.

Various methods including using of fuzzy logic, have been developed to make an automatic irrigation design. For example, a fuzzy logic controller was suggested for drip irrigation system in Qatar. The following parameters were used in fuzzy rules for decision making in Mamdani model: soil moisture, water consumed, solar radiation, and temperature [1]. Fuzzy Logic is used in [2] for the evapotranspiration, that takes into consideration recent rainfall, humidity, radiation, and a crop coefficient. Authors in [3] used fuzzy logic for the automatic control of water pumps.

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In this work we consider the automatic irrigation system based on Z-information. In [4] Zadeh introduced the concept of Z-numbers to describe the uncertain information which are more generalized notions. A Z-number is an ordered pair of fuzzy numbers $(\tilde{A}, \tilde{R})$. Here $\tilde{A}$ is a value of some variable and $\tilde{R}$ represents an idea of certainty or other closely related concepts, such as sureness, confidence, reliability, strength of truth, or probability [5]. It should be noted that in everyday decision making most decisions are in the form of Z-numbers, for example:

(Probability of the state of nature, big, not sure)

(Outcome of the state of nature, medium, very likely)

Zadeh suggests some operations for computation with Z-numbers, using the extension principle [4]. This theme was extended in [5]. It was shown how to use these Z-numbers to provide information about an uncertain variable in the form of Z-valuations, assuming that this uncertain variable is random. In [5] author offers an illustration of a Z-valuation, showing how to make decisions and answer questions. Also an alternative formulation is used for the information contained in the Z-valuations in terms of a Dumpster-Shafer belief structure that made use of type-2 fuzzy sets. Simplified version of Z-valuation of decision relevant information is considered in [6]. Z-number theory was applied in a lot of problems, for example, a linear programming problem [7], the approximate reasoning problem [8], where the approximate reasoning with Z-rules was considered and etc. The paper is organized as follows. In Section II we present required preliminaries, formulate a statement of the problem and present a method used to solve it. In Section III we cover application of the suggested method to a real-life irrigation problem. Concluding comments are included in Section IV.

Problem solution.

Definition. A Z-number [3]. A Z-number is an ordered pair of fuzzy numbers, $(\tilde{A}, \tilde{R})$. $\tilde{A}$ -is a fuzzy restriction on the values which a real-valued uncertain variable is allowed to take. $\tilde{R}$ is a measure of reliability of the first component.

Let the input and output variables for evaporation model are represented as Z-numbers. We will denote input variables: soil moisture as $\tilde{Z}_{sm}$, solar irradiance as $\tilde{Z}_{si}$, air temperature as $\tilde{Z}_{at}$, air humidity as $\tilde{Z}_{ah}$ and output variable – pump voltage as $\tilde{Z}_{pv}$. We use such model because pump voltage impacts directly on the rate of flow of water [3]. An increase of pump voltage will decrease the rate of flow of water. We use three linguistic terms for each of the inputs: low, normal, high for soil moisture ($\tilde{Z}_{sm(low)}$, $\tilde{Z}_{sm(normal)}$, $\tilde{Z}_{sm(high)}$); dim, normal, bright for solar irradiance ($\tilde{Z}_{si(\dim)}$, $\tilde{Z}_{si(normal)}$, $\tilde{Z}_{si(bright)}$); cold, normal, hot for air temperature ($\tilde{Z}_{at(cold)}$, $\tilde{Z}_{at(normal)}$, $\tilde{Z}_{at(hot)}$); low, normal, high for air humidity ($\tilde{Z}_{ah(low)}$, $\tilde{Z}_{ah(normal)}$, $\tilde{Z}_{ah(high)}$) and five linguistic terms for output variable –pump voltage: very low ($\tilde{Z}_{pv(very\ low)}$), low ($\tilde{Z}_{pv(low)}$), normal ($\tilde{Z}_{pv(normal)}$), high ($\tilde{Z}_{pv(high)}$), very high ($\tilde{Z}_{pv(very\ high)}$). We can represent the first and the second components of inputs and output as following:

$$\tilde{Z}_{sm(low)} = (\tilde{A}_{sm(low)}, \tilde{R}_{11}^{1}), \ \tilde{Z}_{sm(normal)} = (\tilde{A}_{sm(normal)}, \tilde{R}_{ij}^{1}), \ \tilde{Z}_{sm(high)} = (\tilde{A}_{sm(high)}, \tilde{R}_{13}^{1})$$

$$\tilde{Z}_{si(\dim)} = (\tilde{A}_{si(\dim)}, \tilde{R}_{21}^{1}), \ \tilde{Z}_{si(normal)} = (\tilde{A}_{si(normal)}, \tilde{R}_{22}^{1}), \ \tilde{Z}_{si(bright)} = (\tilde{A}_{si(bright)}, \tilde{R}_{23}^{1})$$

$$\tilde{Z}_{at(cold)} = (\tilde{A}_{at(cold)}, \tilde{R}_{31}^{1}), \ \tilde{Z}_{at(normal)} = (\tilde{A}_{at(normal)}, \tilde{R}_{32}^{1}), \ \tilde{Z}_{at(hot)} = (\tilde{A}_{at(hot)}, \tilde{R}_{33}^{1})$$

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$$\tilde{Z}_{ah(low)} = (\tilde{A}_{ah(low)}, \tilde{R}^1_{41}),\ \tilde{Z}_{ah(normal)} = (\tilde{A}_{ah(normal)}, \tilde{R}^1_{42}),\ \tilde{Z}_{ah(high)} = (\tilde{A}_{ah(normal)}, \tilde{R}^1_{43})$$
$$\tilde{Z}_{pv(very\ low)} = (\tilde{A}_{pv(very\ low)}, \tilde{R}^2_1),,\ \tilde{Z}_{pv(low)} = (\tilde{A}_{pv(low)}, \tilde{R}^2_2),,\ \tilde{Z}_{pv(normal)} = (\tilde{A}_{pv(normal)}, \tilde{R}^2_3),,$$
$$\tilde{Z}_{pv(high)} = (\tilde{A}_{pv(high)}, \tilde{R}^2_4),, \tilde{Z}_{pv(very\ high)} = (\tilde{A}_{pv(very\ high)}, \tilde{R}^2_5)..$$

where $\tilde{R}^1_{ij} = \{(x, \mu_{\tilde{R}_1}(x)) : x \in [0,1]\}$, i=1…4, j=1…3 and $\tilde{R}^2_k = \{(y, \mu_{\tilde{R}_2}(y)) : y \in [0,1]\}$, k=1…5, represented by trapezoidal and triangle fuzzy numbers as shown in Fig.1.

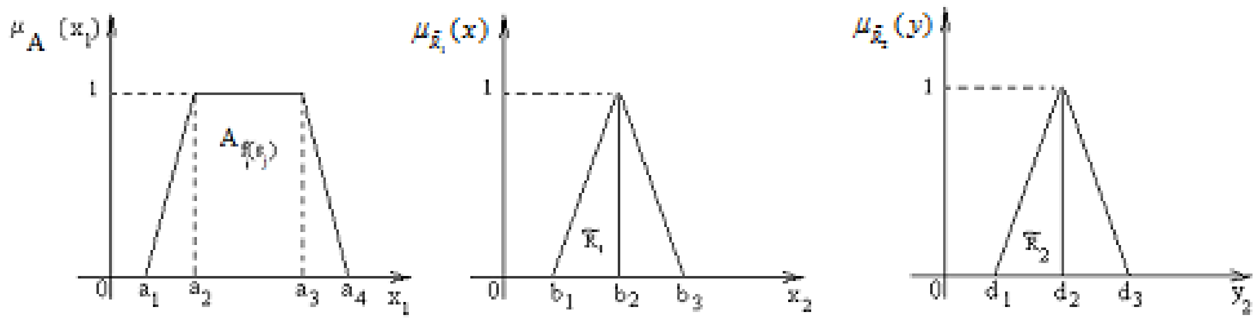

Figure 1: a) A-part for input and output variables; b) R- part for inputs and; c) R-part for output

To convert the given Z-numbers to fuzzy numberst we determine the expected values of fuzzy numbers R_1 and R_2 describing reliability of variables of outcome and probability:

$$\alpha_1 = \frac{\int x\mu_{\tilde{R}_1}(x)dx}{\int \mu_{\tilde{R}_1}(x)dx}, \qquad (1)$$

$$\alpha_2 = \frac{\int y\mu_{\tilde{R}_2}(y)dy}{\int \mu_{\tilde{R}_2}(y)dy} \qquad (2)$$

$$\tilde{Z}' = (\sqrt{\alpha_1} \times a_1, \sqrt{\alpha_1} \times a_2, \sqrt{\alpha_1} \times a_3, \sqrt{\alpha_1} \times a_4; 1) \qquad (3)$$

The mathematical m odel of this system is the following [3]:
Pump voltage is inversely proportional to the rate of flow of water and is proportional to (Solar Irradiance x Air Temperature) / (Soil Moisture x Air Humidity).
We can construct our linguistic rules based on this mathematical model.

Application
We apply the suggested method in a problem of intelligent irrigation. Let the R parts for inputs and output are equal to R=(0.6, 0.7, 0.8; 1) and are shown in Fig. 2:

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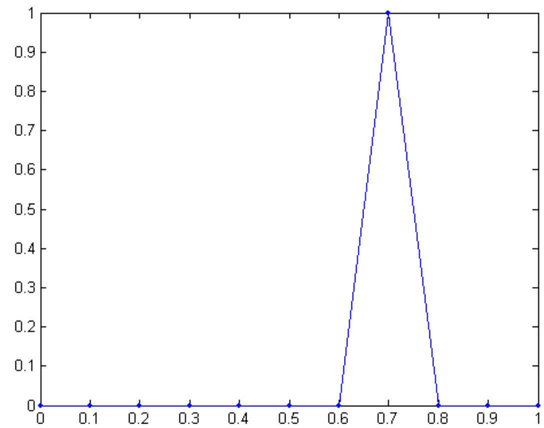

Figure 2. The R –parts for Z-numbers of inputs and output

The A-parts of Z-numbers for inputs and output are given as

$\tilde{A}_{sm(low)} = [-36\ \text{-}4\ 20\ 35]$, $\tilde{A}_{sm(normal)} = [20\ 40\ 40\ 60]$, $\tilde{A}_{sm(high)} = [45\ 60\ 104\ 136]$

$\tilde{A}_{si(\dim)} = [\text{-}360\ \text{-}40\ 350\ 500]$, $\tilde{A}_{si(normal)} = [350\ 500\ 500\ 675]$, $\tilde{A}_{si(bright)} = [500\ 675\ 1040\ 1360]$

$\tilde{A}_{at(cold)} = [\text{-}18\ \text{-}2\ 17.5\ 22.5]$, $\tilde{A}_{at(normal)} = [17.5\ 22.5\ 22.5\ 27.5]$, $\tilde{A}_{at(hot)} = [22.5\ 27.5\ 52\ 68]$

$\tilde{A}_{ah(low)} = [\text{-}36\ \text{-}4\ 35\ 50]$, $\tilde{A}_{ah(normal)} = [35\ 50\ 50\ 70]$, $\tilde{A}_{ah(high)} = [52.5\ 70\ 104\ 136]$

$\tilde{A}_{pv(very\ low)} = [\text{-}2.43\ \text{-}0.271\ 2\ 3.3]$, , $\tilde{A}_{pv(low)} = [2\ 3.3\ 3.3\ 5]$, , $\tilde{A}_{pv(normal)} = [3.3\ 5\ 5\ 7]$, ,

$\tilde{A}_{pv(high)} = [5\ 7\ 7\ 10]$, , $\tilde{A}_{pv(very\ high)} = [7\ 10\ 11.1\ 13.2]$. .

We convert the value of fuzzy reliability into a crisp number based on (1)-(2):

$$\alpha_1 = \alpha_2 = \frac{\int x\mu_{\tilde{R}_1}(x)dx}{\int \mu_{\tilde{R}_1}(x)dx} = 0.7,$$

Our rule base consists of 3 x 3 x 3 x 3=81 linguistic rules.

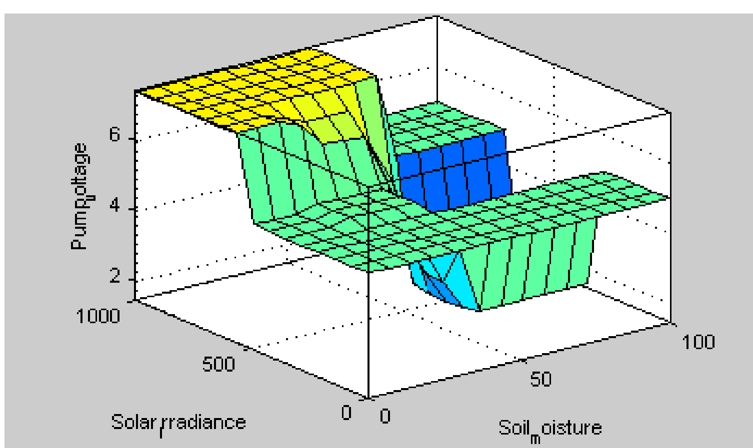

Figure 3. Surface graph.

From Fig. 3 it is clear that, for example an increasing of solar irradiance will increase pump voltage and, consequently, will decrease the rate of flow of water. We can analyze the surface graph relatively to other input variables. It allows us to make a control system for irrigation more effective.

Conclusion

In this paper we constructed the irrigation control system based on Z-information. An important qualitative attribute of information on which decisions are based is its reliability as it allows to take into account a degree of experts qualification. This solution provides us a better precision.

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THE ROLE OF ONLINE LEARNING PLATFORMS IN EDUCATION

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ABSTRACT

Digitization of education is a significant trend for reform and modernization in the global education environment. Digitization refers to the conversion of various information sources, such as texts, sounds, images, and videos, into digital language. Several analysts, including Tim Berners-Lee, the inventor of the World Wide Web, consider the emergence and growth of online education as a pivotal moment in the history of education. The European Union has adopted a digitalization approach to education. The EU 2020 education development plan focuses on digital technology, which was adopted in 2014. The primary goal of this document was to make effective progress in the field of information technology by integrating modern technologies and using technology alongside education. After conducting a comparative analysis of the existing conceptual apparatus, we have identified several fundamental concepts related to this problem area. Text, graphics, and multimedia information placed on Internet sites (servers) are commonly understood as Internet resources. This information is delivered to the user's computer in the form of a set of files or documents (including an archive) in various formats, such as HTML, DOC, PDF, and TXT. Internet resources also encompass executable programs placed on servers (distribution), which can be transferred to the user's computer for further use upon request. This article discusses how the concept of Internet portals is being used to address this problem, which is relevant across all areas of human activity influenced by the Internet. By creating a unified platform that aggregates and organizes educational resources, Internet portals can significantly enhance the accessibility and effectiveness of education.
Keywords: Internet resources, effectiveness of education, digitization.

Introduction

Internet resources can be classified into two broad categories related to the educational process. The first category includes resources designed for use in education, such as teaching, methodological, scientific-methodical, and additional text and illustrative materials, as well as test systems. These resources are tailored to a particular subject area and educational level. The second category includes resources that provide information on the educational system, educational institutions, or educational bodies, such as legal, regulatory, statistical, and reference data. These resources are not intended for use in the educational process but are aimed at providing information on the education system as a whole. The rapid development of the Internet and related technologies has created a pressing need for a single integrated system that provides free and fast access to educational resources to large groups of people. This issue is of utmost importance in education, which is a key driver of social development. To meet the diverse needs of various user groups, it is necessary to integrate information resources, applications, and services from various sources. Before formulating our own concept of creating educational online resources, let's analyze the scientific works that discuss the conceptual basis of creating online educational resources. In their "Concept of creating a system of Internet portals in the field of education", Russian scientists A. N. Tikhonov and A. D. Ivannikov proposed a theory for developing a methodology to populate the catalog of Internet resources, which is the main information component.

Methods

User interfaces are the entry points through which users interact with designs. Graphical user interfaces (GUIs) are design control panels and faces; it witnesses oral-auditory interaction in voice-controlled interfaces, gesture-based interfaces, and body movements through the fields of 3D design. User interface design is an art that includes building an important part of the user experience; users are very quick to evaluate designs in terms of readiness and similarity. At this stage, the main solutions related to the user interface are developed, they are taken into account by the authors when preparing training material and control tasks, templates are prepared \ Web pages, and then they are used in the formation of information components of the UIR [1]. The concept of user interface is still not unambiguously interpreted. In our opinion, the definition given by A.K. Gultyaev and V.A. Mashin is more successful: "An interface is a combination of the information model of the problem area with the means and methods of interaction of the user with the information model, as well as the components that ensure the formation of the information model in the program. Based on the analysis of the works, we list the general requirements for the user interface: - Unity (expecting the same reactions to the same system); - Friendliness (a set of interface features that ensure its simple development and effective use, regardless of the level of preparation of users); - Concise (provided by the method of defining standard parameters, performing icons instead of text expressions, etc.). - Convenience (achieved using customization tools); - Structured dialogue (separation of user interface components according to difficulty level). Based on the list of tasks put forward by A.I. Bashmakov to design the user interface of a computer textbook, let's distinguish specific tasks related to the design of the UIR user interface [2].

1. Determining the composition and characteristics of windows. Tutorial \-e-pages are displayed in windows. Windows are divided into 2 parts: primary and secondary. The main one is the browser window that is displayed immediately after OIR is loaded. Other windows created by SID are called pop-ups. Secondary windows can be located anywhere on the screen and can move independently of the main window. Middle windows are divided into modal and non-modal. A modal window provides a dialog level that is subordinate to the dialog in the window from which it is called. A window of this type blocks interaction with all other browser windows until it is closed. Modal windows are used to provide additional information as well as to enter information about what state further work with IRM will take. Extra-mode windows are used to organize parallel branches of a dialog by switching between main and extra-mode windows. Let's move on to window attributes [1]. The main attributes of windows are: original size and location; support for standard window view manipulation operations; window order relative to other windows; size limits; design style; the shape of the mouse cursor when the window title is in the working area of the window; icon associated with the window. The result of solving this problem is to define the purpose of the window types used in the UIR and the relationships between them. In other words, it is necessary to show what kind of windows will be used to present information of a different nature in certain situations and how to implement the connections between them [3].

2. Development of information presentation schemes. To solve this problem, it is necessary to create a list of typical structural units of the teaching material. They are distinguished by the hierarchical levels in which they are located and the roles they play within the levels. We give an approximate list of such sections: - Content block - A part of the main teaching material; - A piece of additional educational material; - Compact additional information designed to be presented in a modal window; - A fragment with a list of tasks to consolidate knowledge; - A fragment with a list of practical tasks; - A number of tasks for self-checking in the unit; - Page with results of knowledge control and their interpretation; - List of main concepts in the section; - Literature on the section; - Fragment of the dictionary[3].
3. Determining the tools to manage the training material. Navigation in the learning material is determined by the relationships that define the transitions between the structural units of the learning material. To implement these connections at the user interface level, the user-initiated transitions need to specify the previously selected types that define the appropriate means of the user interface [3].
4. Development of dialog schemes. Dialog refers to interaction by exchanging user and application data. The window in which the dialog flows is called a dialog box. It contains fields for displaying data and user interface controls that provide user input and pass it to the application for processing [3].
There are three main principles for organizing the dialogue
1) A user command is a combined action that defines both the data object and the action on it. Examples of dialogs based on this principle are activating by clicking the window title, navigating through educational materials using navigation buttons and hyperlinks, entering an answer to a query by clicking a button corresponding to one of the alternative options, selecting a list item by double-clicking, etc.
2) An action object (first data is entered or one or more data objects are selected, then the action to be performed is indicated). An example of a dialog based on this principle is, for example, text fields to enter or select a control task or a form where keys are placed and buttons to send to the server for evaluation or refuse to execute [5].
3) Action object (first, the action type is selected, as a result, the application switches to the appropriate mode; then the data object to which this action is directed is displayed). An example of a dialogue based on this principle is the manipulation of an interactive three-dimensional representation when, after selecting the type of action (rotate, move, increase, decrease, etc.) in the first step, the part of the scene to which it is closed is shown [6].
5. Definition of a set of user interface controls used in the UIR. The set of control elements is defined during the development of dialog schemes. Control elements act as the main structures from which the application interface is created. Their implementation is the first task in the stage of creating user interface templates. The requirements for the user interface and the rules for its construction are regulated by relevant standards.
6. Highlight customizable user interface settings. Configurability allows users to modify the interface themselves, bringing it to a state that provides the most favorable conditions for interaction with the UIR [4].
An interface that includes advanced customization features is called flexible. We list a number of user interface parameters that can be customized, including: the size, position and state of the main browser window; options for secondary windows; color scheme of pages; font sizes used to

represent educational material; show the status bar; the position of the border between the navigation bar and the workspace (for a frame structure) [3].
One of the main factors when choosing an authoring environment for OID development is the method it uses to support OIR in remote access mode. Here, environments where functional and data components are implemented in HTML, XML, and Java may be preferred.
We need to infer the possibility of using computer-aided design systems and authoring environments to create R-D [7]. Undoubted advantages of these tools include:
- visualization of the UIR design process;
- providing methodological guidance for developers who do not have extensive experience in creating UIR;
- Acceleration of UIR development by applying special templates;
- Project management support.
An insurmountable obstacle to the use of the above-mentioned means remains their high market price. Their other disadvantages include:
- Weak support of the Azerbaijani language in the products of foreign companies;
- Low distribution of localized versions of programs for Azerbaijan;
- Poor integration and compatibility of these funds;
- Large amount of received HTML documents (in kilobytes).
What are the main trends in technology and instrumental development
- To ensure that performers who are not professional programmers and do not have special technical education can use the tools;
- Use of object-oriented approach and the principles underlying CASE-technology;
- Management of the Cheshralization project and creation of conditions for multiple use of resources (functional and informational components, didactic, methodical and interface solutions);
- Provide continuous (until the end) support for all stages of development;
- The embodiment of the possibilities of automated implementation of didactic equipment working with computers in design and research works in specialized tools;
- Using visual development tools that blur the boundaries between design and implementation;
- Intellectualization of tools and products created with its help;
- To provide the ability to quickly build a prototype UIR without waiting for the completion of development of all components [5].

Result

Today, the following definition given by G. Myers is considered the generally accepted definition of testing: “Testing is the process of executing programs to detect errors.”
The testing process to be carried out by IR manufacturers should include three stages:
1) To test the technical implementation;
2) Didactic acceptance test;
3) Testing interactive interactions.
As a result of the technical application test, the following areas are checked.
1) Site structure. The type of site structure, the presence of broken links, the depth of hierarchical levels, etc.
2) Page loading speed. Recommended hardware and software for working with the site, server response speed, largest page size, average page size, average page load time, etc.

3) Design and layout. Combination of colors, font size, type of images used, printing of pages, etc.
4) General statistics of the content. The number of pages of content on the site, spelling, abbreviations, punctuation, spelling, misuse of words.
4) Use of technology: HTML, CSS, XML.
5) Programming: server technologies: CGI, ASP, PHP, etc.; client technologies: JavaScript, VBScript, Java, ActiveX, Plug-Ins, Cookies.
6) Browser support: MS Internet Explorer 5, 5.5, 6, Netscape Navigator 7.8, Opera, etc.
7) Navigation. Navigation efficiency, setting of navigation elements, navigation hierarchy, color of links, etc.
8) Search. Search type (full text, with keywords), search clarity, search precision, etc.
Testing didactic receptivity is usually combined with a pedagogical experiment. In order to test the didactic acceptability, an inspection is carried out in the following areas:
- Goals, content, methods: educational goals and logic in content selection; existence of a justified / recognized relationship between objectives, content and methods; relevance of the didactic approach to the current state of knowledge in terms of scientific content and educational goals;
- Form of presentation (graphics, tables, text, animation): existence of a known connection between the form of presentation, WIR and work sequence, content and didactic method; the freedom of presentation and the way to work with IWR from various didactic strategies;
- Impact: Does SSI contribute to a new learning experience and to the emergence of new forms of learning that would be unthinkable without computers?
Checking for interactive interactions includes: entering incorrect data; feedback; ways to communicate with the teacher; ways to control knowledge; drop-down menus, scrolling images and other interactive navigation elements.

Conclusion

The use of technologies in education can lead to an increase in efficiency, a decrease in various costs, and an increase in effectiveness. Therefore, it is important for educational institutions to create websites that meet modern requirements using technologies such as HTML, CSS, JavaScript, JQuery, Asp.Net, and PHP. one of the issues is the simplicity of the user interface, and the design does not tire people. In addition, the world's oldest and highly ranked universities manage to introduce their educational institutions to students and professors from all over the world using such platforms, and implement the process of students' admission to universities online. Web technologies in education Another advantage of its use is related to the transition to distance education, which recently created the need for distance education after the announcement of the worldwide Covid19 pandemic. However, there are some shortcomings in this type of education:
First, existing services will not be able to withstand such an influx of momentum
Second, not all students have access to the Internet, and some families do not use computers at all for various reasons.
Children are used to the school primarily communicating face-to-face with the teacher, but not the online format.
Students will not be easily interested in participating in distance education.

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Often, parents prefer to educate their children by themselves according to the program approved by the state. At the same time, you can study using both school textbooks and author's methods. The main thing here is the final result and the execution of the program. On this topic, large online communities of parents have been created, who exchange experiences on the Internet and solve emerging problems together. For example, many parents have concerns about how a child will learn the material. By being in the classroom and discussing, for example, some literary work or historical event, the student receives many different opinions in a short time and learns to search for the truth among them. Thus, the material is remembered faster. At home, when a mother acts as a teacher, it is more difficult to gain such experience. There are various solutions for this. For example, you can watch movies adapted with a child based on a historical event, or parents can freely discuss this or that educational material from time to time with their children using some life examples, draw them into independent discussions and express their different opinions.

During these periods, some services, such as Foxford, Yandex.Tutorial, MAXIMUM edu, Uchi.ru, made online services free. I think this is great and shows that modern entrepreneurs in education are ready to work together with public educational institutions in a crisis situation. In addition, we can note that the most important issue for the creation of technologies and the increase in the number of users is the training of specialists, which can be achieved by conducting programming classes from high schools. With the increase in the number of specialists, achievements in the field of technology, including in the application of technologies in education, can increase.

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DEVELOPMENT OF IMAGE PROCESSING ALGORITHM UTILIZING NEURAL NETWORKS AND FUZZY LOGIC

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ABSTRACT

Despite their limitations, robots should have the ability to gather information from their surroundings such as location, color, light, and images. This data must then be analyzed automatically, and based on that analysis, the robot should be able to determine an appropriate reaction to its environment. Once a decision has been made, the robot must be able to execute it through the use of actuators and motion systems. Robots are comprised of sensors that collect real-time environmental data, an electronic brain that processes and decides, and movement controls that carry out those decisions.
Images must be displayed as an analog signal during the image processing process. Video data, originally in the form of analog voltage, must be represented in the form of binary codes.
This article deals with the development of image processing algorithm for industrial robots based on neural network and fuzzy logic.
Keywords: image processing, fuzzy logic, pixel, robot, sensor.

Introductıon

There are several fuzzy methodologies that are employed in image processing, which include fuzzy processing, representation, image segmentation, and fuzzy sets.In the process of image recognition, image preview is of great importance. Because, at the stage of pre-processing of images, the quality of the image is determined, and this information is sent to the inputs of the neural network at later stages. In solving the problem to be performed, the initial fuzzy algorithm is implemented in the following sequence of steps (Figure 1):
- Taking an image using a web camera;
- Converting the color appearance of the image to grayscale;
- Image processing using fuzzy logic.

Image acquisition is the initial stage of fuzzy logic image processing. A web camera is used for this [1]. In the second step, the colors of the image should be converted to grayscale. Converting the colors of the image to gray colors is done as follows. The entire color palette (RGB) is depicted in the form of a cube whose top corresponds to different colors (Figure 1).

Problem solving

To convert an image to grayscale, the intensity of the red, green, and blue colors of the image is determined individually for each pixel. Then, the color of that pixel is replaced with gray color by the calculation based on the following formula:

$$Y = 0.255R + 0.255G + 0.255B$$

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Here, Y is the new color value, R is the intensity of red color, G is the intensity of green color, B is the intensity of blue color [2].

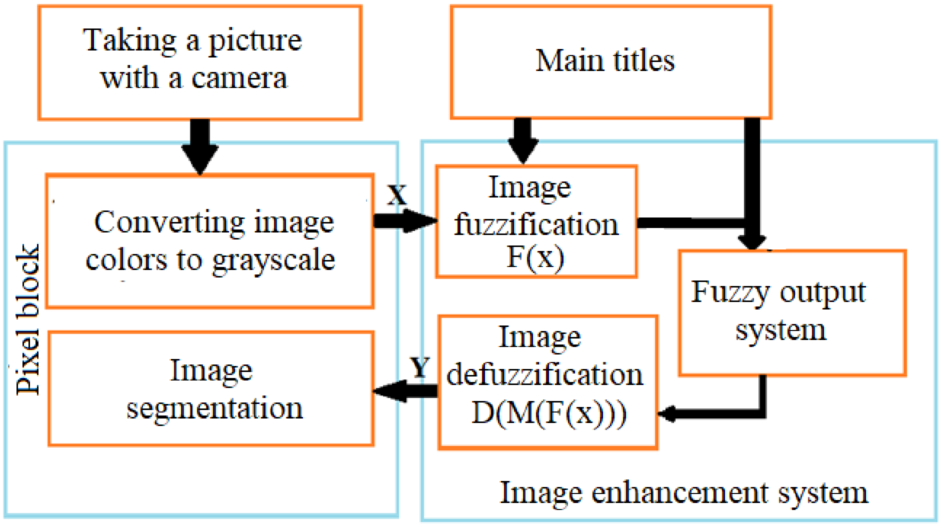

Figure 1. Image processing based on fuzzy algorithm.

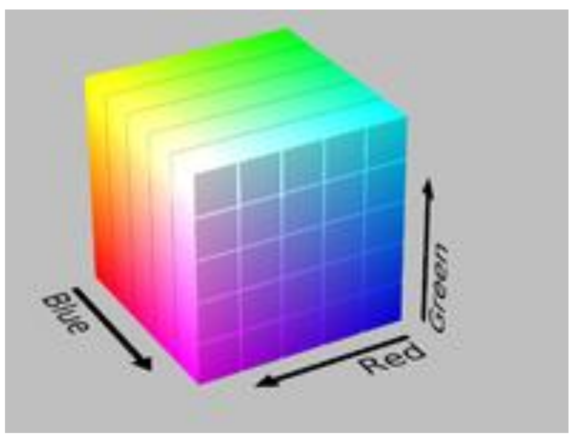

Figure 2. Illustration of the color palette on a cube.

In order to assess the image's brightness level, the average of the RGB color tones is computed by considering the maximum and minimum values:

$$G_{lightness} = \frac{\max(R, G, B) + \min(R, G, B)}{2}$$

The intensity of the image is obtained by calculating the average of the three components in the RGB space. When calculated mathematically, the following expression is obtained:

$$G_{intensity} = \frac{R+G+B}{3},$$

geometrically, it is calculated as follows:

$$G_{intensity} = \sqrt[3]{R \times G \times B}$$

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Considering the sensitivity of the human eye when determining brightness, red, green and blue colors are used with moderate weight. Since the human eye is most sensitive to green, its weight is considered the most important:

$$G_{luminance} = (0.3R + 0.59G + 0.11B)$$

The software automatically determines the brightness during image processing. There is a process of converting colors (RGB) into grayscale depending on the brightness in the email process of the image with the algorithm based on fuzzy logic. The "rgb2gray" function in the MATLAB environment performs this operation [3]. The image is then converted from RGB colors to black and white (Figure 3).

Binarization of the image in the processing process

The purpose of image fuzzy processing is to perform image formation, enhancement, binarization and coding. Binarization is the process of converting each pixel of an image into an image that contains two colors. That means each pixel has only two colors (black and white in our case). As a result of this conversion, the pixel color is conventionally taken as zero or one.Pixels with a value of zero (white pixels in this case) are called background. Pixels with a value of one (black) are called foreground. However, in the image consisting of two colors obtained as a result of such a change, the appearance of gaps and blurs, the overlap of objects, the appearance of objects in homogeneous areas, and the loss of integrity.

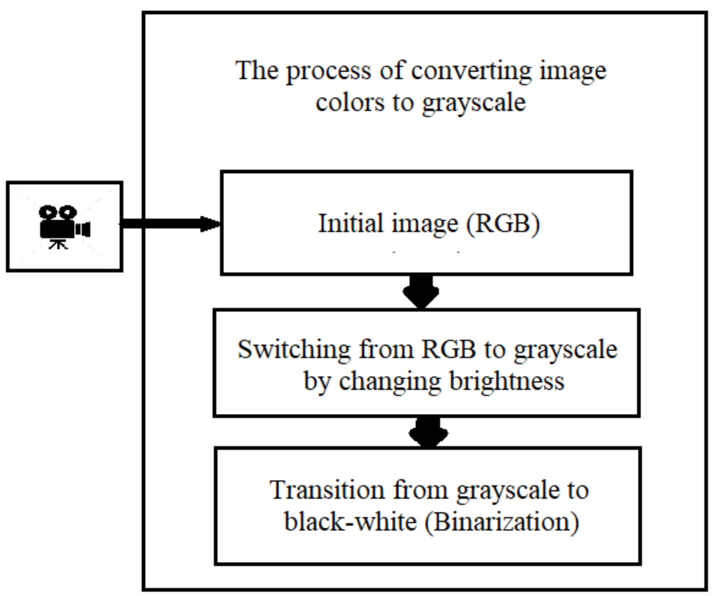

Figure 3. The process of converting colors to grayscale.

Loss of integrity and appearance of the object can be caused by uneven lighting of the object. During the operation, a special difficulty arises due to the overlapping of objects (or the objects touching each other). Because, on the one hand, the image of several objects can be seen as one object. On the other hand, algorithms that analyze the geometric integrity of the object in places

where there are overlaps present these areas as a background. This causes ambiguities. If part of the data disappears, it is impossible to distinguish the objects [4].
In practice, there are two options for applying the algorithm: several intersecting objects are treated as one object. Also, one of the overlapping objects is taken as the background. Field processing converts a color or grayscale image to a black-and-white image. Changes in the field, intuitive features, and applied imagery are central to segmentation. For each pixel of the image, the segment value corresponds to white when it is above a certain level. If it is below that level, then it will match the black color. Color shades range from 0 to 255. 255 cells are taken as black color and 0 cells as white color.
Currently, there are many binarization methods. If the brightness of the pixel exceeds the field value, for example $P(x, y) > P_T(x, y)$, then the pixels in the two-color image will be white. Otherwise, it will be black [5].
In the process of binarization, image processing methods are performed in two ways based on the principle of building the surface of the area. These methods are global and local methods of the binarization process. In global image binarization, the area surface is a plane with a constant value of brightness. The brightness value selected during image loading is calculated during histogram analysis of the image and is the same for all pixels of the original image. The global method has a significant drawback that if the received image has a heterogeneous coverage, then the uncleared areas are taken as the foreground. In the local binarization method, the brightness value is selected based on some characteristics of the points around a certain point. This value usually has a different value for each point. The disadvantage of such transformation is the low speed of the algorithms associated with the recalculation of brightness values for each point of the image [1,2].
Burnsen's method is used to solve the problem. This method is based on comparing the brightness value of the converted pixel with the average brightness value of the original image. The pixels of the image, in turn, are processed by comparing the intensity with the average transparency values in the centers (Figure 4).

P_1	P_2	P_3
P_0	$\longrightarrow$ (m, n)	P_4
P_7	P_6	P_5

Figure 4. Pixel conversion of the image.

Fuzzy logic algorithms for boundary delineation and image segmentation. At this stage, after replacing the colors of the image with black and white colors, a gradient image is obtained with the helpof the Sobel operator. Then the gradient image is transferred to the inputs of the fuzzy image processing (FIP) (Figure 5).
Fuzzy logic image processing consists of three main steps: image fuzzification F, fuzzy output system M and image defuzzification D. Image fuzzification is performed initially. After blurring the image data from the gray level, a fuzzy output system is defined. Fuzzification is the encoding

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of image data, and blurring is a process that provides permission to examine results and process images in fuzzy ways [6].

Image X and gray levels with dimensions M×N and L are g=0, 1, 2, ..., L-1. An image can be defined as a fuzzy set of points. Furthermore, all predefined values (such as brightness, smoothness, etc.) must be assigned to each pixel.

$$X = \cup_{m-1}^{M} \cup_{n-1}^{N} \frac{\mu_{mn}}{g_{mn}} \mu_{mn} \in [0,1]$$

Here, μ_{mn} and g_{mn} are the features of the pixel in the recording of fuzzy sets. A pixel's feature consists of the data of a specific application and the corresponding database.

The interdependence formula of input system Y and output system X is given as follows:

$Y = D(M(F(X)))$

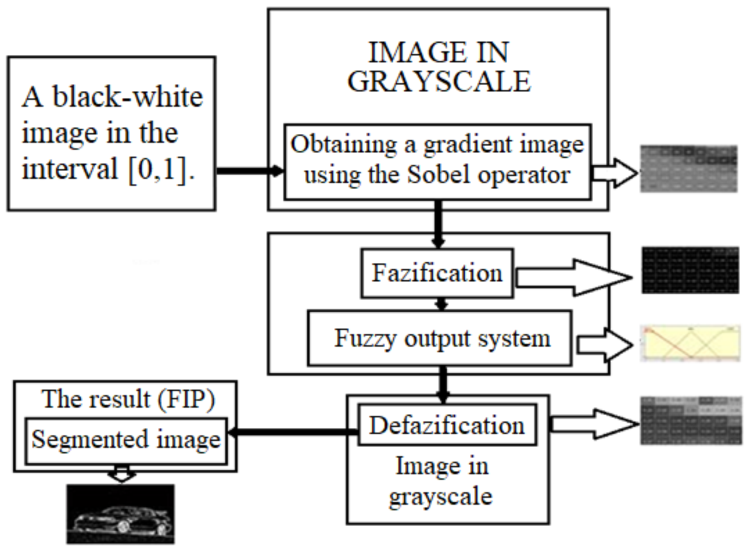

Figure 5. Borders with Fuzzy Image Processing Algorithmrestriction/

Using a neural network in image recognition

Multi-layer perceptron is an artificial neural network that includes an input layer and a computational layer of one or more neurons. Each layer has several input nodes (Figure 6). In such networks, the signal given to the input layer is transmitted in the forward direction to the output layer. This type of neural network is successfully used to solve various problems. It is especially used for the problem of image recognition.

This neural network consists of several layers of neurons. Each neuron of the previous layer is connected to each neuron of the next layer. After determining the number of layers and the number of elements of each layer in such networks, it is required to calculate the values of the weights and the threshold of the network in such a way that it is possible to minimize the prediction error. This task is solved with the help of various learning algorithms. The essence of these algorithms is to match the artificial neural network with the data of the process. The error of the constructed network is determined by comparing the values obtained at the output of the

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network with the target values after using all the input data. Then, the obtained differences are collected in the total error function, which characterizes the entire network error.
One of the algorithms used to learn multilayer neural networks is the "back propagation error" algorithm. In this algorithm, the "error surface gradient" vector is calculated. Then we move forward a little in the direction of the vector (the vector will show us the direction of sharp descent). Here the error volume will be smaller. Such consistent progress will gradually lead to minimization of errors. Here there is a difficulty in determining the value that arises when moving forward. If the step size is large, this will cause a steep descent. But there is also the possibility of "bouncing" to any point or going in the wrong direction depending on the complexity of the surface shape. For example, if the surface is a narrow ravine with steep slopes, the algorithm will move slowly, jumping from one hole to another. If the step size is small, then it will not find the optimal direction [6]. However, the number of repetitions will increase significantly.

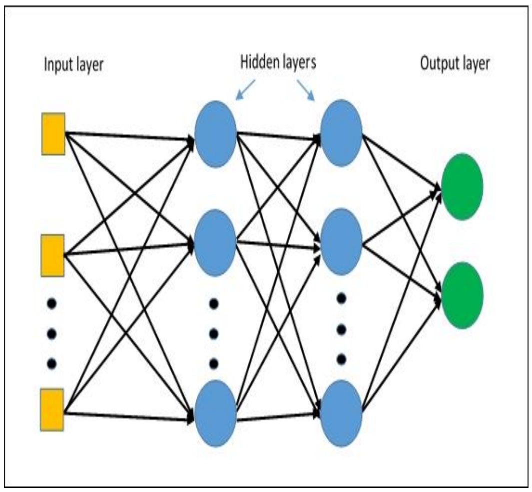

Figure 6. Multi-layer perceptron.

In order to achieve the most optimal result, the step sizes are adjusted to a constant speed according to the steepness of the surface. The choice of this constant is carried out experimentally and is based on the conditions of a certain task.
We provide the following notes. The matrix of weight coefficients from the inputs to the hidden layer is shown in the form - W. The matrix of weights connecting the hidden and output layer - V. For the indices, the following notes should be taken:
-Entries will be given only with this index – i;
-Hidden layer elements – j;
-Output indexes – k;
-Number of network inputs – n;
-The number of neurons in the hidden layer – m;
-Number of neurons in 3 output layers – p.
Allowing the network to run on an instance: $(X^t, D^t)t = \overline{1,T}$.
Then the learning algorithm for the multilayer perceptron will be as follows:

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Step 1. Initialization of the network: Small random values are set for the weight coefficients. For example, ranges (-0.3, 0.3); is given, the learning accuracy parameter –ε, the learning speed parameter – α (as a rule, ≈0.1 can be reduced during the learning process), the maximum allowed number of repetitions – N_{max}

Step 2. Calculation of the current output signal: One of the images from the test samples is fed to the input of the network and the output values of all neurons are determined.

Step 3. Determination of synoptic weights: Calculation of weight changes of the output layer of the neural network by means of formulas:

$$V_{jk}^{N+1} = V_{jk}^{N} - \alpha \frac{\partial E}{\partial V_{jk}}$$

$$\frac{\partial E}{\partial V_{jk}} = \delta_k y_j^c$$

$$\delta_k = (y_k - d_k) y_k (1 - y_k)$$

The following formulas are used to calculate weight changes for the hidden layer:

$$W_{ij}^{N+1} = W_{ij}^{N} - \alpha \frac{\partial E}{\partial W_{ij}}$$

$$\frac{\partial E}{\partial W_{ij}} = \left(\sum_{k=1}^{\infty} \delta_k V_{jk}^{N+1} \right) y_j^c (1 - y_j^c) X_i$$

Step 4. Repeat steps 2-3 for all test vectors. Training is terminated when the error function for each of the training images reaches its eigenvalues. In Step 2, the vectors from the training sequence are presented to the input in random order.

The number of inputs and outputs of the network is usually determined by the conditions of the problem. The size of the hidden layer is found experimentally. Generally, the number of neurons is 30-50% of the number of inputs. A large number of neurons in the hidden layer causes the network to lose its ability to generalize. It remembers only the elements of the test pattern thoroughly and does not react to similar patterns, which are unacceptable for recognition tasks. If the number of neurons in the hidden layer is too small, the network simply cannot learn [5].

Conclusion: The problem of image processing based on the fuzzy algorithm was considered and the boundary limitation with the fuzzy image processing algorithm was analyzed. Also, the issues of using neural network in image recognition were investigated.

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CONSTRUCTION OF THE KINEMATIC MODEL OF ROBOTIC SYSTEMS IN THE MATLAB ENVIRONMENT

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ABSTRACT

Robotics has become relatively accessible with low-cost projects, but there is still a need to create models that accurately represent the robot's physical behavior. Creating a virtual platform allows us to test behavioral algorithms using artificial intelligence. In addition, it will enable us to find potential problems in the physical design of the robot. The article describes the methodology of building a kinematic model and simulation of an autonomous robot. The development of a kinematic model and its implementation using several tools are presented. The environment used for the experiment is very close to natural conditions and reflects the kinematic characteristics of the robot. As a result, the simulation of the model following the mobile robot's kinematics is executed and tested in MATLAB.
As a study, the m-file creation in MATLAB, its use with the Simulink package, and the solution of the forward and inverse problem of kinematics are shown. In addition to constructing the robot body using Simulink blocks, the structure of the kinematic scheme is simulated using the Denavit-Hartenberg (DH) parameters of the robot without blocks. "Simscape" and "Robotics System Toolbox" packages simulate forward and inverse kinematics using the Simulink package, and the robot's handle and body movement are observed. In the forward kinematics problem, the readings in the Scope compare the signals received from joint one and the end effector. For the inverse kinematic problem, the parameters of the manipulator along the XYZ axes are entered using the "Signal builder" block, and the circular movement of the arm is observed. In contrast, the handle of the manipulator remains fixed at a given point.
Keywords: mobile robot, kinematic model, the forward and inverse problem of kinematics, Denavit-Hartenberg parameters, joint types

The purpose of the work

Kinematics is a type of study that shows the behavior of mechanical systems. In mobile robotics, the mechanical behavior of the robot must first be understood to both design task-appropriate mobile robots and understand the process of creating a control program for the mobile robotic hardware. Robotic manipulators have been the object of intensive research for many years. Of course, mobile robots are not the first complex mechanical systems to require such analysis. Manipulator robots are more complex than mobile robots and can consist of five or more joints. However, the first mobile robots were driven machines with a simple differential structure. Recently, the kinematics and dynamics of robotic robot manipulators have been fully understood [1]. The field of application of mobile robotics raises the same kinematic questions as the field of application of a robot manipulator. A robot arm's controllability determines how it can actively connect motors to move from one position to another in its working environment. Similarly, the controllability of a mobile robot determines the possible paths and trajectories in its workplace. Due to mass and force considerations, robot dynamics impose additional constraints on the workspace and trajectory [2].

A new robot kinematic simulation system called ROBOKISS was developed [3]. Engineers can use ROBOKISS software to construct and control geometric models of robotic systems, specify robot tasks, perform kinematic analysis to investigate robot trajectories in space, and simulate robot movements on a Spectragraphics workstation. Since the kinematic simulation is processed independently of the robots, the ROBOKISS program can be considered as part of a generalized offline programming system in the future.

The rapidly growing interest in robotics and mechatronics systems is due to the increasing prevalence of robotic platforms performing various functions in our daily lives. They can be seen in the industry to perform other processes such as welding, painting, assembly (manipulators), and moving or transporting objects from one place to another [4]. Mobile robots can be legged or wheeled, or even a combination of both, depending on the application type they are intended for. Mobile robots can take on different shapes, sizes, and styles of mobility that allow them to operate in their environments, whether on land, in the air, or water; they can be flying devices or even underwater or amphibious [3-5].

From the point of view of kinematics, the main difference between a manipulator and a mobile robot is the nature and location of its joints [4,6]. A manipulator robot is usually modeled as an open kinematic chain consisting of alternating rigid bodies with one degree of freedom joint elements. In contrast, the kinematic structure of a mobile robot can be considered as a set of closed kinematic chains, such as the wheels in contact with the ground. Furthermore, the wheel-ground interaction is defined from a kinematic point of view as a planar joint with three degrees of freedom, where one of them usually represents uncontrolled lateral slip. These two facts complicate the construction of the model.

The kinematic model mathematically describes the robot's movement without considering the forces affecting the action and defines the geometric relationship between the elements. This kinematic model is represented as a tree structure. In a robot's kinematic model, the various manipulator joints are known as links, and the integration of two or more links is called a joint. Joints are the elements of the robot that help the links to move in different types of movements (Fig.1).

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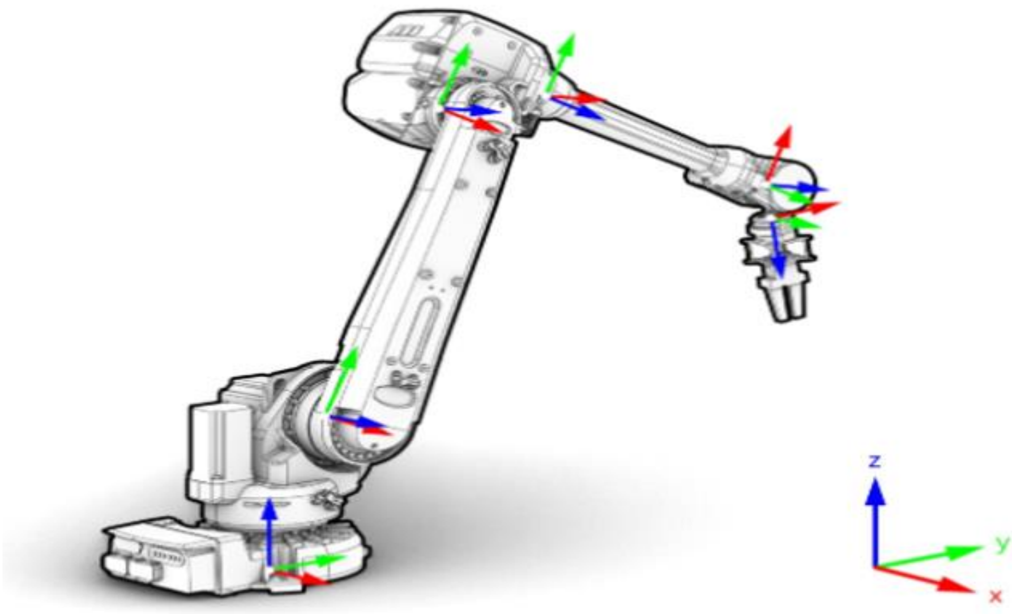

Figure 1. Division of the manipulator into frames.

The manipulator robot's Denavit-Hartenberg (DH) parameters are used incrementally to build the tree robot model. Relative DH parameters are added for each compound. As a result, the robot views the frames and communicates with the final model.
The DH parameters define the geometry of how each rigid body is connected to the other through a joint. Parameters follow four transformation conventions.
A— The length of the standard regular line between two z-axes perpendicular to both axes;
α— Rotation angle for the standard normal;
d— Rotation of the links in the direction typical to each other along the z-axis;

The three main types of joints are: hinge-type (Revolute) - a joint that rotates along the axis and has a limited range defined by upper and lower limits; prismatic- a joint with a limited range defined by upper and lower boundaries, sliding along the axis; fixed- is not a joint (constrained) because it cannot move.
θ— Rotation angle for the x-axis along the previous z-axis.

Kinematic modeling and its working principle
It is necessary to consider the forward and inverse problems of kinematics to build a kinematic model. Suppose the geometry of the robot and all its joint positions are known. In that case, a mathematical calculation can be performed, and the position and orientation of any robot point can be determined (Fig 2). This is a forward kinematics (FK) problem. The more common problem of robot manipulation is the opposite. Calculating the coordinates necessary for the end

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effector to reach a specific position and orientation is essential. This is an inverse kinematics (IK) problem.

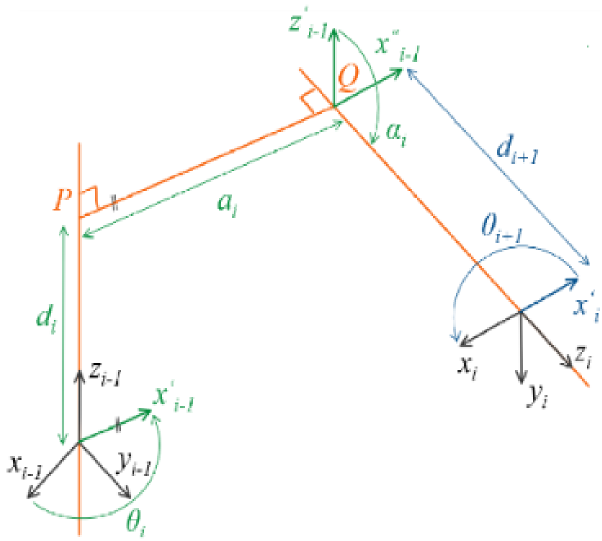

Figure 2. Description of the DH parameters of the manipulator on the kinematic scheme.

During kinematic modeling, three main stages are considered.
1) Robot parameters are displayed as a matrix.
2) The "rigidBodyTree" algorithm is used
for the robot.
3) Items are created in the "rigidBodyTree" object, and other items are defined based on the connections. The DH parameters that perform this process are repeated for each link-joining point (Fig 3).

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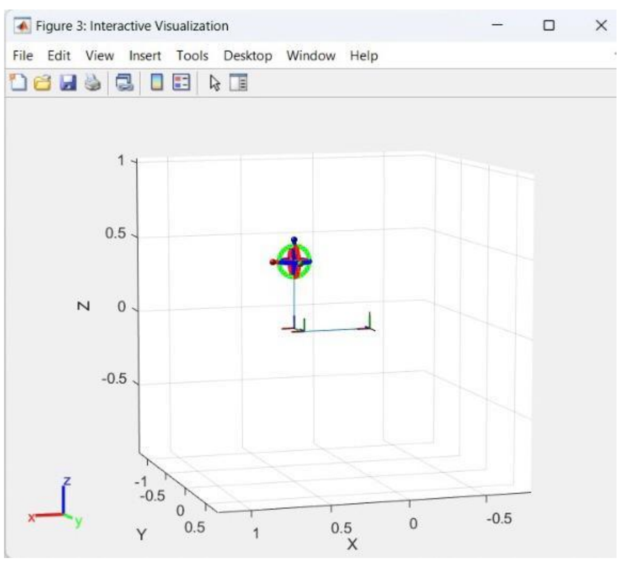
```
>> dhparams = [0      pi/2     0        0;
               0.4318  0       0        0
               0.0203  -pi/2   0.15005  0;
               0       pi/2    0.4318   0;
               0       -pi/2   0        0;
               0       0       0        0];
>> robot = rigidBodyTree;
>> bodies = cell(6,1);
joints = cell(6,1);
for i = 1:6
    bodies{i} = rigidBody(['body' num2str(i)]);
    joints{i} = rigidBodyJoint(['jnt' num2str(i)],"revolute");
    setFixedTransform(joints{i},dhparams(i,:),"dh");
    bodies{i}.Joint = joints{i};
    if i == 1
        addBody(robot,bodies{i},"base")
    else
        addBody(robot,bodies{i},bodies{i-1}.Name)
    end
end
>> showdetails(robot)
--------------------
Robot: (6 bodies)

 Idx    Body Name    Joint Name    Joint Type    Parent Name(Idx)    Children Name(s)
 ---    ---------    ----------    ----------    ----------------    ----------------
   1        body1          jnt1      revolute             base(0)    body2(2)
   2        body2          jnt2      revolute            body1(1)    body3(3)
   3        body3          jnt3      revolute            body2(2)    body4(4)
   4        body4          jnt4      revolute            body3(3)    body5(5)
   5        body5          jnt5      revolute            body4(4)    body6(6)
   6        body6          jnt6      revolute            body5(5)
--------------------
>> figure(Name="PUMA Robot Model")
show(robot);
fx >>
```

Figure 3. Coding based on DH parameters.



Conclusion 1. The final description of the manipulator.

Creating a manipulator in the MATLAB environment and determining the mobility of links. "Simscape" and "Robotics System Toolbox" packages create the manipulator in the MATLAB environment.

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At first, three main parameters are considered. The initial movement function of the robot, the frame of the position in which the main point will be located, and the configuration element of the mechanism (gravitational force is added). After that, the links are placed based on their parameters (Fig 4).

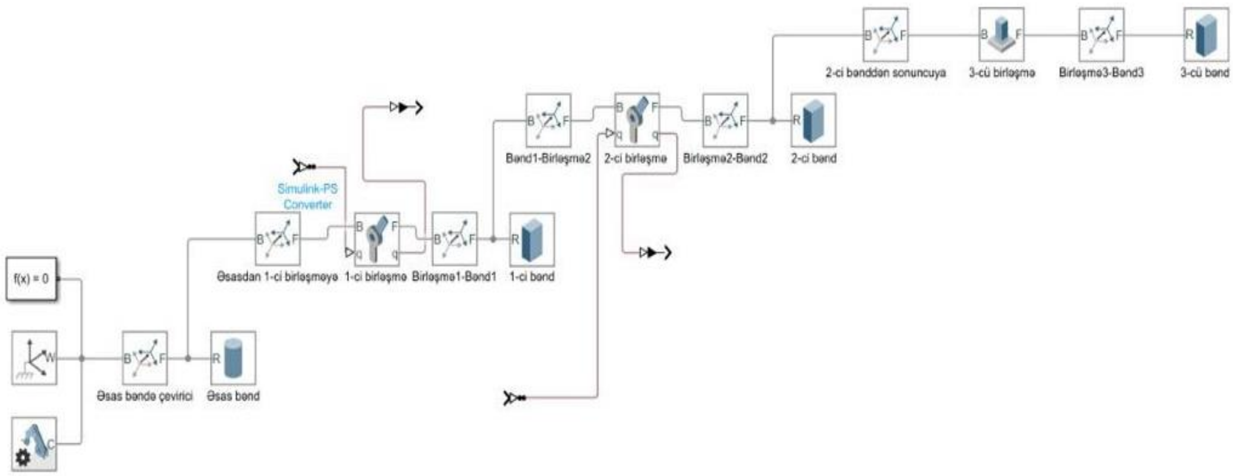
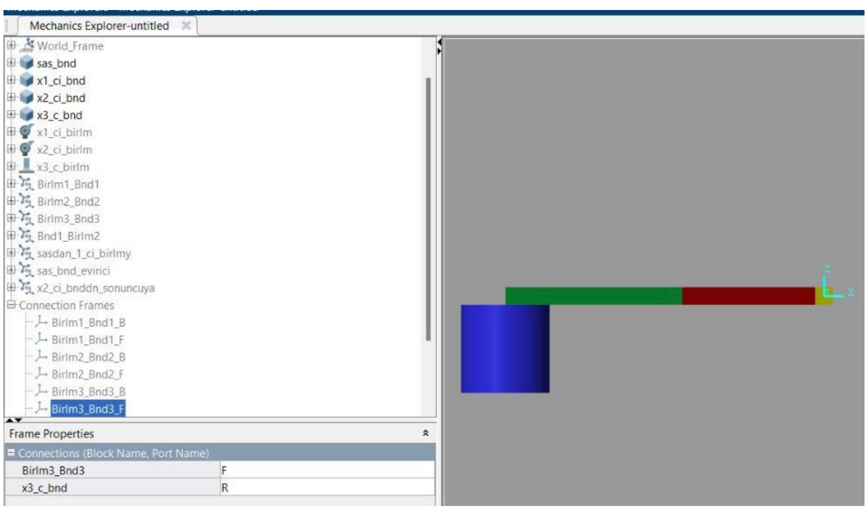


Figure 4: Tree diagram of manipulator creation [5-7].



Conclusion 2. Description of the manipulator without motion of the links.

The problem of forward and inverse kinematics must be solved to give movement to the links. For this, let us first look at the simulation of the forward problem of kinematics. For this, we make the blocks in Figure 5 into a subsystem.

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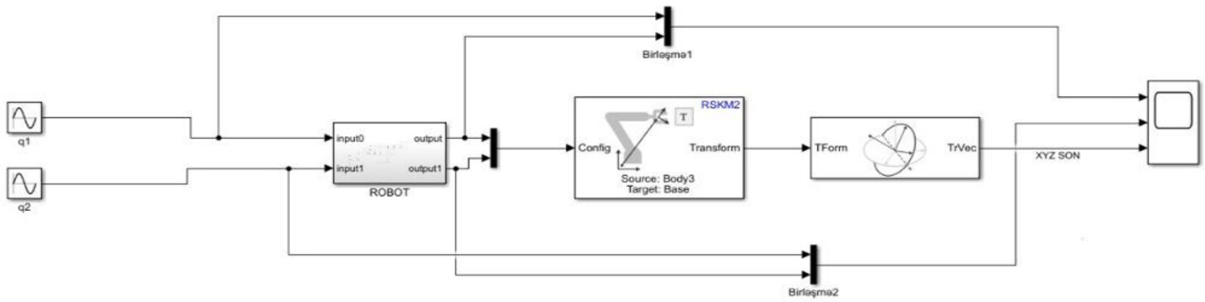
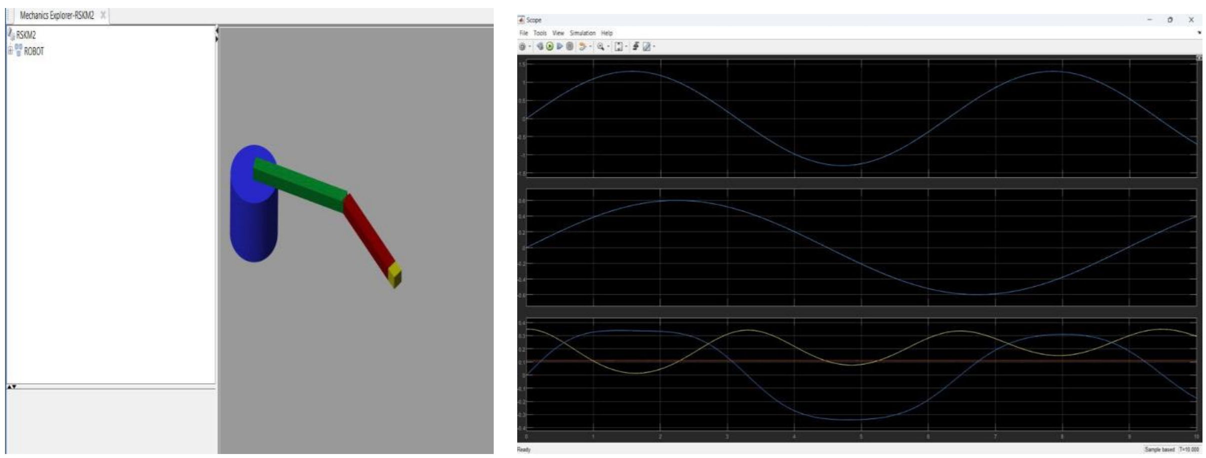


Figure 5. Construction of image blocks of the manipulator movement according to the forward problem of kinematics [8].



Conclusion 3. Description of the motion of the manipulator according to the forward problem of kinematics.

Conclusion 3.1: Description of inputs 1 and 2 and standard output signals in Scope.
In order to solve the inverse problem of kinematics (Fig 6), coordinates should be given, and force and moment should be determined based on this.

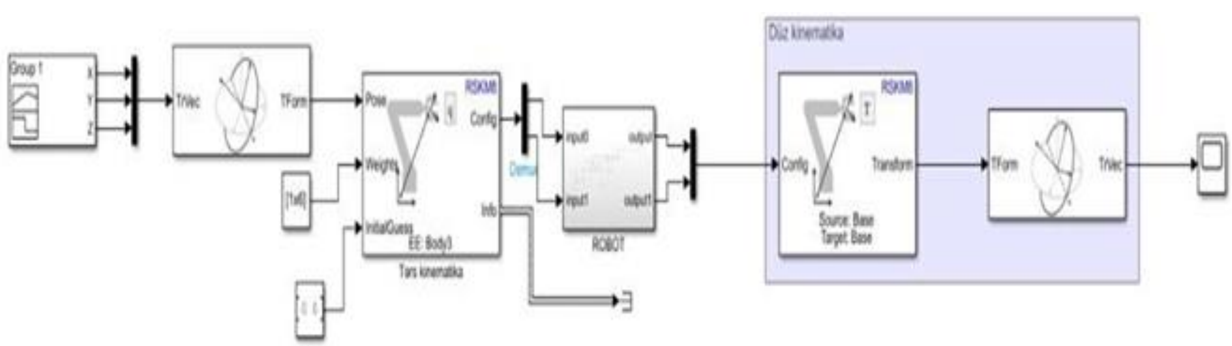


Figure 6. Construction of image blocks of the manipulator movement according to the inverse problem of kinematics.

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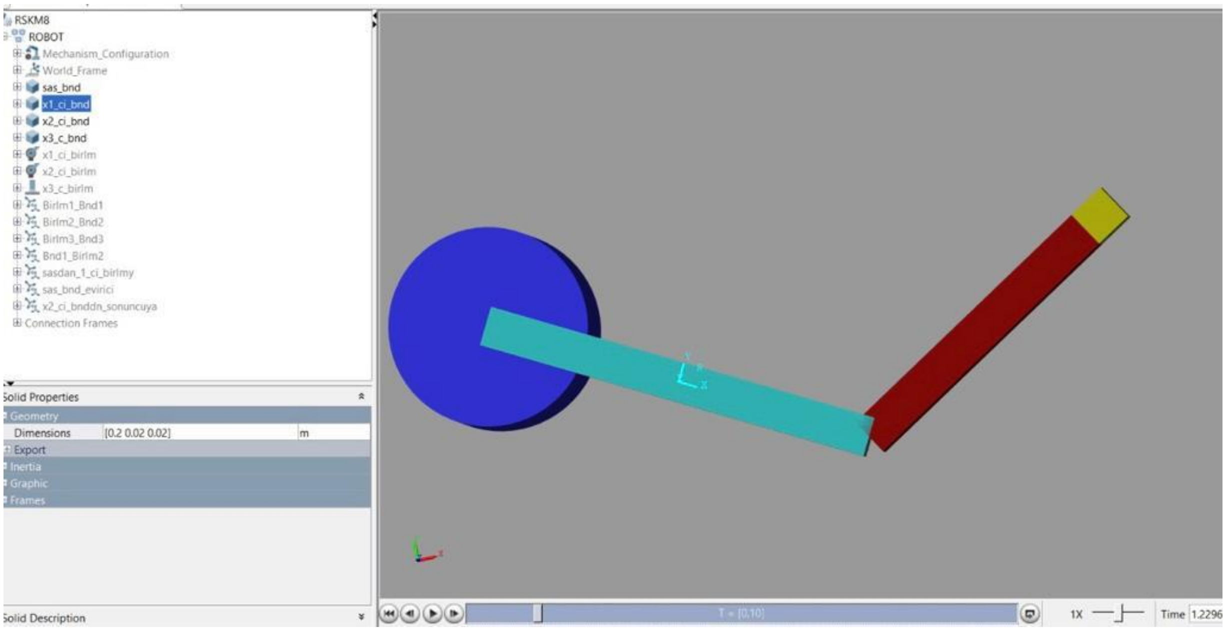

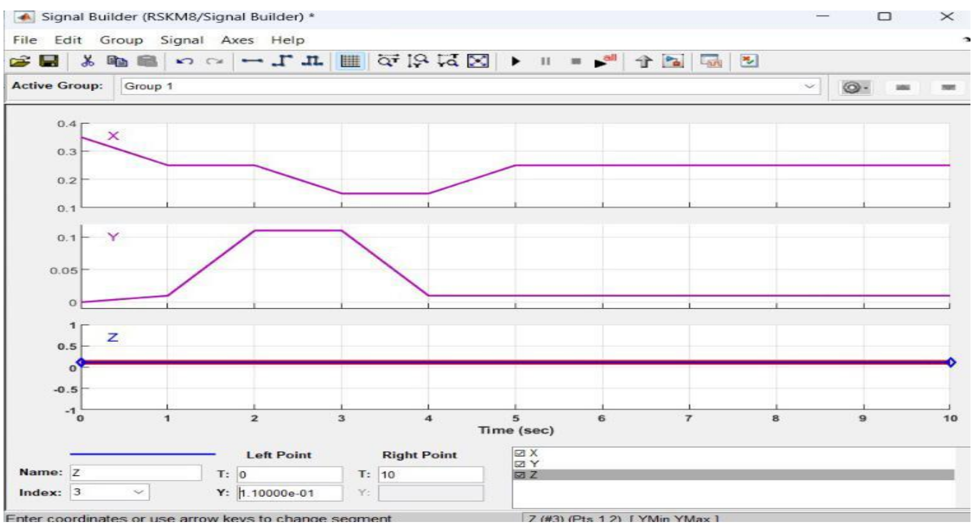

Conclusion 4. Description of the motion of the manipulator kinematics according to the inverse problem.

Conclusion

As a result of the research, the following were obtained: In Figure 3, an m-file was created in MATLAB, the code was executed, and as a result, the kinematic scheme of the manipulator was obtained in Result 1. In Figures 4, 5, and 6, the body of the manipulator was built, and its movements were determined using the Simulink package. The block diagram of the forward kinematics problem of the robot is shown in Figure 5, and the simulation of the forward kinematics problem is obtained in Conclusion 2. It can be seen here that the robot's body moves within a specific range in the forward kinematic problem. Blocks in Figure 6 illustrate the inverse problem of kinematics, and giving coordinates for obtaining the results are reflected in Figure 7.

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In result 4, it is observed that the robot's handle is focused on one point, and the arm is in a circular motion due to the force and moment of the manipulator. As a result, both kinematics problems are solved in the MATLAB environment, and their simulation is given.

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BIG DATA PROCESSING WITH PYTHON IN SOCIAL NETWORKS

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ABSTRACT

Social networks generate a huge amount of data about the behavior, interests, preferences and connections of users, which can be used for various purposes such as marketing, advertising, analytics, research, etc. However, these data have a large volume, variety and update rate, and require special methods and tools for their analysis and processing. Python is a high-level programming language that has many advantages for working with big data, such as simplicity and flexibility of syntax, a rich set of libraries and frameworks for data processing and analysis, support for multithreading and distributed computing, open source code, and a large community of developers and users.
The article shows how to use Python to parse and collect data from various sources, to clean and pre-process data, such as removing duplicates, gaps, outliers and noise, normalizing and standardizing data, encoding categorical features, etc., for analysis and data visualization, such as building statistical characteristics, graphs, charts and maps to study the distribution, correlation and dependence of data, for machine learning and data mining.
Keywords: Python, big data, social networks, data parsing, data analysis, machine learning.

Introduction

Social networks generate a huge amount of data about the behavior, interests, preferences and connections of users, which can be used for various purposes such as marketing, advertising, analytics, research, etc. However, these data have a large volume, variety and update rate, and require special methods and tools for their analysis and processing. The purpose of this article is to look at one such method - social media data analysis with Python. Python is a high-level programming language that has many advantages for working with big data. It is a simple and flexible language that allows you to write and debug code quickly and easily. Also a rich language that has many libraries and frameworks for data processing and analysis, such as Pandas, NumPy, SciPy, Scikit-learn, TensorFlow, PyTorch and others. It is also a powerful language that supports multithreading and distributed computing, which allow you to efficiently use computer resources and process large amounts of data in parallel. Also, one of the main advantages of Python is that it is an open language that has a large community of developers and users who are constantly improving and expanding the capabilities of the language. [1]. This article shows how to use Python to solve various social network data analysis problems using data from the popular social network Facebook as an example. We will also provide Python code examples and data analysis results.
The purpose of this article is to look at the main steps involved in processing big data with Python in social networks:

- Parsing and collecting data from various sources

- Data cleaning and preprocessing
- Data analysis and visualization
- Machine learning and data mining

You should show how to use Python to solve these problems using data from popular social networks such as Facebook, Twitter, Instagram, etc. And also give examples of code in Python and the results of data processing.

Formulation of the problem

Social networks are one of the main sources of big data in the modern world. According to a Cisco report [3], in 2021, global social media data traffic will reach 6.8 zettabytes per month, which is 7 times more than in 2016. This data contains valuable information about the behavior, interests, preferences and connections of users, which can be used for various purposes such as marketing, advertising, analytics, research, etc. However, the processing of these data is a complex and computationally expensive task that requires special methods and tools. Big data in social networks is characterized by high volume (volume), diversity (variety), speed (velocity) and reliability (veracity) [2]. This means that the data is large and constantly growing; data has various formats and structures, such as text, images, video, audio, etc.; data arrives quickly and needs to be processed quickly; data may be incomplete, inaccurate or unreliable. To solve these problems, it is necessary to use effective methods and tools for processing big data in social networks. These methods and tools should take into account the specifics of social media data, such as:

• Data Connectivity: Social media data is a complex network structure that reflects the relationships between users and objects. To analyze these structures, it is necessary to use network analysis methods.

• Data Semantics: Social media data contains a lot of textual information that has varying levels of formality, tone, and meaning. To analyze these texts, natural language processing techniques must be used.

• Multi-modality of data: social media data is made up of different types of media such as images, video, audio, etc., which may complement or contradict each other. To analyze these media, it is necessary to use the methods of multimodal analysis

Table 1. Examples of social media data types and related analysis methods:

Data type	Examples	Analysis Methods
Text	Posts, comments, reviews, tweets, etc.	Natural language processing, classification, clustering, sentiment analysis, etc.
Images	Photos, logos, emotions, etc.	Computer vision, classification, clustering, object and face recognition, etc.
Video	Videos, streams, advertisements, etc.	Computer vision, classification, clustering, object and face recognition, etc.
Audio	Voice messages, music, podcasts, etc.	Speech and sound processing, classification, clustering, object and face recognition, etc.
Net	Associations between users and objects	Network analysis, clustering, association rules, centrality and prestige measurement, etc.

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In our case, we should use the Data Mining method. Data Mining uses various techniques from the fields of statistics, mathematics and machine learning to analyze data and build models. Data mining can be applied to various types of data such as text, images, video, audio, etc., as well as various domains such as social networks, business, healthcare, education, etc.

There are many data mining methods for processing big data in social networks.

Within the framework of this article, a classification method using decision trees will be used for processing big data in social networks. We chose this method for the following reasons:

• Classification using decision trees allows you to determine whether data belongs to one of predefined classes or categories based on their features.

• Decision trees can be used to classify data from social networks if you want to get an interpretable and visual model that shows which features influence belonging to a particular class.

• Decision trees can be easily scaled and parallelized to handle large amounts of data.

The solution of the problem. Let's analyze data from Facebook that contains information about users and their friends, as well as the products or content that they like or comment on. Our goal is to create a model that predicts a user's interest in a particular product or content based on their behavior on a social network. This model can be used to recommend products or content to users on social networks.

For our analysis, a small piece of data was collected from Facebook using the Facebook Graph API. The Facebook Graph API is an application programming interface (API) that allows you to access data about users, groups, pages, and other objects on Facebook.[4] In our case, information was collected on 100 products or content that users like or comment on. The data is presented as a file: likes.csv. The file contains information about pages that users like or comment on. Each line of the file represents one like or comment and its ID (уникальный номер), ID the user who liked or commented, the ID of the page that was liked or commented, the page name, and the page type.

Libraries we need: pandas, sklearn, matplotlib

Data processing

Loading data from likes.csv file. The pd. read_csv function reads data from a file in CSV format (comma-separated values) and returns an object of type DataFrame that represents a tabular data structure with row and column indices.

```
data = pd.read_csv("likes.csv")
```

Feature extraction and target variable. This step extracts the features and target variable from the data. Features are characteristics of objects that are used to predict their classes. The target variable is the label of the class we want to predict. In our case, signs are user and page identifiers, page names. The target variable is the page type (e.g. brand, media, public figure, etc.). We use square brackets to select the desired columns from the dataframe.

```
X=data[["user_id","page_id","page_name"]]#признаки
y = data["page_type"] # целевая переменная
```

Converting categorical features to numeric ones using the get_dummies method. This step converts categorical features to numeric ones using the get_dummies method. If an object has a page_name value of "Apple", then it will have a value of 1 in the page_name_Apple column and 0 in the other two columns. This allows you to convert textual data to numeric data that can be used to train the model.

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```
X = pd.get_dummies(X)
```

user_id	page_id	page_name	...	Jinping page	name_YouTube
0	7226849223	3266636580	...	False	False
1	3013526500	9163978590	...	False	False
2	7512217188	4314567424	...	False	False
3	9686871054	4063357162	...	False	False
4	7007568307	8051063877	...	False	False

Figure 1: Fragment of the converted dataframe

Splitting the data into training and test samples in the ratio 80/20. This step splits our dataset into two parts: training and testing. For this, the train_test_split function from the sklearn library is used.

```
train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

Creating a decision tree classifier object. This step creates a decision tree classifier object using the DecisionTreeClassifier class, which implements the CART algorithm for building the decision tree. The CART algorithm works like this: it chooses the best feature and threshold for dividing the data into two subgroups, so as to minimize class heterogeneity in each subgroup. It then repeats this process for each subgroup until it reaches a stopping criterion (such as the maximum depth of the tree or the minimum number of objects in a node).

```
clf = DecisionTreeClassifier()
```

Classifier training on the training set. This step trains the classifier on the training set using the fit method, which finds the optimal decision rules to split the data into classes.

```
clf.fit(X_train, y_train)
```

Data analysis

Class prediction for a test sample. This step predicts the classes for the test set using the predict method, which applies the decision rules to new data and returns the predicted class labels.

```
y_pred = clf.predict(X_test)
```

Assessment of classification accuracy using the accuracy_score metric. This step evaluates the accuracy of the classification using the accuracy_score function, which compares the predicted scores with the true scores and calculates the proportion of correct answers.

```
Accuracy=accuracy_score(y_test,y_pred)
print(f"Accuracy: {accuracy}")
```

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Result: Accuracy: 1.0

Saving a decision tree in DOT format using the export_graphviz function. This step saves the decision tree in DOT format using the export_graphviz function, which writes the structure of the tree and its metrics to a text file. The DOT format is a graph description language.

```
tree.export_graphviz(clf, out_file="tree.dot", feature_names=X.columns, class_names=clf.classes_, filled=True)
```

Visualization of a decision tree on a chart using the plot_tree function and calculation, output of a quality metric. This step plots the decision tree using the plot_tree function, which plots the tree with node and leaf labels. It also allows us to evaluate how well our decision tree predicts the type of page in two ways: petal width and sepal width.

```
plt.figure(figsize=(20,10
tree.plot_tree(clf,feature_names=X.columns,class_names=clf.classes_,filled=True)
plt.show()
print(classification_report(y_test, y_pred))
```

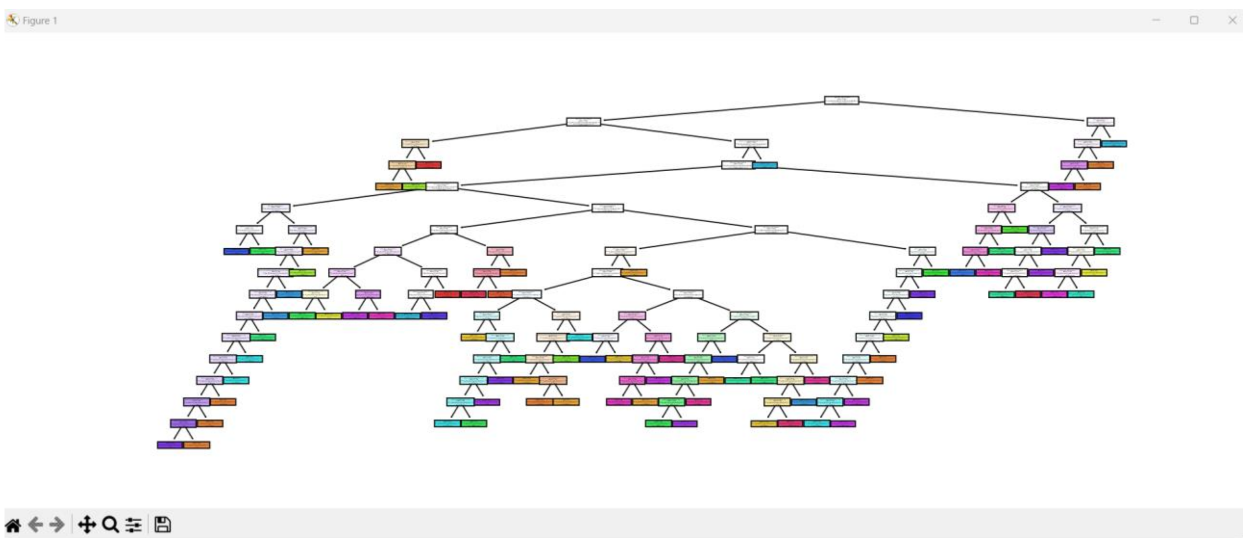

Figure 2. The resulting graph in the visualization stage.

	precision	recall	f1-score	support
Actor	1.00	1.00	1.00	202
Athlete	1.00	1.00	1.00	190
Book	1.00	1.00	1.00	84
Clothing (Brand)	1.00	1.00	1.00	44
Coffee Shop	1.00	1.00	1.00	29
Comedian	1.00	1.00	1.00	38
Community	1.00	1.00	1.00	25
Company	1.00	1.00	1.00	20
….				
accuracy			1.00	2000
macro avg	1.00	1.00	1.00	2000
weighted avg	1.00	1.00	1.00	200

Figure 3. Classification report

Conclusions

In the article, a decision tree was built and carried out qualitative analysis of the obtained results.

- The decision tree that we have obtained can solve the problem of classifying the type of page in a social network. This can be useful for different purposes, for example:
- We may analyze the interests and preferences of your audience by the types of pages they like or comment on. This will help you create more relevant and engaging content for them.
- You can segment your audience by the types of pages they like or comment on. This will help us to set up more effective advertising campaigns or offer more suitable products or services for them.
- It is possible to research competitors by the types of pages they like or comment on. This will help us identify their strengths and weaknesses, as well as find potential niches or development opportunities.

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$$f(x) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right) \quad (1)$$

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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
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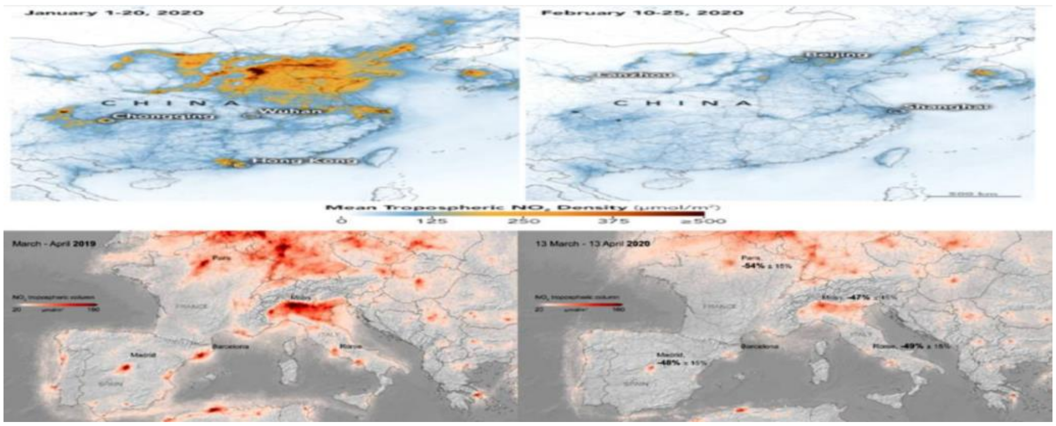

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3. Bahishti, “A New Multidisciplinary Journal; International Annals of Science”, Int. Ann. Sci., vol. 1, no. 1, pp. 1.1-1.2, Feb. 2017. https://journals.aijr.in/index.php/ias/article/view/163
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