IoT based tracking cattle healthmonitoring system using wireless sensors

Jai Ganesh Rajendran[1], Manjunathan Alagarsamy[2], Vaishnavi Seva[3], Paramathi Mani Dinesh[4], Balamurugan Rajangam[5], Kannadhasan Suriyan[6]
[1]Department of Electrical and Electronics Engineering, K.Ramakrishnan College of Technology, Trichy, India
[2]Department of Electronics and Communication Engineering, K.Ramakrishnan College of Technology, Trichy, India
[3]School of Computer Science and Engineering (SCOPE), Vellore Institute of Technology, Vellore, India
[4]Department of Electronics and Communication Engineering, Sona College of Technology, Salem, India
[5]Department of Electronics and Communication Engineering, K.Ramakrishnan College of Engineering, Trichy, India
[6]Department of Electronics and Communication Engineering, Study World College of Engineering, Coimbatore, India

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ABSTRACT

Controlling the health of dairy cows is crucial for increasing global dairy food output. Dairy farmers are losing faith in the sector as cows suffer from a range of health issues, disease outbreaks that are unpredictable, and expensive breeding expenses. As a consequence, farmers must use efficient technology techniques for cow health monitoring in order to enhance milk output. This study looked at a range of wireless sensor-based automated dairy cow health monitoring systems. The fundamental purpose of wireless sensor network (WSN) based smart surveillance systems in agricultural optimization is to follow the health of dairy cows on a continual basis. This monitoring gadget must be installed in both local and remote farm areas so that interested farmers may monitor their cattle's movements throughout the day from several places. The data collected by the automated system would be kept in a database. Farmers may then obtain data using farm automation to execute effective farm management techniques. Furthermore, WSN is a low-cost device created exclusively for identifying illnesses in dairy cows. This achievement in sophisticated technology agricultural automation would assist to boost productivity by reducing human involvement. This article summarises all livestock tracking techniques, as well as the issues and challenges that they confront.

Corresponding Author:

Jai Ganesh Rajendran
Department of Electrical and Electronics Engineering, K.Ramakrishnan College of Technology
Trichy, Tamil Nadu, India
Email: jaiganesh.ram@gmail.com

1. INTRODUCTION

Dairy farms have played an important role in the economic growth of industrialised nations like India. Dairy production is beneficial to the global food sector. India, one of the world's most populated countries, produces the most milk every year. Milk has long been regarded as the most significant source of revenue among all accessible dairy products. The market for dairy products in India, particularly milk, is projected to be worth Rs. 2,000 billion. A large number of milk processing facilities are now being constructed in numerous regions. India's annual milk output has almost quadrupled in the previous 40 years, going from 21 million tonnes in 1968 to 108 million tonnes in 2008–2009. According to the animal husbandry division, fishing, and dairy development of India's Agricultural Ministry, the nation produced 146.3 million tonnes of milk in 2014–2015 [1]–[5]. The demand for value-added milk products such as

Indian yoghurt, cheese, and probiotic drinks is doubling every two years. It has been emphasised that being self-sufficient in milk product processing is critical in order to meet current milk product demand. Foot and mouth disease (FMD) is one of the most frequent animal-killing illnesses, and it has a significant economic impact in numerous affluent nations [6]–[10]. Other disease outbreaks in home pets include bovine mastitis, anthrax, infected bovine ablution, and black quarter, in addition to basil FMD. Farm science equipment for dairy animal health monitoring must be introduced to combat these diseases and minimise production costs. The goal of the sensors would be to gather disease data and reduce long-term animal milk health insurance expenses. Farm optimization employing wireless sensor network (WSN) calculates body temperature, which is crucial in identifying animal sickness. Wireless signals employ transducers to detect direct sudden body temperature changes inside the animal's body. In addition to the workings of WSN, this research discusses the wireless animal body temperature monitoring technique, which advances permitting computational technologies to estimate constantly health information of animals. Animal physiological measurements and infrastructure expenses contribute in the growth of information in order to enhance cattle welfare and production. Monitoring cattle, evaluating conformation in the animal's body, and monitoring effective physiological factors are all important components of farm automation systems. Data from sensors, intelligence libraries, and mathematical models guarantee that the maximum amount of information is available. On the other side, continuous observation involves more time and personnel on the part of farmers. Farmers are unable to maintain continuous visual surveillance owing to the advent of several animal care issues that are unavoidable. An intelligent strategy to livestock healthcare apps must be devised to benefit rural communities [11]–[15]. As a consequence, cutting-edge information systems for analysing animal behaviour and monitoring biological reactions are being merged with enhanced agricultural farming technologies. The supplied cow health monitoring tactics often comprise analysis, monitoring, and procedures that aid livestock owners in forecasting illnesses that resulted in outbreaks. These approaches will examine the wellbeing of any livestock while also providing information to the owner and veterinarian. As a consequence, one of the most quickly increasing sectors is electronic livestock production. The proposed article focuses on using WSNs to monitor animal welfare in order to minimise infectious illnesses such as mastitis ketosis, and milk ferry [16]–[20].

The goal of this project is to create a system that enables farmers to compare their cattle's real health parameters to the typical reference safe values, enabling them to notice any decrease in their health. To construct such a gadget for real-time usage, an Arduino Uno, Arduino Nano, Xbee board, and several sensor devices for recording cow bodily conditions were employed. This page discusses the characteristics of cows' heart rate, heat, introspection, and body humidity [21]–[25]. The web-based cow health tracking system provides exact and important health criteria for the cattle, which are particularly valuable in monitoring the cattle's health state and detecting any changes in behaviour or health concerns. As previously said, the method offers both advantages and disadvantages. Modules for Zigbee networks the system becomes unwieldy, the Zigbee module's functionality is restricted, only one calf can be followed at a time, and the cost of lab view may not be economically viable for farmers. Lab view is a design and development environment for a visual computer language framework [26]–[29]. It is currently unclear where the livestock are located. User of the system currently in place are unable to locate livestock on the property due to a dearth of functionality in the system. In the event that the farm is very large and the bovine is afflicted with an illness, it will be unable to move from the area in which it is currently located; therefore, it is absolutely necessary to keep track of the animal's location. Farmers are absolutely unaware when their animals get unwell. A number of illnesses have attacked the cattle. Farmers are unaware that their cattle are sick, and no notice is given to them when there is an unanticipated change in their condition. Farmers are unable to handle cattle at the proper time as a consequence, resulting in illness severity. It takes a long time to complete. The existing system is inefficient. Farmers must examine the animal in person to determine whether it is sick, which takes longer than using an automated instrument.

2. METHOD

Cattle health is particularly essential in food processing because of owner concerns about nutritional quality and safety. Disease susceptibility and morphology are both affected by the health of better-fed cattle. Farmed cattle's physiological and behavioural responses provide clear knowledge about health statuses, such as the length of grazing time, which is a critical behavioural element in determining the adequacy of given food, which affected health wellbeing and milk quality, and the length of grazing time, which is a critical behavioural element in determining the adequacy of given food. Every major discrepancy in grazing time highlighted a problem that necessitated the farmer's intervention is shown in Figure 1. Dairy cattle's behaviour may be used to assess their health, well-being, and relaxation on the farm. Behavioral changes in dairy cows are unambiguous signals of health and welfare difficulties. As a consequence, they may be supplied into a notification system. The amount of time the animals spend feeding is essential in terms of milk quality. As a consequence, knowing where they are is crucial for monitoring and regulating their behavioural behaviours and behaviour so that data on their wellness and efficacy may be collected. If the viruses develop as a consequence of bioterrorism or evolve spontaneously, they represent a serious threat to dairy cow welfare. Internal parasites, footrot, and lameness are the most detrimental diseases to an animal's health, followed by abortion. The Indian agricultural industry provides significant money, yet FMD, black quarter, anthrax, viral bovine abortion, and bovine mastitis are the most common animal diseases. Viruses have a considerable detrimental impact on cow welfare and producer productivity, according to the conclusions of this investigation. Environmental variables such as drought and fire may also be a problem. As a consequence, focused on the construction of health monitoring systems capable of recognising various behavioural parameters and converting them into comparable lifestyle kinds. These devices could be able to assist the owner in increasing milk output while also enhancing animal wellbeing.

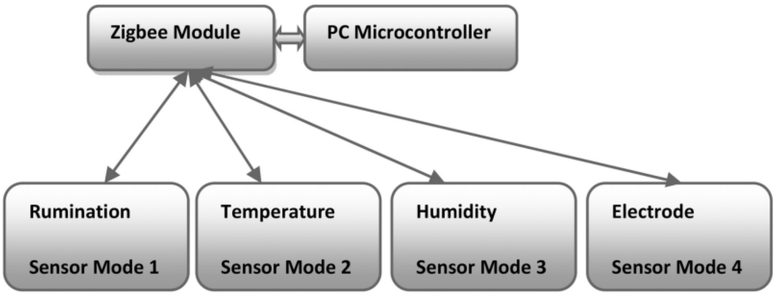

Figure 1. Zigbee based animal health monitoring system

An animal's stress level is generally determined by its temperature. Veterinarians have regularly checked rectal temperatures to follow and identify febrile illness for numerous years. Temperatures were measured in the uterus, udder, ear, and the rectum of cows in a variety of anatomical places. The cow's natural temperature is 38.6 °C. The body's temperature must be regulated between certain parameters in order to manage physiological functioning. The literature has found that the standard maximum temperature is 37.8–40.0 °C room temperature. When the environment is muddy and humid, a pathogen found throughout the soils pollutes the toe membranes, causing the condition. The bacteria that causes Johne's illness and tuberculosis (TB) is the same genus that causes cattle to perform poorly. Among the development disorders include dietary and physiological diseases, as well as hereditary and viral diseases, such as hanging placentas. Development illnesses are responsible for the bulk of the financial losses suffered by cattle welfare organisations and the dairy sector. Abortion may result from a number of factors, including the presence of bovine infectious diarrhoea on the foetus during pregnancy. The bovine viral diarrhoea (BVD) virus causes ovarian cysts, foetal cremation, and preterm deliveries in fragile calves. Abortions may also be caused by extreme heat or exposure to toxins from forbs during pregnancy. The two forms of parasites that cause production losses in cows and their calves are intrinsic and extrinsic parasites. Low weaning weight and poor milk quality are also caused by internal parasites. By altering liver function, Fascioloides magna and Fasciola hepatica promote weight loss. Ticks and flies, for example, are a remote pest that impacts cattle health and productivity.

The fundamental aim of veterinarians is to preserve the wellbeing of farm animals as it was throughout the transition period. The transitional period is defined as the three weeks before to and three weeks following conception. Periparturient refers to the interval immediately before and after the birth of a dairy cow. Cows are at a high risk of getting development illnesses, thus childbirth is an important step in their development cycle. Inadequate nutrition offered to transfer animals leads to a decrease in field enhancement and an increase in treatment expenditures. Ketosis is a kind of ketosis that's associated with liver fibrosis. In animals, ketosis results in lower milk supply, lower gluconeogenic capacity, and lower feed intake, as well as an increased risk of bacterial and other metabolic diseases. There are two types of anorexia: partial anorexia and anxiety. On rare cases, it might be found in young buffalos. As a result of the lack of appetite in balance and uneven walking, nervous disorder symptoms such as crying, pica, aberrant licking, and aggressiveness are often noted. The spread of these illnesses is usually accompanied by a rise in milk production and herd size growth. In general, subclinical illness has a greater frequency than mastitis. It's often associated to major financial losses, such as lower reproductive success, poor milk quality, culling losses, and a greater risk of chronic illnesses.

Mastitis is a kind of mastitis that causes swelling in the mammary gland and is the most common endemic illness in dairy cattle. It's an inflammatory disorder that affects the mammary gland. It causes an immune response in response to a bacterial attack by a variety of bacteria, which might be produced by rectum injury caused by physical, thermal, or chemical damage. During movement, there is an uneven foot action that happens. Milk fever is a contagious condition that affects women who have had a baby and have hypocalcemia or metabolic syndrome. It's marked by a drop in calcium levels in the blood. Hypocalcaemia affects the effective lifetime and yield by lowering blood calcium levels. Diarrhoea is a kind of diarrhoea that arises as a result of the transmission of the pestivirus. It causes weariness, a lack of salt and fluids, loss of appetite, death, and thinning if not treated early and effectively. Pneumonia is a pulmonary infection. It's a multifactorial condition that causes weariness, pain, eye discharge, stiff gait, inappetence, severe nose and cold infections, and a weakened immunological response in cattle. WSNs are also being used to monitor vital signs in animals, such as pulse rate, oxygenation, and body temperature, which are considered early markers of sickness. The impacts of viruses and their detectable indicators for illness detection utilising sensors were discussed in this part the different locations where dairy cattle's wellbeing may be assessed are shown in Figure 2.

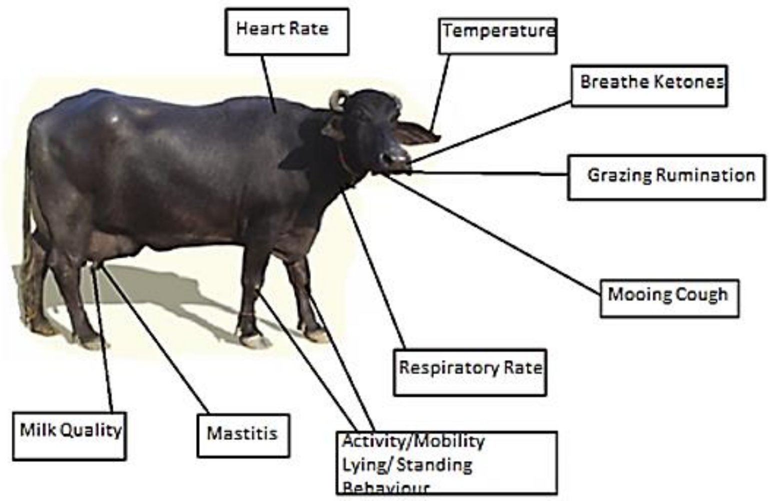

Figure 2. Areas to monitor dairy cattle

A number of instruments have been described for measuring body temperature inside a bolus and through anus or ear. Because it is parallel to the ear mark, the inner ear is the least invasive and most effective technique for detecting body temperature. One of the sensor-based tools used to assess cattle temperature is the FeverTag, a tympanic temperature probe device. With such a probe, it is connected to the ears and is located in the bottom middle ear, flashing a warning when the temperature climbs over 103.6 °F. Another device method for measuring body temperature is the CorTemp bolus. Moisture lowers signals, resulting in data loss when wireless components interact. The quantity of humidity gathered on the farm may be used to compute the signal intensity depletion. Furthermore, the temperature data gathered during the day acts as a reference point for the cows' heat. The CorTemp bolus was also used to determine the relationship between pulse rate and body temperature. This technique employs a microphone to detect the start of each pulse and then converts the duration between pulses into a heartbeat. Polar pulse belts are often used to monitor heart rhythm, with electrodes determining the direction of the animal's heart. A thermocouple is placed to a nasal piercing in the cow's nostril to monitor the animal's respiration. The output of the thermistor rises in proportion to the ambient temperature as the cow exhales. Calculate the respiration rate by counting how many times per minute the temperature rises and falls. One of the most extensively used methods for tracking wireless communications is triangulation. It's a method for finding the location of a point by measuring the time difference between signal deliveries at three different antennas. Data from numerous satellites is currently utilised by global positioning systems to identify location. An irregular heart rhythm and a reduction in red blood cells are early indicators of bovine illness. These vital indicators in animals are monitored using a transmissive pulse oximeter. In cattle, however, these vital indicators are computed using a diffused pulse oximeter. The XBee computer is a commonly used wireless transmitter with a maximum transmission range of two miles and a maximum transmission capacity of 67 mW. XBees are small, around the size of a penny, and may easily be included into an ear label. To minimise the impact on the buffalos' daily activities, it was decided that all WSN data would be sent over a wireless link and tied to a particular location. In farm optimization, the fundamental purpose of WSN based intelligence surveillance systems is to continually monitor the wellbeing of dairy cows. This tracking device should be installed in both real and virtual farm sites to let interested farmers follow their cattle movements throughout the day from several places. All of the data produced by the automated device may be saved in a folder. Farm automation may then be used to obtain information so that suitable farm management techniques can be implemented. WSN is also a low-cost programme created primarily for identifying illnesses in farm animals. This development in sophisticated technology agricultural automation may assist to boost output by reducing human involvement.

Figure 3 shows the block diagram of the recommended system. We utilise this proposed approach to determine two of the most crucial patient conditions: temperature and pulse rate, in order to monitor the health of animals. An Arduino Uno microcontroller was used to gather the sensor information. The body temperature and heart rate of cattle affected with a disease increase. The farmer gets alerted by SMS if the temperature increases. The climate on dairy farms has a significant influence on the animals' well-being. As a consequence, a SMS will be delivered to the producer when the temperature or moisture in the atmosphere increases is shown in Figure 3.

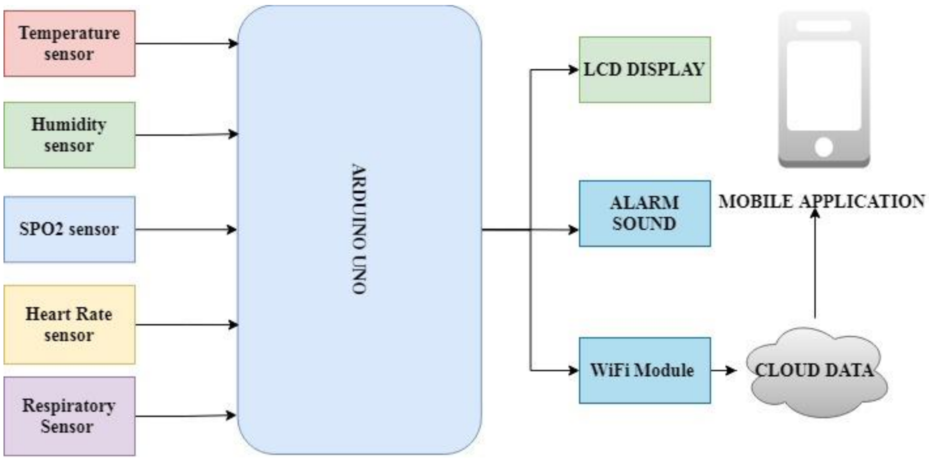

Figure 3. Block diagram of proposed system

3. RESULTS AND DISCUSSION

On huge farms, it's impossible to tell where the cow is or whether the animals are ill. GPS is used to track the whereabouts of agricultural animals. The ESP8266 Wi-Fi gadget sends the temperature and heart rate sensor data to the web, where it can be seen visually from outside the farm. The proposed approach might potentially be employed in agricultural situations where there are a huge number of animals and it is hard to follow each one's behaviour individually. In such cases, the recommended system may be configured as a small IoT unit with all of the sensors that can be connected to the animals. This reduces the risk and expands the possibilities for enterprises. The various connecting components with: i) health-related information and adequate livestock care, ii) the gadgets are used to automatically calculate a range of health variables, iii) the arduino microcontroller is a cost-effective device, iv) for tiny cloud calculations, ESP8266 Wi-Fi modules are affordable, data is scalable, and backups are not required, and v) we can detect a variety of animal motions, including temperature, respiration, pulse, and vibrations. The goal of health monitoring is to regularly check the status of individual cows, making it simpler to evaluate and treat ill cows as quickly as possible. Figure 4 depicts the suggested system's hardware implementation. The sensors that are linked to the controllers are directly affixed to the cattle's body. The sensors will record the cow's live activities and physical conditions, which will then be sent through Wi-Fi to the cattle producers' mobile applications.

To get data on cow activities, the farmer must first log in to the mobile application using his or her user name and password. The farmer may obtain updates on the livestock from Figure 5, such as temperature, humidity, heartrate, oxygen separation level (SPo2), respiratory range, and the position of the animals is shown in Figure 6. The information obtained from the application will be sent to a veterinary doctor for the purpose of identifying any diseases that may exist. Additionally, this programme has the ability to access Google Maps is shown in Figure 7. The farmer has the option to click for a Google Maps position on the website. If the cow is missing, the farmer may acquire a precise location by clicking. The position of livestock is shown in Figure 7 through Google Maps.

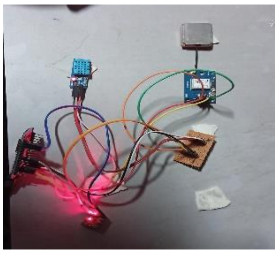

Figure 4. Hardware implementation of proposed work

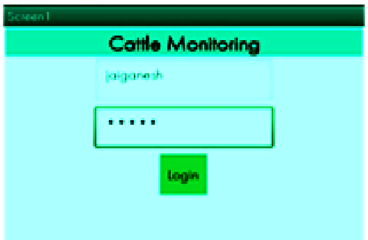

Figure 5. Monitoring through mobile application

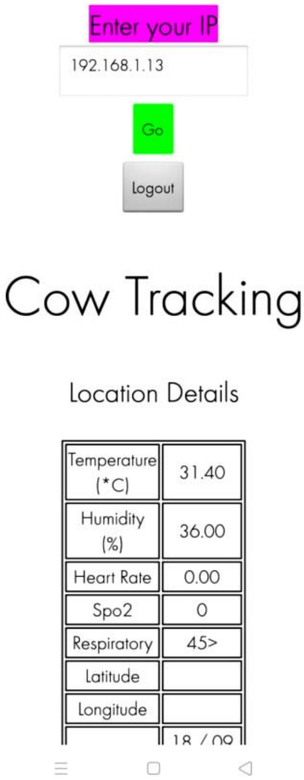

Figure 6. Location of cow monitored by mobile application

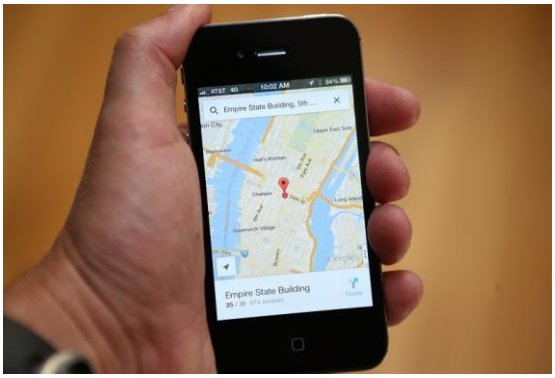

Figure 7. Google Maps showing the location

4. CONCLUSIONAND FUTURE WORK

This study discusses cattle management methods and the issues that they raise. Despite the establishment of various cow health monitoring systems, farmers still face several hurdles. As a consequence, WSN may be used to monitor cow health in order to properly diagnose diseases and prevent their spread. Without depending on a wired network, WSNs enable network topologies to be scalable. Many researchers are there, monitoring and collecting data using a variety of ways. Aside from that, it seems that a number of commercial companies are inventing and selling tracking devices. This is a rapidly expanding field that is shifting from passive to more advanced monitoring systems. The suggested algorithm is most likely to be used in a farming experiment, with the possibility of further research into its procedure in a related sector. There's also the prospect of utilising robots to help a person spot cattle who aren't eating or drinking correctly. In addition, the routers might be powered by solar energy, making the system more ecologically friendly.

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BIOGRAPHIES OF AUTHORS

Jai Ganesh Rajendran received B.E degree in EEE from Mepco Schlenk Engineering College, Sivakasi, affiliated to Anna University, Chennai, Tamilnadu in 2012. M.E degree in EEE from Mepco Schlenk Engineering College, Sivakasi, affiliated to Anna University, Chennai, Tamilnadu in 2016. He is currently working toward the Ph.D. degree at the Department of Electrical Engineering, Mepco Schlenk Engineering College, Sivakasi, affiliated to Anna University, Chennai, Tamilnadu, India. His research interests include soft computing application in power system engineering, renewable energy resources and its protection schemes. He has published 15 papers in referred national and international journals and 10 papers in national and international conferences. He has published five patents and received grant from TNSCST student's project scheme. He has organized many workshops, seminars. He is an active member in IFERP and International Association of Academic plus Corporate Society. He can be contacted at email: jaiganesh.ram@gmail.com.

Manjunathan Alagarsamy received the engineer degree in Electronics and Comunication Engineering from Dr. Navalar Nedunchezhiyan College of Engineering in 2010. He received the master degree in Embedded System Technologies from Raja College of Engineering and Technology, Madurai, Tamilnadu, India in 2013. He is currently working as an assistant professor in the Department of Electronics and Communication Engineering at K. Ramakrishnan College of Technology, Trichy, India. His area of interests includes embedded systems, image processing, sensors, interfacing networks, and internet of things. He has published 25 articles in peer reviewed international journal and presented 6 papers in international conferences. He can be contacted at email: manjunathankrct@gmail.com.

Vaishnavi Seva received her doctor of philosophy from Anna University, Chennai. She received the goldedalist in master degree from RMD Engineering College, Chennai. She is currently working as assistant professor senior grade-1 in VIT, Vellore. Her research area is internet of things and security. She has published 2 articles in peer reviewed international journals presented 4 papers in international conferences. She can be contacted at email: sevavaishnavi@gmail.com.

Paramathi Mani Dinesh received his bachelor's engineering in Electronics and Communication Engineering in the year 2009 and master's engineering in VLSI design in the year 2011. He has completed his doctoral research in the area of image processing. His areas of interest include pattern recognition, pattern classification, text recognition and texture analysis. He is currently working as associate professor of ECE Department, at Sona College of Technology, Salem. He is also a team member of Sona SIPRO, Sona Signal and Image Processing Research Centre. He has published more than twenty-five papers in leading conferences and journals in the country. He can be contacted at email: pmdineshece@live.com.

Balamurugan Rajangam received the engineering degree in Electronics and Comunication Engineering from Arasu Engineering College in the year 2008. He received the master degree in VLSI Design from Kings College of Engineering, Thanjavur, Tamilnadu, India in 2012. He is currently working as an Assistant Professor in the Department of Electronics and Communication Engineering at K. Ramakrishnan College of Engineering, Trichy, India. His area of interests includes VLSI design, IoT, embedded systems, image processing, sensors and interfacing networks and internet of things. He has published 8 articles in peer reviewed international journals and presented 4 papers in international conferences. He can be contacted at email: balawow@gmail.com.

Dr. Kannadhasan Suriyan is working as an assistant professor in the Department of Electronics and Communication Engineering in Study World College of Engineering, Coimbatore, Tamilnadu, India. He is completed the Ph.D in the field of smart antenna for Anna University in 2022. He is twelve years of teaching and research experience. He obtained his B.E in ECE from Sethu Institute of Technology, Kariapatti in 2009 and M.E in Communication Systems from Velammal College of Engineering and Technology, Madurai in 2013. He obtained his M.B.A in Human Resources Management from Tamilnadu Open University, Chennai. He has published around 45 papers in the reputed indexed international journals indexed by SCI, Scopus, Web of science, major indexing and more than 146 papers presented/published in national, international journal and conferences. Besides he has contributed a book chapter also. He also serves as a board member, reviewer, speaker, session chair, advisory and technical committee of various colleges and conferences. He is also to attend the various workshop, seminar, conferences, faculty development programme, STTP and online courses. His areas of interest are smart antennas, digital signal processing, wireless communication, wireless networks, embedded system, network security, optical communication, microwave antennas, electromagnetic compatability and interference, wireless sensor networks, digital image processing, satellite communication, cognitive radio design and soft computing techniques. He is member of IEEE, ISTE, IEI, IETE, CSI, IAENG, SEEE, IEAE, INSC, IARDO, ISRPM, IACSIT, ICSES, SPG, SDIWC, IJSPR and EAI Community. He can be contacted at email: kannadhasan.ece@gmail.com.