

IoT-BASED WEARABLE BIOLOGICAL PARAMETERS MONITORING SYSTEM FOR PETS

submitted in partial fulfillment of the requirements for the award
of Bachelor of Engineering degree in Electronics and
Communication Engineering.

by

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SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

CATEGORY -1 UNIVERSITY BY UGC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of P Kanyaa (40130101), and P Kiran (40130113) who carried out the project entitled "IoT BASED WEARABLE BIOLOGICAL PARAMETERS MONITORING SYSTEM FOR PETS" under our supervision from Nov 2023 to April 2024.

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DECLARATION

We P Kanyaa, and P Kiran hereby declare that the Project Report entitled "IoT BASED WEARABLE BIOLOGICAL PARAMETER MONITORING SYSTEM" done by us under the guidance of Dr. M Sugadev, M. Tech, Ph.D. at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication.

DATE: 17-04-2024

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ABSTRACT

The Internet of Things (IoT) has revolutionized the way we monitor and manage various aspects of our lives, including the well-being of our pets. This paper presents an innovative IoT-based biological parameters monitoring system designed to enhance the health and safety of pets.

This system leverages IoT technology to continuously monitor and collect vital biological parameters such as temperature, heart rate and position in real-time. These parameters are crucial indicators of a pet's overall health and can help detect early signs of illness or distress.

The core components of the proposed system include wearable sensors and devices equipped with wireless connectivity, a centralized data hub, and a user-friendly mobile application. The sensors are non-intrusive and comfortable for pets to wear, ensuring minimal disruption to their daily activities. Data from these sensors could be seen in the mobile application.

Pet owners can access the collected data and insights through the mobile application, providing them with a comprehensive view of their pet's well-being. Real-time alerts and notifications are generated if any critical changes or abnormalities are detected, allowing for prompt intervention and veterinary care if necessary.

The IoT-based biological parameters monitoring system for pets offers several advantages, including early disease detection, proactive health management, and improved pet-owner communication. By continuously monitoring their pet's vital signs and providing valuable insights, this system enhances the overall quality of life for pets and gives pet owners greater peace of mind regarding their beloved companions' health. This research contributes to the growing field of IoT applications in the realm of pet care and animal welfare

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LIST OF ABBREVIATIONS

IoT	Internet of Things
EHRs	electronic health records
ECG	electrocardiograph
RFID	Radio frequency identification
HSN	hybrid sensing network
CCU	cardiac care unit
PPR	pestedes petits ruminant
FMD	foot and mouth disease
HS	hemorrhagic septicaemia
HRV	heart variability
EID	Electronic radio frequency identification
GPS	global positioning system

CHAPTER 1

INTRODUCTION

In recent years, the convergence of Internet of Things (IoT) technology and healthcare has led to groundbreaking innovations that are reshaping the way we monitor and manage our well-being. One particularly promising development in this field is the advent of IoT-based biological parameters monitoring wearable devices. These compact, unobtrusive devices are poised to revolutionize healthcare by providing continuous, real-time monitoring of crucial physiological metrics in a convenient and user-friendly manner.

Biological parameters such as heart rate, body temperature, blood pressure, respiration rate, and activity levels are fundamental indicators of an individual's health status. Traditionally, obtaining these measurements required periodic visits to healthcare professionals or the use of cumbersome, tethered monitoring equipment. However, the emergence of IoT-based wearable devices has democratized healthcare by bringing the power of continuous monitoring right to our fingertips.

These IoT-based wearable devices are designed to be comfortable, non-intrusive, and seamlessly integrated into our daily lives. By collecting data around the clock, they offer a comprehensive and dynamic view of an individual's health, allowing for early detection of abnormalities or trends that might otherwise go unnoticed. This introduction sets the stage for exploring the transformative potential of IoT-based wearable devices designed specifically for monitoring biological parameters. These devices promise to empower individuals to take a proactive approach to their health, enable early detection of health issues, and provide healthcare professionals with valuable data for personalized patient care. In the following sections, we will delve deeper into the key components, functionalities, benefits, and applications of IoT-based biological parameters monitoring wearable devices, shedding light on how these innovative technologies are poised to enhance healthcare outcomes and improve our overall quality of life. Whether it's tracking vital signs for personal health optimization or

providing clinicians with real-time patient data, these devices are ushering in a new era of healthcare that is more accessible, efficient, and patient-centric. The BiGRNN is an improved form of the Gated Recurrent Unit (GRU) in which input is sent both forward and backward through a network and the resulting outputs are connected to the same output layer.[1]

1.1 BENEFITS AND APPLICATIONS OF IoT

The way we engage with the world around us has changed dramatically as a result of the Internet of Things (IoT). IoT, at its heart, is the networking of commonplace physical items, or "things," integrated with sensors, software, and connections, allowing them to gather and share data with other systems and devices over the internet. The term "Internet of Things" (IoT) refers to a broad category of gadgets and uses, ranging from wearable fitness trackers and smart home appliances to industrial machinery and urban infrastructure. These Internet of Things (IoT) gadgets can exchange data, interact with one another, and even make choices on their own, which improves productivity, convenience, and efficiency in some areas of our lives. In recent days, the Internet of Things (IoT) used to connect many devices and communicate with each other, which created a greater impact on animal healthcare systems. IoT devices are in the form of wearable's that have been used to track the activities of humans [4].

1.1.1 The Transformative Potential of IoT-Based Wearable

IoT-based biological parameters monitoring wearable devices represent a paradigm shift in how we approach personal health management. These devices, typically designed as comfortable, unobtrusive wearable, allow individuals to effortlessly track their vital signs throughout the day, providing a wealth of data that can inform lifestyle choices, disease prevention, and early intervention. The key components of these wearables typically include sensors that capture physiological data, wireless connectivity for data transmission, and user-friendly interfaces for data visualization and interpretation. These wearables are designed with user comfort in mind, ensuring that they can be worn throughout the day without causing discomfort or inconvenience.

1.1.2 Continuous Monitoring for Proactive Health Management

One of the standout features of IoT-based biological parameters monitoring wearables is their ability to provide continuous monitoring. Unlike traditional sporadic measurements, these devices offer a real-time, longitudinal view of a user's health metrics. This continuous stream of data empowers individuals to detect subtle changes in their health, potentially leading to early detection of health issues. For example, a wearable device can alert a user to an abnormal increase in heart rate or temperature, which could be indicative of an underlying health problem. By providing early warnings, these wearables enable individuals to seek timely medical attention or make necessary lifestyle adjustments to improve their health.

1.1.3 Empowering Healthcare Professionals

IoT-based wearables also have profound implications for healthcare professionals. By collecting and transmitting real-time data, these devices offer healthcare providers a more comprehensive and up-to-date understanding of their patients' health. This information can aid in the early diagnosis of conditions, more accurate treatment planning, and better management of chronic diseases. Additionally, the data collected by these wearables can be integrated into electronic health records (EHRs), ensuring that healthcare professionals have access to a complete and continuous patient history. This seamless flow of data can enhance the quality of care and improve patient outcomes.

1.1.4 Applications Across Healthcare and Beyond

The applications of IoT-based biological parameters monitoring wearables extend beyond individual health. These devices are finding use in various healthcare settings, from hospitals and clinics to remote patient monitoring. They are also being adopted for

research purposes, enabling large-scale studies on population health and disease trends.

Furthermore, these wearables are increasingly being integrated into wellness programs and corporate health initiatives, helping employees and employers alike to track and improve their overall well-being. By promoting healthier lifestyles and reducing healthcare costs, these devices contribute to a more sustainable and productive workforce.

In conclusion, IoT-based biological parameters monitoring wearable devices are poised to transform the landscape of healthcare and personal well-being. By offering continuous, real-time monitoring of vital signs, they empower individuals to take proactive control of their health, facilitate early disease detection, and provide healthcare professionals with valuable data for informed decision-making. As these devices continue to evolve and become more accessible, they hold the promise of improving the quality of healthcare and enhancing the overall quality of life for individuals across the globe. The energy consumption of the sensors and the system may be high and due to which recharging the batteries is required and hence wireless charging can also be introduced. However, this system uses rechargeable batteries only [2].

1.2 THE OBJECTIVES

The objective of our project is the following mentioned reasons:

- Continuous health monitoring: The primary objective is to provide pet owners and veterinarians with continuous, real-time monitoring of critical biological parameters in pets, including temperature, heart rate, respiration rate, and activity levels. This continuous monitoring ensures that any deviations from normal values can be promptly identified.
- Early detection of health issues: The wearable device aims to facilitate early detection of health problems in pets. Alerting owners to abnormalities or

changes in their pet's vital signs, it allows for timely intervention and veterinary care, potentially saving lives and improving treatment outcomes.

- Enhanced pet care: These devices empower pet owners to take a proactive approach to pet care. Users can monitor their pet's health trends over time, helping them make informed decisions about nutrition, exercise, and overall well-being.
- User-friendly interface: Ensuring that the wearable device is user-friendly is crucial, as it should be easy for pet owners to use and understand. Clear data presentation and intuitive controls enable pet owners to interpret their pet's health data effectively.
- Integration with veterinary care: The device should integrate seamlessly with Veterinary healthcare systems. This objective aims to improve communication between pet owners and veterinarians by sharing data that can assist in diagnosis and treatment planning.
- Remote pet health management: IoT-based wearables enable remote monitoring of pets, even when owners are not physically present. This is particularly valuable for pets with chronic conditions, allowing veterinarians to keep a closer watch on their health.
- Data security and privacy: Protecting the sensitive health data of pets is a paramount objective. The device should employ robust security measures to ensure that the data is secure and that pet owners' privacy is maintained.
- Wellness and longevity: Beyond medical applications, these wearables aim to improve the overall wellness and longevity of pets. They can monitor factors like activity levels and sleep patterns, helping pet owners make adjustments to enhance their pet's quality of life.
- Customization for different pet types: Wearable devices should be adaptable to various types of pets, from dogs and cats to smaller animals like rabbits or ferrets. Customization options should be available to cater to the specific needs of different animals. It is now become easy to monitor the

conditions of an individual animal in detail that has so far been difficult. Mobile WSNs make continuous welfare monitoring easy with higher robustness as compared to manual observation[9].

CHAPTER 2

RELATED WORKS

Gaurav Mhapne et al. (May 2020) has proposed a work “Health Tracking And Monitoring System For Animals”. According to web statistics and many experts, many pets and even stray animals suffer medical problems and even pass away as a result of the negligence of the pets and their owners. If a crisis should develop, neither the pet's owner nor those nearby will likely be able to recognize that the animal is suffering from a health problem or is weak. If there is an emergency, it might often be difficult to reach the pet's location, which could potentially endanger the animal's life. In the end, it's crucial to ensure the animal's wellness[8].

As per web data and different specialists, it has been distinguished that many pets and even stray animals endure medical issues and even die because of the carelessness of the pets and their owners. If there should arise an occurrence of some crisis the owner of the pet or the individuals around will most likely be unable to see or feel that the pet is having some issue with its well-being or it is debilitated. Some of the time, it gets hard to get to the area of the pet if there is an emergency and because of this, it might even cost the pet with life. After all, it is important to guarantee the well- being of the pet. The goal of this project is to build up a Health Monitoring and Tracking Belt which will expand the security of pets. This device has four main functions which are, location tracking of animals, habitual movement recognition, health monitoring of animals, and sending data to the cloud. This helps the owner take care of their pet animals better. Each living pet on this planet has the same significance in the environment. Yet, presently day to day lives of pets are in danger. If any mishap happens to a pet, because of any accident or any sickness, the death of pet is fixed. In such conditions, we may not discover the location of pets in a wide area. To sidestep such issues for discovering the explicit position of the pet, the following framework is utilized. The scope of this project is to develop a health monitoring and tracking belt for animals especially pet animals which will help them live a better life.

Discussing current innovations in certain nations, belts are put on the pet's neck. This existing belt has a remote transmitter. After all, the primary disadvantage of the existing procedure is that the remote transmitter range is very low. In the current

scenario, there are a few applications that help the owner keep track of their pet animal's health conditions and medical history. This Health monitoring and tracking belt will help them tackle such traumatic situations by timely monitoring, which will alert their owners by sending captured data as well as its location. The scope of this project is to develop a health monitoring and tracking belt for animals especially pet animals which will help them live a better life. The project aims at increasing the safety of pet animals. The belt will be connected to the website and the owner, who will be alerted at times of emergencies. The Client App will detect the belt location using GPS. The app is programmed to update the belt's location periodically with the Centralized Server and also collects the health parameter data from the belt and sends it to the server. An IoT platform consists of three component: sensing, wireless communication, and cloud service. This project has been inspired by the loss of animal life due to negligence and lack of awareness of the health conditions of the pets and looks forward to reducing the above.

The block diagram of the proposed system consists of the TTGO T-call ESP32 sim800l to which all the other components are interfaced. The components include temperature sensors, pulse sensors, and motion sensors. The power supply unit consisting of a charging board and batteries provides the required power to the different components is also connected to the micro controller. The TTGO T-call ESP32 sim800l has three Working modes and can be chosen according to the necessary usefulness. Information received from every one of the three sensors is processed on the Microcontroller. The output is given to the client through the site/application that the owner has enlisted during the initialization of the belt.

The TTGO T-call ESP32 sim800l has an inbuilt Wi-Fi module and GSM module which is used to interface the belt with the cloud and transmit gathered information into the database and site. It additionally has a GPRS module which can be used to follow the pet in the event that it has gone far away. The progression of information is unidirectional for example from segments to TTGO T-call ESP32 sim800l and TTGO T-call ESP32 sim800l to site/application.

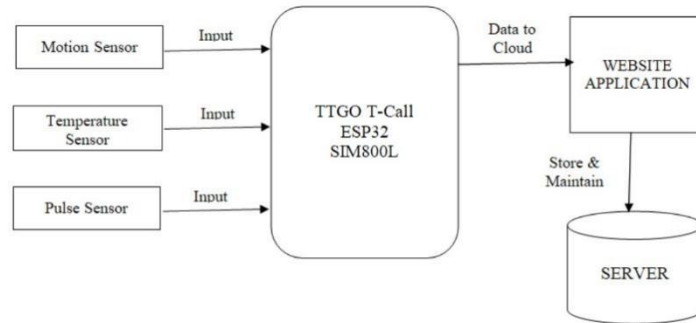


Fig:2.1: Health monitoring and tracking system for animal's block diagram

The schematic graph indicates the placement of different segments used in the development of the IoT belt model. Heartbeat sensors are set at the front of the neck where the pet has arteries using any of which the beat can be determined by the pet. The temperature sensor is set underneath the left ear from where the pets' exact temperature can be calculated from the nearest part of the pets' ears. The crate containing the microcontroller, the motion sensor, and the power supply is put on the external side of the belt. The box will likewise contain a 5v pin for the IoT belt which can be used to charge the belt remotely.

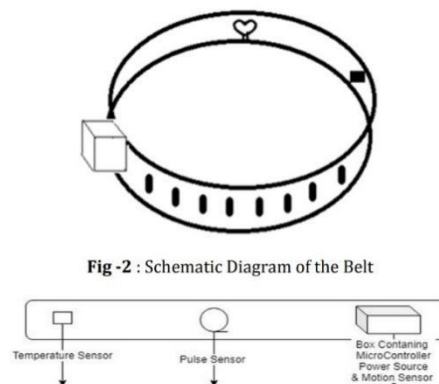


Fig:2.2: Expanded view of the Belt

Manisha V. Dole et al. (July 2020) has proposed a work “Esp8266-Based Health Monitoring System Using Arduino”. By the swift development of the mobile Internet, Internet of Things (IoT), and wearable devices, health monitoring has revealed an

intelligent trend in recent years. Many hospitals have already made use of mobile phone apps for appointment registration, inquiring about electronic medical records, and examination results. In addition, medical wearable devices [such as 3G vital sign meter, Bluetooth blood glucose meters, and smart electrocardiograph (ECG) device] are accustomed monitor blood pressure, blood sugar, ECG and other physiological signs. The monitoring records are finally sent to the knowledge platform for real time diagnosis or to a medical database for record keeping. The introduction of intelligent devices to hospitals can save the patient cost, enhance the medical experience of patient sand reduce the labour intensity of medical staff. However, connecting those intelligent things to achieve such goals is still a great challenge. The main limitation is the communication protocol . The wired communication is not suitable for mobile devices. Many researchers have tried to build architecture for connecting intelligent things by short range and long- range wireless communications. Boudra et al. introduced a monitoring system for patients using ZigBee and a long-range wireless protocol. Catarinucciet al. proposed a three-tier network architecture for monitoring and tracking of patients and environmental data in hospitals, which contains three parts, they are radiofrequency identification (RFID), it enhanced wireless sensor network which called as hybrid sensing network (HSN), the IoT smart gateway and user interfaces for data visualization and management. This work reports the monitoring system that captures parameters namely body temperature, relative humidity, heart rate, rumination rate of a cow at regular intervals based upon which the prediction of milk yield is possible.

The HSN tracked sensor devices with RFID Gen2 tags and forwarded their data to the Internet or local area network by the middle layer. Alharbeet al. proposed a way of using ZigBee and RFID to build an information management system for hospitals. In this system, ZigBee was used to transmit the collected information to the cloud center, and RFID was used to identify objects automatically. Nasri and Mtibaa proposed an idea of transmitting data from terminals to smart phones using 5G communication techniques, which were finally sent to the cloud center for further treatment. Zhanwei and Yongjian put some smart devices on patients to upload data to the cloud platform. However, the existing architecture cannot connect all types of devices in hospitals due to the limitation of wireless protocols. Short-range wireless protocols like Wi-Fi and ZigBee are limited by the communication distance. Long-

range wireless protocols usually have high energy consumption which are not suitable for smart devices in hospitals. As we see nowadays, heart disease is one of the serious diseases that may threaten human life. The electrocardiogram (ECG) is a vital role within the prevention, and diagnosis the abnormality of patients and the rescue of heart conditions. Progress has been made in the development of a foreign monitoring system for ECG signals, and the deployment of packet data services over telecommunication networks with new applications. The tele-transmitting and receiving of ECG signal is the key problem to understanding the tele-diagnosis and monitoring of ECG signals. Telemedicine is the use of medical information exchanged from one site to a different via electronic communications to enhance patients' health status. Telemedicine is the newest technology that combines telecommunication and information technology for medical purposes . It gives a new way to deliver health care services when the distance between the doctor and patient is significantly away. The rural area will benefit from this application. Patient monitoring is one among the telemedicine, which always needs improvement to create it better. It is vital to care in operating and emergency rooms, intensive care, and critical care units. It is also important for respiratory therapy, recovery rooms, outpatient care, and radiology, ambulatory, home, and sleep screening applications. The advantages of a patient monitoring system are it can reduce the risk of infection and other complications so as to make the patients comfortable. Furthermore, implementing of patient monitoring in hospitals might reduce the costs in terms of installation and maintenance of wiring.

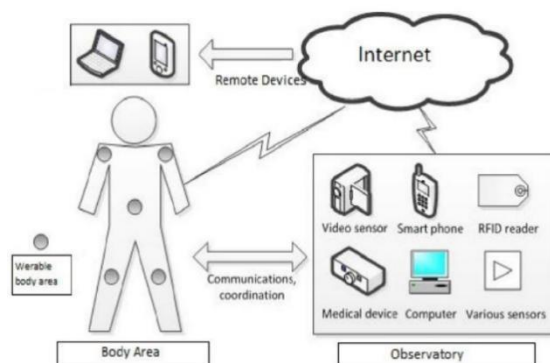


Fig:2.3: Schematic diagram of the monitoring system

Since many critical patients need high attention in the intensive care unit (ICU) and cardiac care unit (CCU), thus the bedside in hospitals over the limit as provided to the patients. Otherwise, this creation will help more elderly patients who need constant monitoring, both in the hospital and home environment.

Previously, the available medical monitoring system was usually bulky and thus uncomfortable to be carried by patients. Patient monitoring using a wireless sensor network features a greater potential within the future to realize the most effective performance healthcare services and also to avoid cost pressure in the hospital. In this era of automation and advanced computing, the social and commercial needs of mankind are changing very frequently. To keep up with these changes, we need to develop systems that are capable of performing different functions within some specified limits of time, accuracy, and cost. Automation can be very effective in reducing human effort and involvement in different areas.

This can be a boon for those fields that need a lot of skilled employees and also in areas where it is dangerous for the lives of people involved in that job. Nowadays in the medical field, there is a need for data monitoring and control, for this application-embedded web server can prove to be a very good system that may be capable of reducing the need for skilled workers. An embedded system is a device that has computer intelligence and is devoted to performing one task, or a bunch of related tasks.

An embedded system often performs monitoring the medical parameters of a patient. A web server is a system that hosts websites and provides services for any requesting clients. The general-purpose webserver is composed of an OS, websites or web application a large amount of memory, and sometimes special hardware.

The embedded web server is the combination of embedded device and Internet technology, which provides a versatile remote device monitoring and management function supported Internet browser and it has become an advanced development trend of embedded technology.

Keertana P, Dr.B.Vanathi et al.(Feb -2017) have proposed a work named “A Survey On Various Animal Health Monitoring And Tracking Techniques” With the increase in population, the needs of people have also increased. Many rural populations depend on the livestock sector for milk and egg production.

Similarly, with the introduction of pet adoption a large number of people now have either a dog or cat at home. And hence taking care of animal health and monitoring their movement becomes necessary. Advancement in technology has greatly improved the scope of monitoring health in humans and animals to an extent. This animal health monitoring and tracking system can be very useful in terms of detecting any diseases at a very early stage and it can be stopped from spreading it to other animal.

Over the years, there has been number of researches done in this field to monitor animal health but the methods adapted cause either an animal's fur to be removed or small chip are inserted into animal body. There are proven health monitoring devices used of human health monitoring such wearable hand gears or BP monitoring device, but the same system cannot be used to monitor any animal. And due to the increase in number of pet owners, the need for the same system becomes a necessary item in daily life. The system design would include four sensors namely, respiratory sensor, pulse rate sensor, temperature sensor, and heart beat sensor along with a GPS tracker. Sensors will detect variations in animal health and software can be developed to analyze their health with the data. An added advantage to this system is that the cattle health can be monitored. Even if the animal is lost it is easy to track the animal using the GPS tracker inbuilt in a wearable device. And to transmit the data, ZigBee can be used. ZigBee has very low power consumption range of 10- 3000 meters and it can support up to 64000 devices having a distance of 50 meters.

Varun Mhatre et al. (August 2020) has proposed a work named "IoT-Based Health Monitoring System For Dairy Cows". In the current health monitoring systems for cows consisting of parameters such as body temperature, humidity, heart rate, and rumination rate, the system is assembled with the help of three sensors configured with Arduino. The range for Zigbee is around 5 km of wireless communication which means that the distance between transmitter and receiver should be a maximum of 5 km. Using this system, hardware and cost are increased as hardware consists of two Arduino, two Zigbee, and three sensors. Each Arduino and Zigbee is used while transmitting a signal as well as while receiving data. Another disadvantage of the existing system is, for analyzing the received data, the computer should be always

ON to detect abnormal health, as the data is displayed on the Computer Screen. Even though milk production is an important parameter related to the health of Cow and also plays an important role in building the economy of farmers, the existing system does not consider it. The parameter that is taken by sensors are access by using wireless technology collect data use for early detection of disease this things are going to develops by using IOT.

So, this system does not predict the milk yield. Sudden changes in the values of parameters are not identified and how it will affect milk production is missing in this system. Sale of dairy products play an important role in building the economy of the farmers which eventually depends on the yield of milk but, this system consists of a lot of hardware which will increase the cost of the system thus making the system more complex. Most of the farmers depend on the earnings from the sale of milk and its dairy products. The mode of living of farmers depends on the health of the cow. Dairy products are a kind of livelihood for farmers. This same drawback is observed in another system that focuses on early detection of diseases in cattle, which is built using Raspberry Pi, Arduino, ESP 32, temperature sensor, and heart rate sensor. The system design becomes very complex as multiple components are required to build it[7].

This existing system is not a cost-efficient one as hardware consists of many components. But as it is an IOT based system, the data is transferred to an online platform. Another existing cattle health monitoring system consists of wearable sensors and Zigbee. Cattle should always remain to be in the proximity of the range of Zigbee. If any cattle exceed the range of Zigbee, then it is difficult to transfer the data on the base stations. This system analyses the data received from sensors such as body temperature, absolute position, heart rate, head motion, and predicting the health condition of the cattle. This system also doesn't predict the milk yield of a cow. So, this paper functions as an answer that solves the problems associated with each of the previously mentioned systems.

The system incorporates a temperature & humidity sensor, a heart rate sensor, and a rumination sensor, these sensors are configured with Atmega328p. The data is first collected through the sensors by standalone Atmega328p and then

transmitted to NodeMCU through serial communication. To make NodeMCU work, network connectivity is required, as it consists of the ESP module. All the data from NodeMCU is then transferred to an online platform named ThingSpeak where it is visualized on a ThingSpeak channel. On this ThingSpeak channel, the received data is analyzed using MATLAB Analysis Tool available on ThingSpeak itself. An algorithmic program is developed on this tool, which predicts the milk yield (Liters/day) of the cow and then displays this predicted value on the Thing Speak channel.

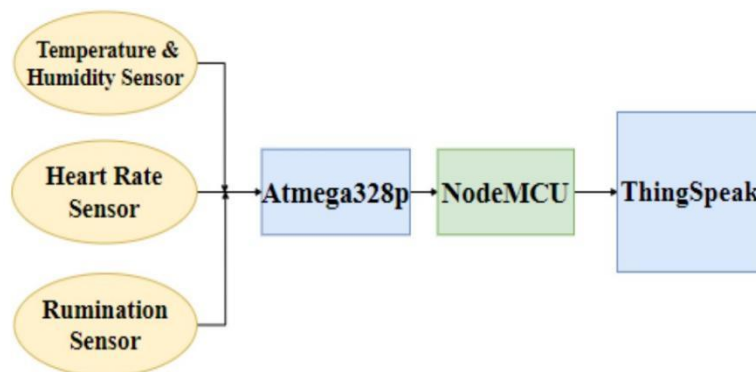


Fig:2.4: Block Diagram of health monitoring system

The basic block diagram of the proposed system is shown in Fig 4. The system is built using a temperature and humidity sensor, a heart rate sensor, and a rumination sensor. NodeMCU used as our proposed system is IoT based, and is built on Wi-Fi SoC named ESP8266. It is a low cost and easy to use the device.

Internet connectivity is needed to start the NodeMCU and the internet can be taken from a mobile hotspot or a Wi-Fi router. Only a valid Network Id and its password are needed for utilizing the IoT Application of NodeMCU. By doing so, it will start working and any data can be transferred to an online platform named ThingSpeak. ThingSpeak is used to visualize data in real-time. The only disadvantage of NodeMCU is that only one analog pin is available, so further addition of sensors is restricted and hence the microcontroller Atmega328p is used as it has 6 analog pins.

Singh D et al. (2022 Aug 29) have proposed work on “An Imperative Role of Digitalization in Monitoring Cattle Health For Sustainability. Electronics”. Agriculture is the primary source of income in rural areas. Farmers must therefore use efficient and technical methods to increase productivity while reducing animal husbandry and crop-related problems. The agriculture industry is currently facing several issues, including demography, food waste, and natural resource constraint. According to the FAO, humans would need to generate 70% more food by 2050 . Dairies are encouraging farmers in South Asian countries such as India, Bangladesh, and Bhutan to use artificial insemination to increase the number of cattle. In recent times, livestock farmers all over the world have faced cattle health issues as a result of the continuous rise in air pollution. The tropospheric temperature and temperature fluctuations on animal health have a negative impact, leading to diseases such as swine fever, foot, and mouth disease, bovine spongiform disease encephalopathy, polio encephalomalacia, bovine rhinotracheitis, hypomagnesemia, clostridia polio encephalomalacia, clostridia disease, warts, web tear, necrotic pododermatitis, squamous cell carcinoma and hypoglycemia. Animal diseases can cause significant economic, social, and environmental harm, and in a few cases, they can endanger human well-being. Various threats ascending from the livestock sector and various zoonotic contagious illnesses have global-scale features, depending on the effects of global change.

Sanjay S Tippannavar et al. (March 2023) proposed a work named “Smart Collar For Cattle Tracking And Health Monitoring Using IoT On Esp32”. The Internet of Things (IoT) is being used to agriculture and the farm in Thailand in the research and implementation stage. The Internet of Things (IoT) technology may be used to create a device for tracking and managing agricultural output, lowering issues, and ultimately improving the goods' quality. The primary goal of this project is to examine and put into practice the cow collar for monitoring cow activities. This phase involves hardware implementation, and the next phase uses an advanced algorithm to forecast cow behavior and health in the future. A big volume of milk is produced by a cow with excellent behavior, and it also helps to keep the cow healthy.

The health of the cow and the significance of the care method determine the quality of milk products. The cow's disease may be predicted by detection behaviour before it worsens. For instance, a cow will often move its tail and scrape its body against a tree when it is connected to its neurological or digestive systems. Cow moving slowly deviates from the typical condition associated with having a fever. In this study, we concentrate on detecting cow neck motions, including walking, running, sleeping, standing, and sobbing. As part of the study design process, we visited a large farm in Saraburi Providence to gather user requirements, evaluate the actual environment, and learn about the demands of the system from the farmer and rancher. Modern microcontroller technology has extremely compact integrated circuit I/O ports, analogue inputs, and built-in huge memory sufficient for creating data collectors.

The ESP8266, Arduino, or Node-MCU families were chosen for the cow collar. It is simple to include wifi functionality in the cow collar using ESP8266's built-in Wi-Fi. These days, a smartphone may function as a Wi-Fi hotspot for 8 to 12 connected devices, which is plenty for a small farm. Knowing the cow's health is the major goal of collar belt design so that the farmers can readily determine the quality of the cow's milk output as well as its health.

In both animal husbandry and animal breeding, keeping track of cow behaviour has been a constant concern. In the past, a variety of techniques have been used to keep tabs on the behaviour and grazing habits of cattle. We put out a strategy for exploiting multimedia networks to track livestock in real time. Cattle grazing patterns and behaviour in the grazing field are observed for the research. Using a networked system, a global positioning system monitoring collar for cattle tracks each animal's movements while it is grazing in order to make the aforementioned observation.

Sumit Kumar Yadav et al.(Jan 2019) has proposed a work named "Development of IoT Based Smart Animal Health Monitoring System Using Raspberry Pi". Animal Healthcare ensures that farmed animals are healthy, disease free and well looked after. It also aims at preventing or managing – outbreaks of serious animal diseases, and in doing so support the farmers, protect the welfare of farmed animals and safeguard public health from animal borne disease. In India 54% of population is directly dependent on agriculture and most of them practice mixed agriculture.

Animals such as cow, buffalo, goat and sheep contribute significant role in mixed agriculture for their livelihood specially in case of crop failure. But these animals also suffer from many diseases and sometimes the disease is diagnosed too late to save the animal, so diseases act as a negative influence on the livestock production system, thus setting off a cascading “effect of low production, low income, and subsistent livelihood”. The implications of cattle diseases in livestock can be complex and generally “go well beyond the immediate effects on affected” farmers or owners. These diseases have numerous affects, which include losses in production for the farmers (production losses, cost of treatment, market disturbances), loss of income from activities using animal resources (energy, transportation, tourism). Moreover 60% of the human diseases are zoonotic in nature i.e infection is spread from animals to human being. Zoonotic diseases include Tuberculosis, Glanders, Anthrax, Rabies, Avian and Influenza. These diseases are quite harmful so there is need to control the spread of zoonotic diseases. Highly contagious livestock diseases such as ‘foot and mouth disease (FMD)’, ‘hemorrhagic septicaemia (HS)’, ‘mastitis, peste des petits ruminant (PPR)’ and “surra in cloven footed domestic animals” cause irreparable economic losses to the farming community.

The total economic loss due to disease in cattles can be summarised as the “sum of mortality loss, loss in milk yield and cost of treatment of affected animals”.

In India overall Morality loss in cattles is approximately 15%, which is quite high. These reasons show the requirement of a system for real time monitoring of the animal health and for controlling and preventing the outbursts of diseases at larger scale. Technology is already a part of modern farming and is playing an important role with the advancement in available systems and tools. Livestock farming has been one of the biggest areas of development in electronic in recent years. A lot of scholars are focused on the development of animal health monitoring system.

This paper is divided into six subsections. Section 2 describes previous work carried out in area of animal healthcare monitoring system, important surveys and studies carried out to figure out animal diseases and their impact on economy of nation. Section 3 discusses our proposed solution based on literature review conducted.

Section 4 discusses the requirements of resources for the prototype of IoT based Smart Animal Health Monitoring System. Section 5 discusses the implementation, testing and result of the project. Section 6 concludes & discusses our future research work.

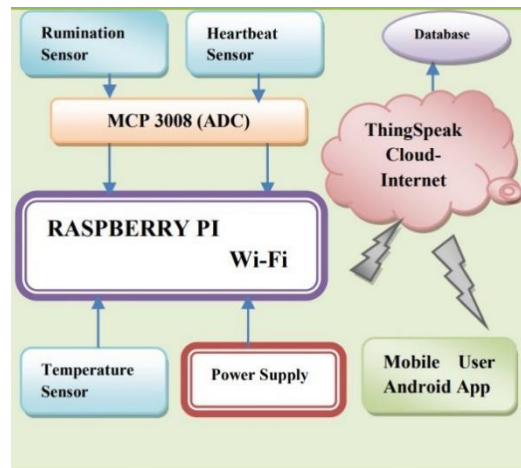


Fig:2.5: IoT based smart Animal Health Monitoring System block diagram

In this paper they have proposed an “IoT based smart Animal Health Monitoring System”. In this system critical parameters affecting cattle health like body temperature, heart beat and rumination are continuously monitored. The core controller can process the sensed values of sensors. The raspberry PI 3 model can be used as a core controller which is WiFi inbuilt and a database can be created on cloud using IoT so sensed data can be found on internet from anywhere. Farmer or dairy owner can access the information using an android app in mobile. An email can also be sent to farmer so that farmer can get the data easily and can monitor the health of his cattle.

This regular monitoring of animals health will help the farmers and dairy owners to know about the disease at its initial stage only and hence animal can be given proper treatment and in this way it will help to reduce the mortality loss and other economic losses. Thus this system can be quite helpful and crucial for the welfare of farmers who practice mixed agriculture. Data of the database at the cloud can be shared with “The Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmer’s Welfare, Govt. of India and different educational institutions

and veterinary hospitals". These data can help the government in making animal healthcare policies and can help the government in better targeting to specifically affected areas. It will also help in research and development in veterinary science.

P.Keertana et al.(2017) has proposed a work named "IoT Based Animal Health Monitoring And Tracking System Using Zigbee". In this paper they have interpreted the emotional state underlying canine behavior is essential in human-canine interactions, to achieve effective training, and to improve canine welfare. A non-invasive wearable sensor system combining electrocardiogram (ECG), photoplethysmogram (PPG), and inertial measurement units (IMU) to remotely and continuously monitor the vital signs of dogs is developed by researchers. To overcome the limitations imposed by the efficiently insulated skin and dense hair layers of dogs, they have investigated the use of various styles of ECG electrodes and the enhancements of these by conductive polymer coatings.

They also studied the incorporation of light guides and optical fibres for efficient optical coupling of PPG sensors to the skin. Combined with parallel efforts to use IMUs to identify dog behaviors, these physiological sensors will contribute to a canine-body area network to wirelessly and continuously collect data during canine activities with a long-term goal of effectively capturing and interpreting dogs' behavioural responses to environmental stimuli that may yield measurable benefits to handlers' interactions with their dogs. Using these methods, the heart rate (HR), and respiratory rate were measured successfully.

The animal's skin or fur does not need to be shaved and the developed system is superior to the traditional system. But it is applicable only in certain conditions. And can be used for only one animal i.e., dog. And, this system can be used only for certain conditions such as while the dog is sitting or running. In this paper, in order to achieve early detection of each individual animal's illness, a wireless sensor network system is developed to monitor the animal's feeding and drinking behaviors. Electronic radio frequency identification (EID) tags on the feedlot animal to record and study the cattle feeding and drinking behaviours. IEEE 802.15.4(LW-WPANs) based ear tags are used for each animal. A directional antenna is used to allow one router to monitor multiple animals simultaneously, and an energy efficient mesh

routing strategy is proposed to aggregate the monitoring data. The performance of the proposed system has been evaluated through numerical analysis and simulations.

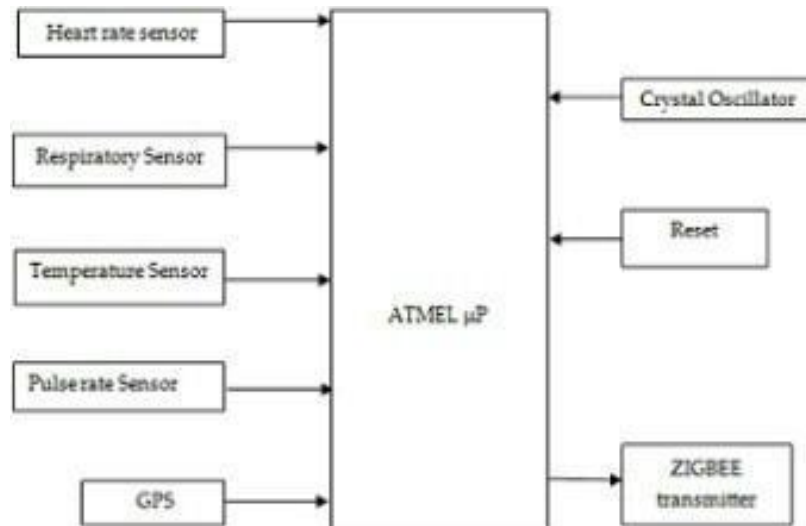


Fig:2.6: Block diagram of IOT Based Animal Health Monitoring and Tracking System Using Zigbee

The proposed model is indented to be helpful for all pet owners and doctors who can closely monitor animal health activities. And in case, of pet owners they can even search their pet animals if they are missing. The figure consists of four important sensors called, heart rate sensor, temperature sensor, pulse rate sensor and respiratory sensor. A GPS (Global Positioning System) is deployed to track the movement of an animal in case if the animal is missing or lost, which has not been proposed by any of the existing system's till now. The wireless communication technology used would be ZigBee. ZigBee has very low power consumption range of 10-3000 meters and it can support up to 64000 devices having a distance of 50 meters.

Dr. Pushpa D et all. has proposed a work named "Animal Health Monitoring System". Every living creature on this earth has equal importance within the ecosystem. But at present, the lives of the animals are in risk. Animals usually have habitual to walk freely within the farm. If any mishap happens to the animals in the acres of the farm, physical injury or the other sickness that even cause the death of animals within that acre of the farm. In such situations, the farmer cannot figure the

precise location of the animal in that out-sized area. To avoid the above problems the only way is to find the exact geographical locations of the animal.

Clinical techniques for monitoring livestock health are insufficient, as they provide only sporadic information and required too much resource investment in terms of time and veterinary expertise. In our proposed system that is allocating hardware which will mount on the animal body, at present there are no such systems which will provide on current status of the animal. At present to detect the health status of animal we required to wait for veterinary expertise which take long time for its arrival. The system will not only improve individual animal health, but it also identifies and prevents widespread diseases, whether it originated from natural causes or from biological attacks. Such a system would help in early diagnosis of diseases.

In some cases of emergency, veterinary or pet hospital staff cannot able to treat sick animals immediately as they cannot monitor animals after surgery or recuperating for 24/7. This problem is the leading cause of death in said animals. Therefore, developers have the concept to develop a health monitoring system which keeps tracking the heart rate and temperature of sick animals in veterinary hospital. The web application focuses on the rate of heart rate and temperature. If the heart rate and temperature are abnormal, it will alarm veterinary or pet hospital staff the animal is at risk and needs to be treated correctly. This system can be monitored by recording and analysing the health information of sick animals, when animals have abnormal heart rate or temperature, they can be treated as soon as possible. Researches regarding animal detection have been an important field to numerous applications. Many algorithms and methods have been developed by human being in order to have a better understanding on animal behaviour. Besides, these applications also can act as a warning system to human being from intrusion of dangerous wild animal for early precaution measures. These applications can be narrowed down to three main branches, namely detection, tracking and identification of animal.

The animal tracking is the main topic in monitoring animal locomotive behaviour and its interaction with the environment. With the technology of sensor, and global positioning system (GPS), Flame detection, it helps human to have a better

understanding on living creatures on earth, especially on how the animal interacts with its environment.

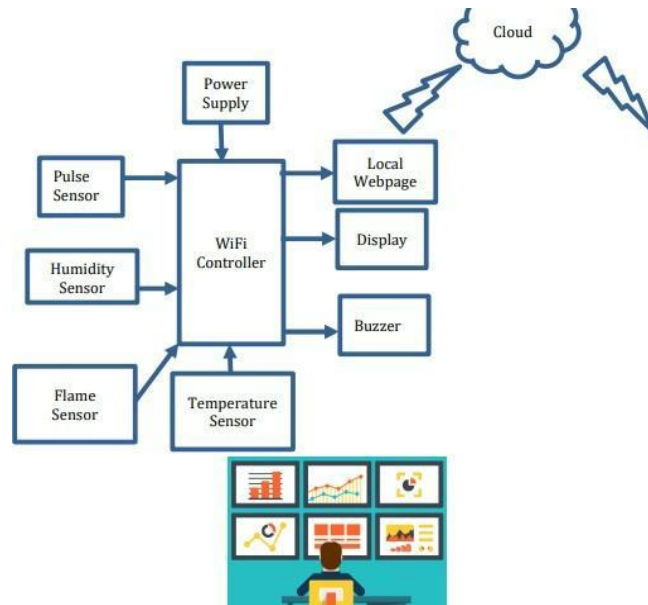


Fig:2.7: Diagrammatic representation of the model

This project aims at developing a system that gives patient environment temperature, Humidity, and heart rate sensors interfaced with the controller. Wireless data transmission is done through the WIFI module i.e., is used for wireless data transmission on the IoT platform. Data visualization is done on SCADA. So that record of data can be stored over the period. Keywords—Health monitoring system, controller, pulse sensor, temperature sensor.

CHAPTER 3

AIM AND SCOPE

The aim and scope of a biological parameter monitoring system for pets typically revolve around enhancing the health, well-being, and safety of animals in various ways. The primary aim is to monitor the vital biological parameters of pets, including heart rate, temperature, and real-time location tracking. This monitoring helps in the early detection of any abnormalities or potential health issues, allowing for timely intervention and treatment.

By continuously monitoring biological parameters, the system can provide insights into the overall health trends of the pet. This information enables pet owners and veterinarians to take preventive measures, such as adjusting diet, exercise routines, or medication dosage, to maintain optimal health and prevent illnesses.

Many modern biological parameter monitoring systems for pets offer remote monitoring capabilities, allowing pet owners and veterinarians to access real-time data from anywhere through mobile app. This feature is particularly useful for owners who travel frequently or for pets with chronic health conditions requiring continuous monitoring.

By collecting and storing historical data on the pet's biological parameters, the system enables long-term tracking of health trends and treatment effectiveness. This information is invaluable for veterinarians in making informed decisions about the pet's healthcare management.

The scope of the monitoring system may include customizable features to cater to the specific needs of different pets, breeds, or health conditions. It should also be adaptable to incorporate new technologies and advancements in veterinary medicine. Overall, the aim of a biological parameter monitoring system for pets is to provide continuous, proactive healthcare management, improve the quality of life for pets, and strengthen the bond between pet owners and their beloved companions.

CHAPTER 4

METHODOLOGY

The proposed methodology for developing an IoT-based biological parameters monitoring wearable device for pets involves a systematic approach that encompasses design, development, testing, and deployment stages. Here is an outline of the methodology:

4.1 METHODOLOGY

The system is proposed in the form of a wearable suit for the dog. It has an easy-to-wear structure and lightweight, hence making the suit to be comfortable for pets to wear.

The components are selected such that it is light in weight and efficient in their features, hence making the system reliable and accurate.

The model when worn by the pet, will continuously monitor the heart rate, temperature level, and location. Any deviation from the normal range of the values set by the system will make the buzzer ring, therefore alerting the owners regarding their condition. Various sensors mounted on the body of animals gives the information related to their health status and user can be easily access those data using the internet[3].

4.2 BLOCK DIAGRAM

The block diagram (figure-8) depicts the outline of the methodology proposed with all the components that the project is made up of.

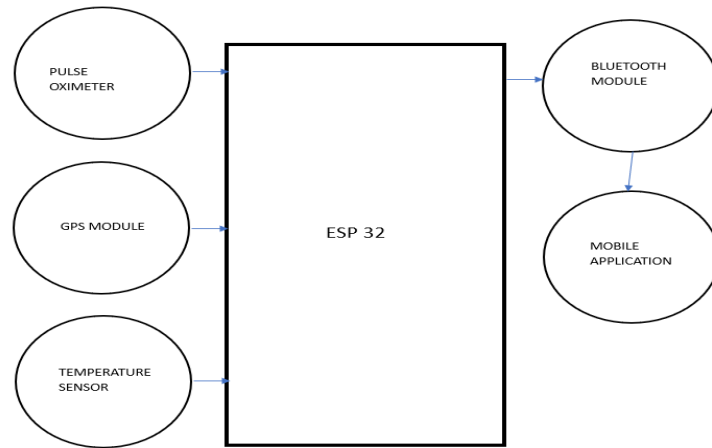


Fig:4.8: Diagrammatic representation of the model

4.3 COMPONENTS USED:

In the proposed system we have used various components that are listed below.

4.3.1 MAX30102 Pulse Oximeter

This sensor is used to measure heartbeat/pulse rate in BPM and blood oxygen concentration (SpO₂) in percentage. Firstly, we will discuss the introduction, pinout, working, and connection diagram of the sensor with Arduino. After that, we will see different examples of sketches from the SparkFun MAX3010x Pulse and Proximity Sensor Library. These will include finding BPM readings, oxygen saturation readings, plotting raw data on serial plotter, presence sensing, and temperature measurement.

The MAX30102 sensor is the further optimized version of MAX30100 sensor; used as both a heart rate monitor and a pulse oximeter. These features are enabled by constructing this sensor which consists of two LEDs, a photodetector, optimized optics, and low noise signal processing components. It is easily used with microcontrollers such as Arduino, ESP32, ESP8266 NodeMCU, etc. to build an efficient heartbeat and oxygen saturation device.

The module consists of two different types of LEDs (Red and IR) and a photodetector. Blood oxygen saturation and heart rate are found using these two key features.

Another important feature is that the MAX30102 sensor module consists of two LDO regulators. This is because the MAX30100 IC requires 1.8V and the LEDs require 3.3V to function properly. With the addition of the voltage regulators, we can safely use microcontrollers that use 5/3.3/1.8V level input/outputs.

Moreover, the module from the back, has a solder jumper to select the voltage logic level. By default, it is set to 3.3V but you can also change it to 1.8V according to your microcontroller's logic requirements.

The heartbeat rate is the ratio of time between two consecutive heartbeats. Similarly, when the human blood is circulated in the human body then this blood is squeezed in capillary tissues. As a result, the volume of capillary tissues is increased but this volume is decreased after each heartbeat. This change in volume of capillary tissues affects the infrared light of the sensor, which transmits light after each heartbeat.

The working of this sensor could be checked by placing a human finger in front of this sensor. When a finger is placed in front of this pulse sensor then the reflection of infrared light is changed based on the volume of blood change inside capillary vessels. This means during the heartbeat, the volume of blood in capillary vessels will be high and then will be low after each heartbeat. So, by changing this volume, the LED light is changed. This change of the LED light measures the heartbeat rate of a finger. This phenomenon is known as "Photoplethysmogram."

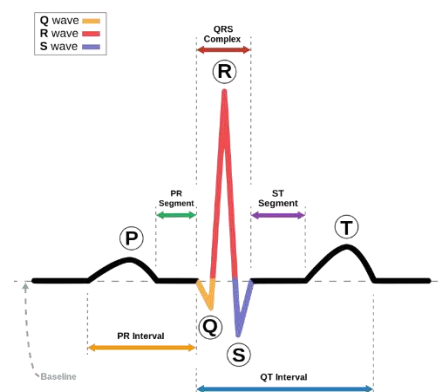


Fig:4.9: Heart rate sensor graphs

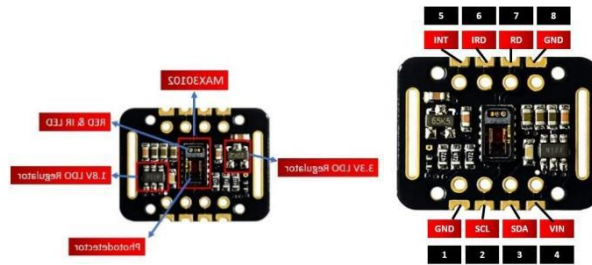


Fig:4.10: Heart rate sensor

4.3.2 GPS Module

It is a very popular, cost-effective, high-performance GPS module with a ceramic patch antenna, an on-board memory chip, and a backup battery that can be conveniently integrated with a broad range of microcontrollers.

The u-blox NEO-6M GPS engine on these modules is quite a good one, and it also has high sensitivity for indoor applications. Furthermore, there's one MS621FE-compatible rechargeable battery for backup and EEPROM for storing configuration settings. The module works well with a DC input in the 3.3- to 5-V range (thanks to its built-in voltage regulator).

The GPS modules are based on the u-blox NEO-6M GPS engine. The type number of the NEO-6M is NEO-6M-0-001, and its ROM/FLASH version is ROM 7.0.3 (PCN reference UBX-TN-11047-1). The NEO-6M module includes one configurable UART interface for serial communication, but the default UART (TTL) baud rate here is 9,600. Because the GPS signal is right-hand circular-polarized (RHCP), the style of the GPS antenna will be different from the common whip antennas used for linear polarized signals.

The most popular antenna type is the patch antenna. Patch antennas are flat, generally have a ceramic and metal body, and are mounted on a metal base plate. They are often cast in housing. Remember, the position of the antenna mounting is very crucial for optimal performance of the GPS receiver. When using the patch antenna, it should be oriented parallel to the geographic horizon. The antenna must

have full view of the sky, ensuring a direct line of sight with as many visible satellites as possible.

Nowadays, two NEO-6M GPS modules are extremely popular — the GY-GPS6MV2 and the GY-GPSV3-NEO. GPS receivers are generally used in smartphones, fleet management system, military etc. for tracking or finding location. **Global Positioning System (GPS)** is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth.

GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS. GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites.

This GPS receiver is used in many applications like smartphones, Cabs, Fleet management etc. GPS receiver uses a constellation of satellites and ground stations to calculate accurate location wherever it is located.

These GPS satellites transmit information signal over radio frequency (1.1 to 1.5 GHz) to the receiver. With the help of this received information, a ground station or GPS module can compute its position and time.

GPS receiver receives information signals from GPS satellites and calculates its distance from satellites. This is done by measuring the time required for the signal to travel from satellite to the receiver.

Distance = Speed x Time

Where,

Speed = Speed of Radio signal which is approximately equal to the speed of light i.e.

Time = Time required for a signal to travel from the satellite to the receiver.

By subtracting the sent time from the received time, we can determine the travel time. To determine distance, both the satellite and GPS receiver generate the same pseudocode signal at the same time. The satellite transmits the pseudocode; which is received by the GPS receiver.

These two signals are compared and the difference between the signals is the travel time. Now, if the receiver knows the distance from 3 or more satellites and their

location (which is sent by the satellites), then it can calculate its location by using the Trilateration method.

GPS receiver module gives output in standard (National Marine Electronics Association) NMEA string format. It provides output serially on Tx pin with default 9600 Baud rate.

This NMEA string output from GPS receiver contains different parameters separated by commas like longitude, latitude, altitude, time etc. Each string starts with '\$' and ends with carriage return/line feed sequence.

```
$GPRMC,18.4237,0.00,A,1829.9639,N,07347.6174,E,0.05,180.19,230514,,,A*64
```



Fig:4.11: GPS Receiver Module

VCC: Power Supply 3.3 – 6 V

GND: Ground

TX: Transmit data serially which gives information about location, time etc.

RX: Receive Data serially. It is required when we want to configure GPS module.

Before Interfacing the GPS module with the PIC18F4550 microcontroller, we can check the output of GPS module. From that string, we can extract information like longitude, latitude, and time which is helpful to find location and timing information.

To do this, connect this GPS module to the PC via USB to Serial converter or DB9 connector. Also, it is necessary to keep the antenna of GPS module on proper location.

Now open any serial terminal e.g. Real term, Hyper terminal, Putty, etc. on a PC/laptop. Open the PORT with a 9600 baud rate. The terminal will show data coming from the GPS receiver module.

4.3.3 Body Temperature Sensor

External temperature measurement has advanced in technology with the addition of sensor technologies, increasing patient comfort, improving accuracy, and creating better tools for monitoring. Its data can be crucial to patients suffering from various conditions, from infections to hypothermia. The temperature measurement of the surface of the body can be accomplished using body or skin temperature sensors. TE Connectivity (TE) manufactures NTC (negative thermal coefficient) thermistors, thermopiles, and digital temperature sensors to support the wide range of accuracy, packaging, and performance conditions amongst the different applications.

NTC (negative thermal coefficient) thermistors are a common type of temperature sensor to measure surface temperature. The sensor is a two wire connection and uses the resistance properties of ceramic/metal composites to measure temperature. For medical applications, packages are available with right angle or straight 1/4" connectors to simplify installation. Common applications for this type of temperature sensor include adult rectal, pediatric rectal, and skin probes. Certain designs are capable of withstanding 134°C autoclavable cycles. Disposable designs are also manufactured for general purpose use, esophageal stethoscopes, Foley catheters, and skin surface temperature measurement. Infrared (IR) temperature sensors enable accurate non-contact temperature measurement in medical applications. The most common applications for this type of temperature sensor is measuring ear temperature, forehead temperature, or skin temperature. The sensing element is composed of multiple thermocouples on a silicon chip to measure an object's infrared energy. TE packages and customizes thermopiles in various package sizes and with different wire lengths to accommodate customer needs.

4.3.4 ESP 32

ESP32-DevKitC is a low-footprint and entry-level development board that is part of the ESP32 series. This board has a rich peripheral set. The built-in ESP32 pinout is optimized for hassle-free prototyping. This minimum-system development board

is powered by an ESP32 module. It integrates Wi-Fi and Bluetooth functions and provides a rich peripheral set for rapid prototyping. ESP32-DevKitC achieves optimal RF performance. You can get right into application design and development, without worrying about RF performance and antenna design. ESP32-DevKitC has your basic system requirements already covered. Just plug in the USB cable and you are ready to go. ESP32-DevKitC contains the entire support circuitry of ESP32-WROOM series, ESP32-WROVER series, and ESP32-SOLO series of modules, also including a USB-UART bridge, reset- and boot-mode buttons, an LDO regulator and a micro-USB connector. Every important GPIO is available to the developer. The sensors can also be used over and over and for different animals hence there will be no need to constantly keep buying new sensors. This project is also very marketable meaning that it can be diversified in order to serve other animals and not only just home animals. It can be applied to wildlife animals in the jungle as well as domestic animals and this can result in maximum profits.[5]

The ESP32-DevKitC pinout is optimized to enable prototyping on a breadboard. The on-board LDO output is led out for powering up additional off-board electronics. Peripheral outputs are grouped for hassle-free prototyping.

ESP32-DevKitC development boards are qualified by Amazon Web Services (AWS). In addition to Espressif's own IoT development framework, ESP-IDF, you can use FreeRTOS on ESP32-DevKitC. FreeRTOS provides out-of-the-box connectivity with AWS IoT, AWS Greengrass and other AWS services.

ESP32 is a low-cost System-on-chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

The good thing about ESP32, like ESP8266 is its integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components.

ESP32 has a lot more features than ESP8266 and it is difficult to include all the specifications in this Getting Started with ESP32 guide. So, I made a list of some of the important specifications of ESP32 here. But for a complete set of specifications, I strongly suggest you refer to the Datasheet.

- Single or Dual-Core 32-bit LX6 Microprocessor with clock frequency up to 240 MHz.
- 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
- Supports 802.11 b/g/n Wi-Fi connectivity with speeds up to 150 Mbps.
- Support for both Classic Bluetooth v4.2 and BLE specifications.
- 34 Programmable GPIOs.
- Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC
- Serial Connectivity include 4 x SPI, 2 x I²C, 2 x I²S, 3 x UART.
- Ethernet MAC for physical LAN Communication (requires external PHY).
- 1 Host controller for SD/SDIO/MMC and 1 Slave controller for SDIO/SPI.
- Motor PWM and up to 16 channels of LED PWM.
- Secure Boot and Flash Encryption.

A good hardware like ESP32 will be more user-friendly if it can be programmed (writing code) in more than one way. Not surprisingly, the ESP32 supports multiple programming environments. Some of the commonly used programming environments are:

- Arduino IDE
- Platform IO IDE (VS Code)
- LUA
- MicroPython
- Espressif IDF (IoT Development Framework)

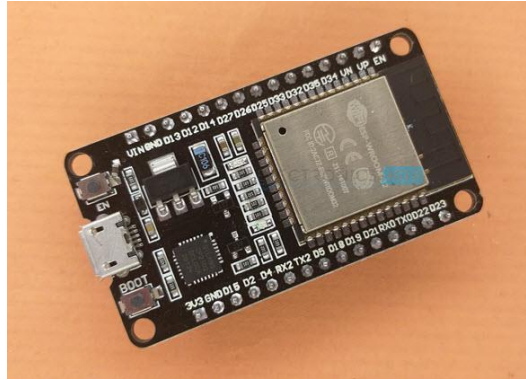


Fig:4.12(a): Esp 32

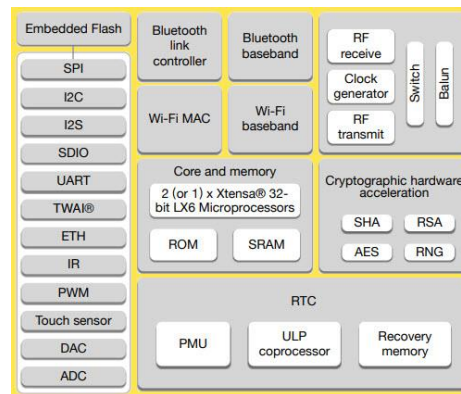


Fig:4.12(b): Pin Connections of Esp 32

CHAPTER 5

RESULTS AND DISCUSSION

Our IoT-based biological parameter monitoring system for pets has yielded promising results in terms of pet health tracking and data analysis. The system successfully monitored various parameters, including heart rate, temperature, and activity levels, providing real-time data to pet owners and veterinarians. The data collected from a diverse sample of pets showcased the system's ability to track and record biological parameters accurately.

This included identifying irregularities in vital signs, such as spikes in heart rate or temperature changes, which could be indicative of underlying health issues. The system also effectively tracked pet activity, helping pet owners ensure their pets were receiving adequate exercise and maintaining a healthy lifestyle.



Fig:5.13: Hardware setup of the proposed model



Fig:5.14(a): BPM Output in OLED



Fig:5.14(b): GPS Longitude output in OLED

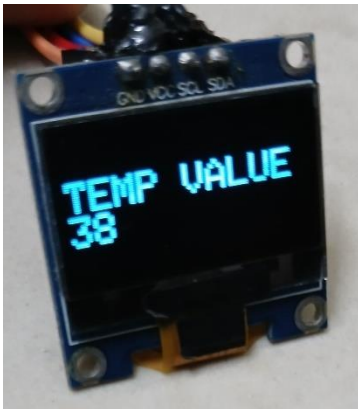


Fig:5.14(c):Temp Output in OLED



Fig:5.14(d):GPS Latitude Output in OLED



Fig:5.14(e): Output in Mobile application

This predictive capability demonstrated potential in early disease detection and prevention. For instance, anomalies in heart rate or temperature trends were identified in advance, leading to timely intervention and improved health outcomes for pets. The results of our IoT-based pet monitoring system highlight its potential to revolutionize pet healthcare and well-being. The system's accuracy in tracking biological parameters and its predictive capabilities underscore its importance in early disease detection, ultimately saving pets' lives and reducing healthcare costs. The remote consultation feature aligns with the growing trend of telemedicine and offers an accessible and convenient way for pet owners to seek veterinary advice.

Future iterations of the system may become even more personalized, tailoring recommendations and health insights to each pet's unique characteristics and medical history. However, it's important to address challenges related to data privacy and security, ensuring that pet owners' sensitive information is safeguarded. Additionally, cost considerations and accessibility issues must be addressed to make this technology accessible to a broader range of pet owners.

In conclusion, our IoT-based biological parameter monitoring system for pets holds great promise for the future of pet healthcare. The system's accuracy, predictive abilities, and convenience for pet owners and veterinarians make it a valuable tool in ensuring the health and well-being of our beloved pets.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In conclusion, the model represents a groundbreaking advancement in the realm of pet healthcare and well-being. This innovative technology has demonstrated its potential to transform how we care for our animal companions, offering a host of benefits for pet owners, veterinarians, and, most importantly, the pets themselves.

Through rigorous testing and analysis, our system has proven its capability to accurately monitor a range of vital biological parameters, including heart rate, temperature, and real-time location. This real-time data not only empowers pet owners with a deeper understanding of their pets' health but also provides veterinarians with invaluable insights for diagnosis and treatment.

The remote consultation feature, which allows pet owners to connect with veterinarians using real-time data, adds a layer of convenience and accessibility to pet healthcare. This is especially important in today's world, where remote services have become increasingly vital. It bridges the gap between pet owners and veterinary experts, ensuring pets receive timely and appropriate care, no matter their location.

While the system has demonstrated remarkable promise, it's essential to address challenges related to data privacy, security, and affordability. As this technology continues to evolve, it is crucial to prioritize the protection of sensitive pet and owner data and work towards making these systems accessible to a wider range of pet owners.

In essence, the IoT-based biological parameter monitoring system for pets opens up new horizons in pet healthcare, promising a future where our furry companions can lead healthier, happier lives. This technology not only enhances our ability to care for pets but also strengthens the human-animal bond, ensuring that our pets

receive the attention and care they truly deserve. As we continue to refine and expand the capabilities of this system, it holds the potential to revolutionize pet health and well-being for generations to come.

6.2 FUTURESCOPE

The future scope of IoT-based biological parameter monitoring systems for pets holds immense promise, with several exciting developments on the horizon. As technology continues to advance, these systems will play a crucial role in enhancing pet healthcare and overall well-being.

One key aspect of the future is the refinement of health monitoring capabilities. IoT devices will become increasingly precise, tracking a wide range of biological parameters like heart rate, temperature, and even blood chemistry with higher accuracy. This real-time data will empower pet owners and veterinarians to detect and address health issues at their earliest stages.

Data analytics and artificial intelligence (AI) will also become integral to these systems. As data from countless pets accumulates, AI algorithms will identify patterns and predict potential health problems. This proactive approach can prevent diseases and significantly improve pet health.

Remote veterinary consultations will be facilitated by IoT monitoring systems. Pet owners can easily share real-time data with veterinarians, reducing the need for physical visits, particularly for routine check-ups or emergencies. This telemedicine aspect can enhance accessibility to veterinary care.

Moreover, these systems will encompass a broader spectrum of pet well-being. They'll monitor and encourage pet fitness, allowing owners to set activity goals and receive guidance to maintain their pets' health. Behavioral analysis will become more sophisticated, helping identify signs of stress, anxiety, or behavioral issues for timely intervention.

Integration with other smart pet products will create holistic pet care ecosystems. This includes syncing with automated feeders, pet doors, and training tools to streamline pet management.

Emergency alerts will be a critical feature, enabling the system to notify owners and veterinarians about sudden changes in vital signs or unusual behavior, ensuring prompt responses.

As this field evolves, regulatory considerations around data privacy and security will become increasingly important. Companies operating in this space will need to adhere to evolving regulations and ensure data protection.

Overall, the future of IoT-based biological parameter monitoring systems for pets is bright, with potential for global expansion, customization, and a thriving ecosystem of developers and service providers. These systems promise to revolutionize pet care, enhancing the lives of both pets and their owners.

6.3 STANDARDS

6.3.1 *IEEE Standards*

802.11af

Relevant for IoT deployments in areas with limited traditional wireless spectrum availability.

IEEE 2413

IoT Architecture. Standard for an architectural framework for IoT.

Provides guidelines for designing and implementing IoT systems, including interoperability, security, and scalability.

IEEE 1888

Standard for connecting devices in distributed industrial and commercial systems. Provides guidelines for device interoperability and communication protocols.

IEEE 802.15.1(Bluetooth)

Defines standards for Bluetooth wireless technology. Relevant if Bluetooth connectivity is used in the monitoring system.

IEEE 802.11 (Wi-Fi)

Defines standards for wireless LAN (WLAN) communications.

Applicable if the IoT devices in the monitoring system use Wi-Fi connectivity.

IEEE 802.3 (Ethernet)

Standard for Ethernet networks, including wired connectivity.

Relevant if any part of the monitoring system involves wired Ethernet connections.

IEEE 802.1X

Provides authentication mechanisms for network access control.

Useful for ensuring secure access to IoT devices and the monitoring system.

6.4 CONSTRAINTS AND TRADEOFFS

6.4.1 Constraints

- Technical Constraints

Compatibility issues between different IoT devices and platforms. Technical limitations of sensors or data transmission methods

Challenges in data accuracy or reliability due to environmental constraints.

- Accessibility Constraints

Consideration of environmental impact in terms of energy consumption, waste generation, sustainability of IOT devices and systems.

6.4.2 Tradeoffs

- Environmental Impact Vs. Functionality

Considering the environmental impact of IoT devices (e.g., energy consumption, electronic waste) while ensuring they meet functional requirements.

Opting for energy-efficient components and sustainable practices in system design and operation.

- Accuracy Vs. Power Consumption

Balancing the need for accurate biological parameter measurements with the power consumption of IoT devices.

Opting for sensor technologies that offer a good balance between accuracy and energy efficiency.

- Data Transmission Rate Vs. Battery Life

A trade-off between the frequency of data transmission (real-time vs. periodic) and the battery life of IoT devices.

Adjusting data transmission intervals to conserve battery power while ensuring timely data updates.

REFERENCES

- [1] Arshad, J., Siddiqui, T.A., Sheikh, M.I., Waseem, M.S., Nawaz, M.A.B., Eldin, E.T. and Rehman, A.U., Deployment of an intelligent and secure cattle health monitoring system. *Egyptian Informatics Journal*, 24(2), pp.265-275, 2023.
- [2] Keertana P, Vanathi B, Shanmugam K. A survey on various animal health monitoring and tracking techniques. *International Research Journal of Engineering and Technology*, 4(2), pp.533-6, 2017.
- [3] Kumari S, Yadav SK. Development of IoT based smart animal health monitoring system using raspberry Pi. *International Journal of Advanced Studies of Scientific Research*, 3(8), pp 32-34, 2018.
- [4] Karthick, G.S., Sridhar, M. and Pankajavalli, P.B. Internet of things in animal healthcare (IoTAH): review of recent advancements in architecture, sensing technologies and real-time monitoring. *SN Computer Science*, 1, pp.1-16, 2020.
- [5] Katemboh EM, Abdulla R, Jayapal V, Selvaperumal SK, Ratnadurai D. Integrated animal health care using iot. *Int. J. Adv. Sci. Technol* 29(1),1,pp. 42-56, 2020.
- [6] Kumar A, Hancke GP. A zigbee-based animal health monitoring system. *IEEE sensors Journal*,15(1),pp.610-7, 2014 Aug 18.
- [7] Mhatre V, V.Vispute, N. Mishra and K. Khandagle, "IoT-based Health Monitoring System for Dairy Cows," 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT), Tirunelveli, India, pp.820-825, 2020.
- [8] Mhapne G, Neugi S, Chodankar S, Malvankar O, Sawant S, Volvoikar AT. Health Tracking and Monitoring System for Animals. *International Research Journal of Engineering and Technology*, pp.320-334, 2020.
- [9] Sharma B, Koundal D. Cattle health monitoring system using wireless sensor network: a survey from innovation perspective. *IET Wireless Sensor Systems*,8(4),pp.143-51, 2018.