A Minor Project Report

On

IOT-BASED HEALTH AND LOCATION SURVEILLANCE SYSTEM

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATION ENGINEERING

SUBMITTED BY

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JYOTHISHMATHI INSTITUTE TECHNOLOGY AND SCIENCE

(AUTONOMUS)

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that the project work entitled "IOT-BASED HEALTH AND LOCATION SURVEILLANCE SYSTEM" is a bonafide work carried out by **GAJJELA SHARANYA (21271A0442), VENAMPALLI SAIKOUSHIK (21271A0435), PULI SUMANTH (21271A0454), NIMMA MAHESH (21271A0420)** in partial fulfillment of the requirements for the degree of **"BACHELOR OF TECHNOLOGY"** in ***"Electronics and Communication Engineering"*** from the Jyothishmathi Institution of Technology and Science, (Autonomous) during the academic year 2024-25.

No part of this report has been submitted elsewhere for award of any other degree

Submission for mini project viva voce examination held on__________

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DECLARATION

This is to certify that the work reported in the present project entitled "**IOT-BASED HEALTH AND LOCATION SURVEILLANCE SYSTEM**" is a record of work done by us in the partial fulfillment for the award of the degree of ***Bachelor of Technology*** in ***Electronic & Communication Engineering, Jyothishmathi Institute of Technology and Science (Autonomous),*** affiliated to JNTUH, Accredited By NAAC and NBA, under the guidance of **Dr. N. UMAPATHI, Professor**, ECE Department. We hereby declare that this project work bears no resemblance to any other project submitted at Jyothishmathi Institute of Technology and Science (Autonomous) or any other university/college for the award of the degree. The conclusion and results in this report are based on our own.

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ABSTRACT

Healthy animals form the backbone of thriving ecosystems and robust economies, making their well-being a cornerstone for both ecological resilience and agricultural prosperity. Many animal diseases can progress rapidly, and without immediate attention, they often result in high mortality rates and significant economic losses. The aim of this project is to develop a IoT-based system that enables real-time health monitoring and location tracking of animals, timely treatment, ensuring early detection of diseases to minimize risks and improve overall management efficiency. The proposed system integrates wearable sensors and GPS technology to monitor animal health and location in real-time. It collects physiological data such as heart rate, body temperature, and stress levels, along with environmental parameters measured by the BME680 sensor, including ambient temperature, gas resistance, humidity, and pressure. This allows for accurate differentiation between internal health issues like fever and external factors such as heat stress, while also detecting harmful gases and assessing environmental impacts on animal well-being. The data is transmitted via wireless communication to an IoT cloud platform like ThingSpeak, enabling real-time monitoring, analysis, and improved decision-making for efficient animal management. This system provides a scalable, cost-effective solution for real-time animal health and location monitoring, enhancing welfare and transforming agriculture and conservation practices.

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LIST OF ABBREVIATIONS

IOT	-	Internet Of Things
ESP32	-	Espressif32
DS18B20	-	Dallas Semiconductor18B20
Wi-Fi	-	Wireless Fidelity
RFID	-	Radio Frequency Identification.
ADXL	-	Analog Devices' accelerometer
GSR	-	Galvanic Skin Response
GPS	-	Global Positioning System
IDE	-	Integrated Development Board
API	-	Application Programming Interface
UART	-	Universal Asynchronous Receiver Transmitter
BPM	-	Beats Per Minute

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CHAPTER 1

INTRODUCTION

The livestock industry plays a vital role in global food production, providing a source of income for millions of people worldwide. However, Animal health issues like diseases and parasites impact welfare, productivity, and livestock sustainability. Traditional monitoring methods are labour-intensive and error-prone. The advent of the Internet of Things (IoT) technology has revolutionized the way animal health can be monitored and managed. The system can provide real-time insights into animal health, enabling early disease detection, improved treatment outcomes, and enhanced animal welfare.

Lumpy Skin Disease (LSD) is a viral infection in cattle, spread by biting insects, causing fever, skin nodules, swelling, and reduced food intake. It leads to weakened health, lower milk production, infertility, and sometimes death. In 2022, LSD caused over 7,000 cattle deaths in Pakistan and 80,000 in India, with Rajasthan being the worst affectedTo control the spread, cattle movement has been restricted, and the Indian Council of Agricultural Research is developing an indigenous vaccine.

In today's world, the livestock industry, pet care, and wildlife conservation face significant challenges due to the lack of timely health interventions and effective tracking mechanisms. Livestock diseases often lead to substantial economic losses, while the theft of animals and the inability to locate them in emergencies exacerbate the problem. Similarly, pet owners and wildlife researchers struggle with monitoring animal health and behavior effectively. This system aims to bridge these gaps by integrating IoT-based sensors and communication technologies into a unified platform.

1.1 NEED FOR ANIMAL HEALTH MONITORING

Monitoring animal health is crucial for ensuring their well-being, productivity, and longevity. Animals, whether pets, livestock, or wildlife, often cannot communicate their health issues, making it essential to rely on technology and observation for early detection of problems. Poor health management can lead to significant losses, including reduced productivity, increased veterinary costs, and in severe cases, the death of animals. In the case of livestock, this can have a direct economic impact on farmers and the agricultural industry. Moreover, monitoring animal health also plays a vital role in preventing the spread of zoonotic diseases, which can pose risks to human health.

- Early detection of diseases to prevent severe health issues.
- Reducing mortality rates through timely intervention.
- Enhancing productivity and performance of livestock.
- Minimizing economic losses for farmers and animal owners.
- Ensuring animal welfare and ethical treatment.
- Preventing the spread of zoonotic diseases to humans.
- Tracking health trends for better veterinary care planning.
- Supporting conservation efforts for endangered species.
- Facilitating data-driven decision-making in animal management.
- Improving overall quality of life for animals.

1.2 ROLE OF IOT IN PROVIDING REAL TIME DATA

IoT plays a crucial role in providing real-time data by enabling seamless connectivity between devices, sensors, and networks. Through IoT, sensors can collect data continuously from various sources, such as environmental conditions, wearable devices, or industrial equipment, and transmit it instantly to cloud-based platforms for analysis. This ensures timely, accurate insights for faster decision-making and improved efficiency. IoT supports automation and remote monitoring, enhancing predictive analytics, resource optimization, and performance in applications like smart cities, healthcare, and agriculture.

1.3 PROBLEM DEFINITION:

The livestock industry faces significant challenges in maintaining animal health, welfare, and productivity. Traditional animal health monitoring methods are often manual, time-consuming, and reactive, relying on visual observations and periodic veterinary checks. This can lead to delayed disease detection, reduced treatment efficacy, and increased mortality rates. Furthermore, the lack of real-time data and insights on animal health makes it difficult for farmers and veterinarians to make informed decisions, optimize treatment strategies, and improve animal welfare. The absence of an effective and efficient animal health monitoring system can result in significant economic losses, reduced productivity, and compromised animal welfare. Therefore, there is a pressing need for a reliable, automated, and real-time Animal Health Monitoring and Tracking System that can provide accurate and timely insights into animal health, enabling proactive disease management and improved treatment outcomes.

1.4 AIM AND OBJECTIVE:

The goal of this system is to design and develop an automated, real-time solution for monitoring and tracking the health and well-being of animals. The primary aim is to provide accurate, timely insights into animal health, enabling farmers, veterinarians, and caretakers to detect diseases early, optimize treatment strategies, and improve overall animal welfare. Specifically, the objectives of this system are to:

- Monitor animal health parameters in real-time
- Detect early warning signs of diseases
- Provide alerts and notifications to farmers and veterinarians
- Enable data-driven decision-making
- Enhance animal health, welfare, and productivity

By achieving these objectives, the system aims to transform the livestock industry, making it more efficient, productive, and sustainable. Real-time and continuous monitoring will allow for the detection of irregularities or health risks as they arise.

CHAPTER 2

LITERATURE REVIEW

Forest fires are a common occurrence in Mediterranean climates, such as Turkey, due to high air temperatures, making fire detection and reforestation critical. Regarding animal health, current approaches rely heavily on veterinary assessments, causing delays in diagnosis and treatments. [1] proposed sensors, cameras, and thermal imaging monitor the forest for unusual activity and security risks. Captured images are analyzed and classified using SVM or KNN, or deep learning methods. It activates alarms and alerts when humans or wild animals are detected and identifies potential fire sources.

Using IoT and smart farming technologies, the system highlights the need for digital transformation in farming, especially in bio and organic food production. It can be accessed from anywhere and on any device. It provides information about every animal and pasture, predicts animal health based on historical data, and assesses pasture conditions using multi-sensors and cameras. It also includes daily monitoring of animal movements and body temperature and sends emergency alerts for any issues.[2]

In modern farming, there's a growing need to increase productivity while reducing labour. A key priority is monitoring the health of dairy cows through sensors that capture temperature and heart rate data. By using wireless technology, this data can be sent in real time to farmers, helping them detect health problems early. [3] not only improves animal care but also makes farming more efficient.

Monitoring and supervising animals is a vital component of Precision Farming (PF), using a variety of sensing and control systems that operate in real time via Wireless Sensor Networks (WSNs). [4] introduces a compact, cost-effective wireless sensor node for monitoring, measuring 26 × 33 mm and consuming 3 to 9 mA. Using Bluetooth Low Energy, it maintains a power-saving “sleep state” for the microcontroller and demonstrates low energy use in both “Advertising” and “Connection” modes.

This IoT-based system utilizes an Arduino Uno R3 and sensors to monitor temperature, pulse rate, and SpO2 levels with high accuracy. It includes an alert mechanism and SMS gateway for remote monitoring and early disease detection. It has significant potential to improve animal care, lower costs, and facilitate further advancements in livestock management.[5]

In order to decrease the poor health and lack of attention for wildlife animals that are becoming endangered and on edge of extinction, [6] tracks the animal health using a heart rate sensor and Global positioning system. It continuously monitors their movement and health, sending alerts if vital signs go out of range. However, challenges such as high maintenance costs, significant manpower requirements, and the need for constant medical updates complicate the system's implementation.

[7] introduces a smart belt for stray animals that provides real-time location tracking and heart rate monitoring. It also features a web platform to document the vaccination status of each animal, enabling timely interventions for their well-being. Overall, it enhances safety and supports vaccination initiatives for stray animals.[8] automatically monitors animal well-being and tracks their location by measuring body temperature, heartbeat, respiration, humidity, and position. If any abnormalities are detected, it alerts the farmer with a buzzer or a message to their smartphone through application or website. This advancement paves the way for developing systems that can identify, weigh, and track animals.

This research explores a LoRa (Long Range)-based system for monitoring the health of stray animals, utilizing GPS technology to track their location and wirelessly transmit health data to veterinarians. Field tests show reliability and low power consumption, but improvements in receiver sensitivity are needed.[9]

[10] proposes an integrated approach to improve cattle management by addressing disease outbreaks and veterinary care shortages. It utilizes Convolutional Neural Networks (CNN) for early diagnosis of lumpy skin disease through image processing of a dedicated dataset. Additionally, RFID technology enables effective tracking and identification of cattle, enhancing inventory control. Real-time monitoring of feed quantities using load cells optimizes nutrition and reduces waste.

This review article emphasizes the importance of productivity and profitability in poultry farming to address food security challenges, particularly through effective economic management and standards like the Feed Conversion Ratio (FCR). It highlights the gaps in existing literature concerning universally accepted criteria for assessing poultry welfare and monitoring strategies, especially for broiler chickens. The paper explores the application of sensor-based AI technologies for analyzing chicken behavior and health tracking, pointing out the significant opportunities for intelligent automation in poultry management. It discusses the integration of computer vision and IoT systems to enhance smart farming practices, aiming to produce high-quality, affordable chicken. Furthermore, the article presents case studies showcasing the use of AI and IoT in monitoring chicken health and preventing disease outbreaks. It contributes to the body of knowledge by guiding stakeholders on effectively leveraging digital technologies to improve poultry welfare and production efficiency. Ultimately, this research aims to inspire innovations in technology that can enhance the productivity and profitability of the poultry industry.[11]

Utilizing IEEE802.15.4 and IEEE1451.2 standards, system monitor physiological parameters such as rumination, body temperature, heart rate, and environmental factors like temperature and humidity, employing a Zigbee device and PIC18F4550 microcontroller, along with a graphical user interface (GUI) implemented in LabVIEW 9.0 for real-time monitoring. The prototype demonstrated high accuracy in analyzing stress levels using the thermal humidity index (THI) and incorporates low-power electronic components for extended operation.[12]

[13] highlights the growing importance of animal tracking across various sectors, such as livestock management and wildlife conservation, focusing on the use of Radio Frequency Identification (RFID) technology. The research identifies key problems addressed, including livestock management and traceability, and notes that passive UHF RFID tags are most commonly used alongside technologies like GPS and cameras.

[14] proposes a wireless sensor network (WSN) system that utilizes directional antennas to monitor feeding and drinking behaviors, allowing for simultaneous tracking of multiple animals. Each animal is equipped with an IEEE 802.15.4-based ear tag, which records feeding behavior and communicates with a water trough router to log drinking behavior. Simulation results indicate that a wake-up time of 2500 ms is necessary for maintaining a high tag reading success rate. This innovative monitoring system is expected to enhance cattle health tracking efficiency and reduce deployment costs.

2.1 EXISTING SYSTEM

The existing systems for animal health monitoring and tracking are primarily based on traditional methods that are inefficient and often unreliable. Health monitoring is largely manual, relying on visual observation and periodic veterinary checkups, which can delay the detection of illnesses. Tracking systems typically use RFID tags for identification and standalone GPS devices for location tracking, but these systems lack integration and real-time capabilities. Data collection is often fragmented, stored manually, or recorded on standalone devices without centralized access, making it challenging to analyze and respond to emergencies effectively. In the context of wildlife, monitoring methods are invasive, requiring tranquilization or other stressful techniques to collect health data. These limitations lead to delays in detecting health issues, increased risks of theft, and economic losses due to ineffective resource utilization and missed early interventions.

Limitations of the Existing System:

- Inability to provide real-time health updates and location tracking.
- Lack of integration between health monitoring and tracking systems.
- Inefficient use of resources and higher chances of human error.
- Delayed detection of diseases or emergencies, resulting in economic losses or loss of animal life.

CHAPTER 3

PROPOSED SYSTEM

The proposed system enhances traditional approaches by integrating real-time health monitoring, location tracking, and data analytics into a unified platform. It employs advanced sensors, including the DS18B20 for temperature, MAX30100 for heart rate, ADXL355 for movement, and now includes the GSR sensor for stress levels and the BME680 for environmental conditions. These additions enable the system to collect comprehensive health and environmental data continuously. GPS modules ensure real-time location tracking for safety and theft prevention. IoT-enabled devices, such as ESP8266 or ESP32 microcontrollers, wirelessly transmit data via Wi-Fi or Bluetooth to a centralized cloud platform. The data is analyzed using advanced tools to detect anomalies, predict health issues, and provide actionable insights.

A user-friendly mobile or web application enables stakeholders to monitor animals remotely, set thresholds, and receive real-time alerts for emergencies. The system is energy-efficient, scalable, and transformative for animal health management, facilitating early disease detection, theft prevention, and data-driven decision-making for better animal care and productivity.

The Fig 3.1 represents an IoT-based animal health monitoring and tracking system. At the core of the system is the NodeMCU ESP32 microcontroller, which acts as the central processing unit. It collects data from various sensors, processes it, and transmits it to the cloud for storage and analysis. The GSR sensor detects stress, the ADXL335 accelerometer monitors movement, the MAX30100 tracks heart rate and SpO2, the DS18B20 measures body temperature, and the BME680 monitors environmental conditions. The NEO-6M GPS module provides real-time location tracking to prevent theft and monitor movements. Powered by a portable battery, the system ensures continuous operation. Data is securely transmitted to cloud platforms like Blynk or ThingSpeak for real-time analysis and visualization through web dashboards or mobile apps, enabling efficient remote monitoring and timely responses.

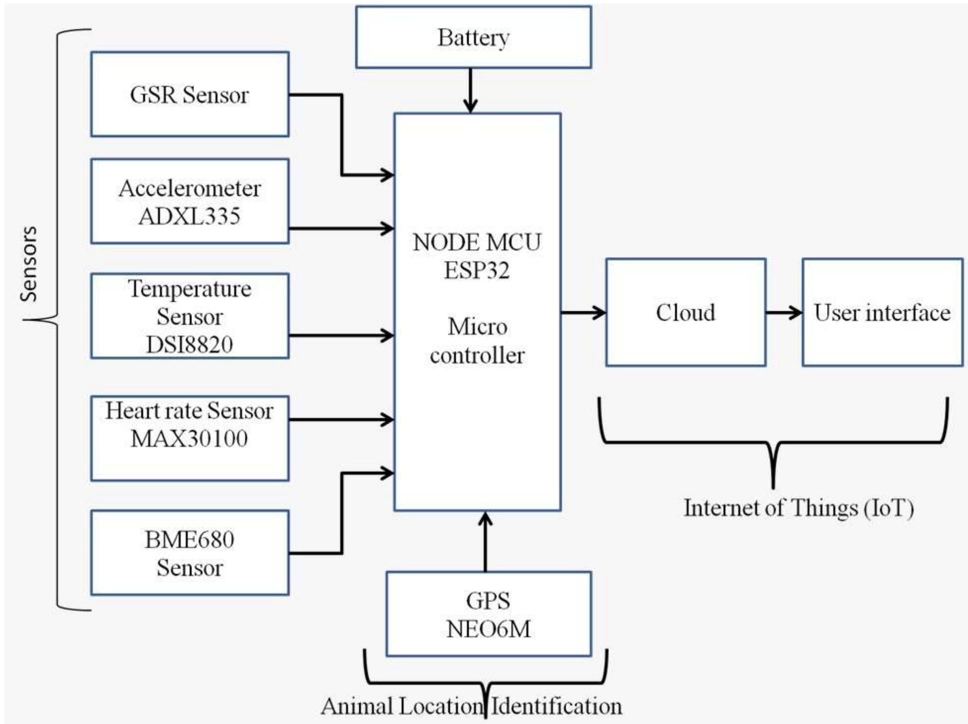

Fig 3.1: Proposed Block Diagram

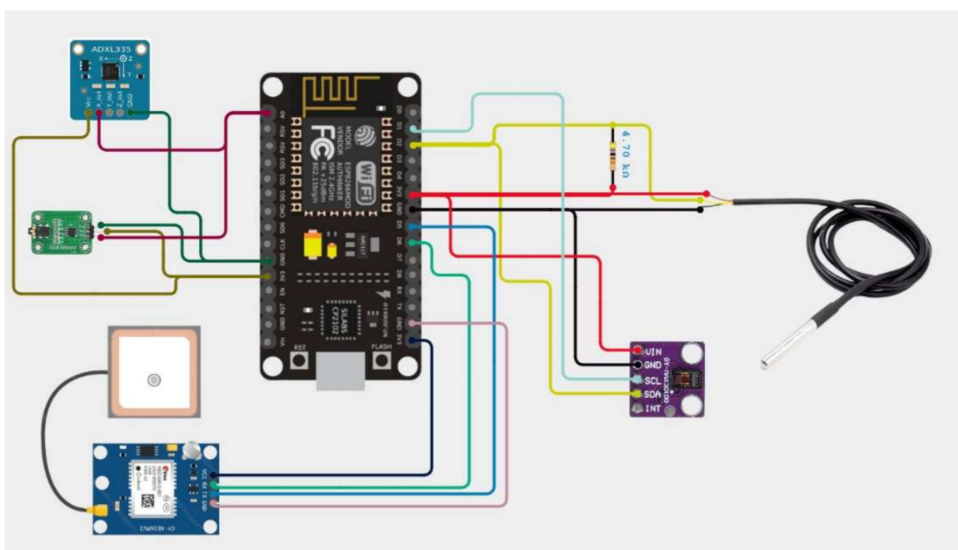

Fig 3.2: Circuit Diagram of Proposed System

Additionally, the BME680 environmental sensor is also connected to a NodeMCU using the I2C protocol.

CHAPTER 4

COMPONENTS

4.1 HARDWARE REQUIREMENTS

4.1.1 Node MCU ESP32

ESP32, developed by Espressif Systems, is a versatile and cost-effective 32-bit microcontroller series designed for IoT and wireless applications. It features integrated Wi-Fi (802.11 b/g/n) and Bluetooth v4 (including BLE) capabilities, operating at a 2.4GHz frequency.

This microcontroller includes built-in components such as an RF balun, power amplifier, low-noise receive amplifier, filters, antenna switches, and power management modules. These features make it well-suited for applications requiring reliable wireless connectivity and low power consumption. Its combination of advanced processing power and integrated communication protocols enables seamless development for IoT, smart devices, and embedded systems.

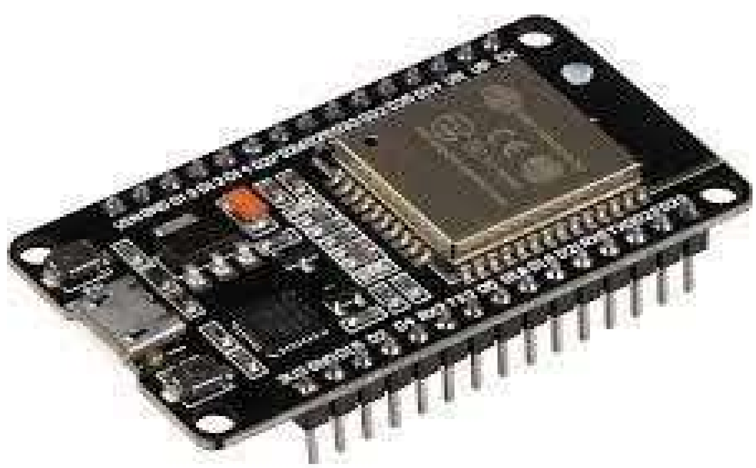

Figure 4.1.1 NODE MCU ESP32

Features:

- Onboard ESP32-S module

- Onboard CH340, USB to UART converter
- USB port for power input, firmware programming, or UART debugging
- 2x19pin extension headers, breakout all the I/O pins of the module
- 2x keys, used as reset or user-defined

Specifications:

WIFI module	:	ESP32-S
Processor	:	ESP32
Built-in Flash	:	32Mbit
Antenna	:	Onboard PCB antenna
Peripheral interface	:	UART/GPIO/ADC/DAC/SDIO/PWM/I2C/I2S
WiFi protocol	:	IEEE 802.11 b/g/n
Bluetooth	:	Bluetooth 4.2
Frequency range	:	2.4G ~ 2.5G (2400M ~ 2483.5M)
WIFI mode	:	Station / Soft AP / Soft AP + Station
Power supply	:	5V
Logic level	:	3.3V
Dimensions	:	48.26mm x 25.4mm

4.1.2 DS18B20 1-Wire Temperature Sensor

The DS18B20 is a 1-Wire temperature sensor by Dallas Semiconductor (now Maxim Integrated), requiring just one digital pin for communication. It comes in a TO-92 package or a waterproof probe, ideal for various applications.

The DS18B20 temperature sensor can be used in an animal health monitoring system to measure and track the body temperature of animals. By integrating this sensor into the system, you can continuously monitor temperature fluctuations, helping to detect signs of illness or stress in animals. This data can be valuable for early identification of health issues and timely intervention, contributing to better animal welfare.

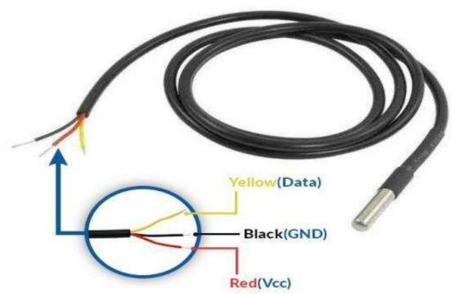

Fig 4.1.2 Temperature Sensor (DS18B20)

Specifications:

Power Supply : 3V to 5.5V

Current Consumption : 1Ma

Temperature Range : -55 to 125°C

Accuracy : ±0.5°C

Resolution : 9 to 12 bit

Conversion Time < : 750ms

4.1.3 Heartrate Sensor Max30100

The MAX30100 is a compact Pulse Oximeter and Heart-Rate Sensor IC designed to monitor blood oxygen levels and heart rate, making it ideal for detecting conditions like heart attacks, heart failure, asthma, and other health concerns

The sensor integrates two LEDs, a photodetector, and advanced signal processing units to deliver precise and reliable measurements. In animal health monitoring, the MAX30100 enables quick, non-invasive assessment of oxygen saturation and heart rate, providing critical data to evaluate and maintain the health and well-being of animals in various environments.

Fig 4.1.3: Heart Rate Sensor (MAX30100)

Specifications:

Operating Voltage	:	1.8V to 5.5V
Optical Sensors	:	Integrated Red and Infrared LED drivers. Photodetector with analog front-end (AFE)
Communication Interface	:	I2C communication protocol. Fast-mode I2C (up to 400 kHz)
Pulse Oximetry	:	Measures SpO2 level. Detects changes in blood volume
Heart Rate Monitoring	:	Measures heart rate based on PPG signals. Provides a raw PPG output for further signal processing
Data Output	:	Digital output of SpO2 and heart rate data. Raw PPG data can be accessed for advanced signal processing
LED Current Control	:	Adjustable LED pulse width and LED current for power optimization
Temperature Sensor	:	On-chip temperature sensor for ambient temperature measurement
Interrupt Function	:	Programmable interrupt for various events such as SpO2 or heart rate threshold crossing
Low Power Consumption	:	Low power consumption for battery-powered

applications.
Shutdown mode for further power savings

Compact Size : Typically, available in a small surface-mount package for easy integration into wearable devices and other applications

4.1.4 Accelerometer Sensor (adxl335)

The ADXL335 is a compact, low-power 3-axis accelerometer with signal-conditioned voltage outputs and a ±3 g full-scale range. It measures static acceleration for tilt sensing and dynamic acceleration from motion, shock, or vibration. The bandwidth, adjustable via CX, CY, and CZ capacitors, ranges from 0.5 Hz to 1600 Hz (X, Y axes) and 0.5 Hz to 550 Hz (Z axis).

In animal health monitoring, the ADXL335 tracks movement and activity patterns, providing insights into behaviour, stress levels, and physical well-being. By detecting motion anomalies or inactivity, it helps identify potential health issues. Its small size and low power consumption make it ideal for wearable tracking devices, ensuring minimal interference with the animal's natural behaviour.

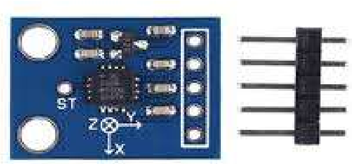

Fig 4.1.4: Accelerometer Sensor (ADXL335)

Specifications:

Supply Voltage	:	2.8V to 3.6V
Current Consumption	:	320Ua
Sensitivity	:	300mV/g
Bandwidth	:	3Hz to 5kHz

Dynamic Range	:	±3g
Operating Temperature	:	-40°C to +85°C
Package Type	:	Surface Mount Plastic Package
Pin Configuration	:	5 Pin, 1.27mm Pitch
Output Type	:	Voltage Output
Interface	:	SPI/I2C
Output Range	:	0V to Vcc
Storage Temperature	:	-65°C to +150°C

4.1.5 GPS Neo 6m:

GPS is a system of 30+ navigation satellites orbiting the earth. We know where they are in space because they constantly transmit information about their position and current time to Earth in the form of radio signals. A GPS receiver listens to these signals. Once the receiver calculates its distance from at least three GPS satellites, it can figure out where you are.

Fig 4.1.5: GPS NEO 6M

The NEO-6M GPS chip features a Power Save Mode (PSM) that reduces power consumption to just 11mA by selectively switching parts of the receiver on and off, making it ideal for power-sensitive applications like GPS wristwatches. It includes 0.1 pitch headers for communication with a microcontroller via UART. GPS technology allows researchers or farmers to track the movement patterns of animals. This information can be valuable for understanding behaviours, migration patterns, or detecting any irregularities that might indicate health issues.

Specifications:

Receiver Type	:	50 channels, GPS L1(1575.42Mhz)
Horizontal Position Accuracy	:	2.5m
Navigation Update Rate	:	1HZ (5Hz maximum)
Capture Time	:	Cool start: 27sHot start: 1s
Navigation Sensitivity	:	-161dBm
Communication Protocol	:	NMEA, UBX Binary, RTCM
Serial Baud Rate	:	4800-230400 (default 9600)
Operating Temperature	:	-40°C ~ 85°C
Operating Voltage	:	2.7V ~ 3.6V
Operating Current	:	45mA
TXD/RXD Impedance	:	510Ω

4.1.6 BME680 Sensor

The BME680 is a compact, low-power environmental sensor developed by Bosch Sensortec. It integrates multiple sensors into a single package, capable of measuring temperature, humidity, barometric pressure, and indoor air quality (IAQ) based on gas sensing.

The BME680 sensor integrates four sensing capabilities in a single module, making it a versatile choice for environmental monitoring. Its gas sensor measures volatile organic compounds (VOCs) in the air to estimate air quality, while the pressure sensor utilizes piezo-resistive technology to accurately measure atmospheric pressure.

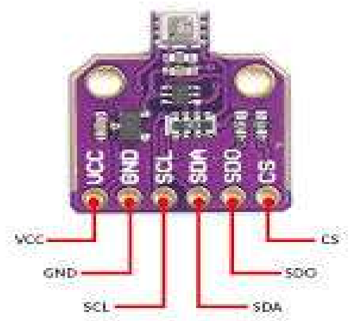

Fig 4.16: BME680 Sensor

Key features:

1. Multi-sensor integration: Measures temperature, humidity, pressure, and gas (VOC)levels.
2. High accuracy: Provides accurate readings with minimal drift.
3. Low power consumption: Suitable for battery-powered devices.
4. Small footprint: Compact size makes it ideal for IoT and wearable devices.

Specifications:

1. Temperature range: -40°C to 85°C.
2. Humidity range: 0% to 100% RH.
3. Pressure range: 300 to 1100 hPa.
4. Gas (VOC) range: Detects VOCs in the range of 0 to 1000 ppb.
5. Interface: I2C and SPI interfaces.
6. Power consumption: Typically 0.15 µA in sleep mode and 1.5 mA in active mode.
7. Dimensions: 3.0 x 3.0 x 0.95 mm.

4.1.7 GSR Sensor

The GSR (Galvanic Skin Response) sensor is a device that measures the electrical conductivity of the skin, which varies depending on the body's physiological state.

The working principle of the GSR sensor is based on detecting skin conductance by passing a small, imperceptible electrical current through the skin. Variations in sweat gland activity, often influenced by emotional or physiological states, cause changes in the skin's electrical resistance. The sensor measures these changes as variations in voltage or resistance, providing a reliable indicator of arousal or stress levels.

Key Features:

1. Measures skin conductivity: Detects changes in skin conductivity, which can indicate emotional arousal, stress, or other physiological responses.
2. Non-invasive: Attaches to the skin using electrodes, providing a non-invasive measurement.
3. High sensitivity: Can detect small changes in skin conductivity.
4. Low power consumption: Suitable for battery-powered devices.

Fig 4.1.7: GSR Sensor

Specifications:

1. Measurement range: Typically measures skin conductivity in the range of 1-100 μS.
2. Sensitivity: Can detect changes in skin conductivity as small as 0.1 μS.
3. Frequency response: Typically measures skin conductivity at frequencies between 0.1-10 Hz.
4. Interface: Often uses analog or digital interfaces, such as I2C or SPI.
5. Power consumption: Typically consumes low power, around 1-5 mA.

4.1.8 BREAD BOARD

A breadboard is a reusable, solderless platform for building and testing electronic circuit prototypes. Popular among students and beginners, it supports a wide range of circuits, from simple analog to complex digital designs. Breadboards are ideal for experimenting and testing components like ICs without soldering. While versatile, they are unsuitable for high-frequency applications above 10 MHz due to parasitic effects. Multiple breadboards can be linked for larger projects.

4.1.9 BATTERY

A battery is a device that stores energy and then discharges it by converting chemical energy into electricity. Typical batteries most often produce electricity by chemical means through the use of one or more electrochemical cells. Many different materials can and have been used in batteries, but the common battery types are alkaline, lithium-ion, lithium-polymer, and nickel-metal hydride. Batteries can be connected to each other in a series circuit or a parallel circuit. Batteries come in various types and sizes, powering devices from cars to hearing aids and playing a vital role in daily life. A cell, the basic unit of a battery, generates electricity through thermal, chemical, or optical processes. It consists of two electrodes (anode and cathode) in an electrolyte, separated by a porous barrier. Electrons flow from the anode to the cathode, creating a voltage difference and enabling electricity to flow. Batteries can contain a single cell, like an AA battery, or thousands, such as the 7,100 cells in a Tesla Model S battery.

4.1.10 JUMPER WIRES

A jumper wire (or DuPont wire) is an electrical wire used to connect components on a breadboard or other circuits without soldering. It typically has connectors or pins at each end, which can be inserted into breadboards, circuit boards, or test equipment. Jumper wires come in three types: male-to-male, male-to-female, and female-to-female. Male-to-male wires are the most common, used for connecting two ports on a breadboard, while female ends are used to connect to male pins. These wires are essential for prototyping and testing electronic circuits quickly and efficiently.

4.2 SOFTWARE REQUIREMENTS

4.2.1 Arduino IDE

The Arduino IDE is open-source software used to write and upload code to Arduino boards. It supports C and C++ programming languages and is compatible with Windows, macOS, and Linux. Code written in the IDE is called a "sketch" and is saved with the .ino extension. Below are the steps to set up the Arduino IDE for an ESP8266-based Node MCU board:

Steps to Set Up Arduino IDE for ESP8266

1. **Download and Install Arduino IDE**
   - Visit https://www.arduino.cc/ and download the IDE compatible with your operating system.
   - After downloading, unzip and install the software.
2. **Connect and Power the Board**
   - Power the Node MCU via USB or an external power supply.
   - Connect the Node MCU to your computer using a USB cable.
3. **Add ESP8266 Board Support**
   - Open the Arduino IDE.
   - Navigate to File > Preferences.
   - In the "Additional Boards Manager URLs" field, add:
   - https://arduino.esp8266.com/stable/package_esp8266com_index.json
   - If other URLs are present, separate them with a comma. Click **OK**.
4. **Install ESP8266 Board Package**
   - Go to Tools > Board > Boards Manager.
   - Search for **ESP8266** and install the "esp8266 by ESP8266 Community" package.
5. **Select the ESP8266 Board**
   - Go to Tools > Board > ESP8266 Boards.
   - Select **NodeMCU 1.0 (ESP-12E Module)**.
6. **Configure the Port**
   - Go to Tools > Port and select the port where the NodeMCU is connected (e.g., COMx or /dev/ttyUSBx).

7. **Set Additional Parameters**
   - Flash Size: **4MB (FS:2MB OTA:~1019KB)**
   - Upload Speed: **115200**
   - CPU Frequency: **80 MHz**
   - Flash Mode: **DIO**
8. **Install Required Libraries**
   - **Using Library Manager**:
     - Go to Sketch > Include Library > Manage Libraries.
     - Search for required libraries (e.g., Wi-Fi, ThingSpeak, or PubSubClient) and install them.
   - **Manually Adding Libraries**:
     - Download the .zip file for the library.
     - Go to Sketch > Include Library > Add .ZIP Library and select the file.
9. **Test the Setup**
   - Load an example sketch:
     - Go to File > Examples > ESP8266 > Blink.
     - Modify the pin number for the onboard LED (e.g., D4 for NodeMCU).
   - Upload the sketch:
     - Click the **Upload** button and wait for the process to complete.
     - Verify the onboard LED blinks, confirming the setup.

This process ensures the Arduino IDE is configured for ESP8266-based boards, enabling efficient programming and testing.

4.2.2 ThingSpeak:

ThingSpeak is an open-source IoT platform and API for collecting, storing, analyzing, and visualizing sensor data. It provides scalable and secure data storage, real-time analytics, statistical tools, and machine learning capabilities. With visualization features like charts and maps, and integration through its RESTful API, ThingSpeak is ideal for IoT applications, sensor monitoring, machine learning, and data science. Here are the steps for setting up ThingSpeak,

ThingSpeak Setup for IoT

ThingSpeak is an open-source IoT platform for collecting, storing, analysing, and visualizing sensor data. Here's a concise guide to set it up:

1. **Create an Account**
    - Sign up at ThingSpeak and verify your email.
2. **Create a Channel**
    - Go to Channels > My Channels > New Channel.
    - Add a name, description, and enable required fields (e.g., temperature, BPM).
    - Save and note the **Channel ID**.
3. **Get API Keys**
    - In the API Keys tab, copy the **Write API Key** (for sending data) and **Read API Key** (for retrieving data).
4. **Write the Code**
    - Use the API keys and Channel ID in your code to send data via HTTP requests.
5. **Monitor and Visualize Data**
    - View data in the channel's Private View.
    - Add charts or gauges to visualize parameters.

This streamlined process helps you efficiently integrate ThingSpeak with your IoT project.

CHAPTER 5

RESULTS

5.1 Wearable Belt Design and Sensor Placement

The prototype has been successfully converted into a wearable belt, designed to continuously monitor the health and activity of the animal. The belt is equipped with various sensors, including temperature, heart rate, and accelerometer sensors, to track vital signs and movement patterns.

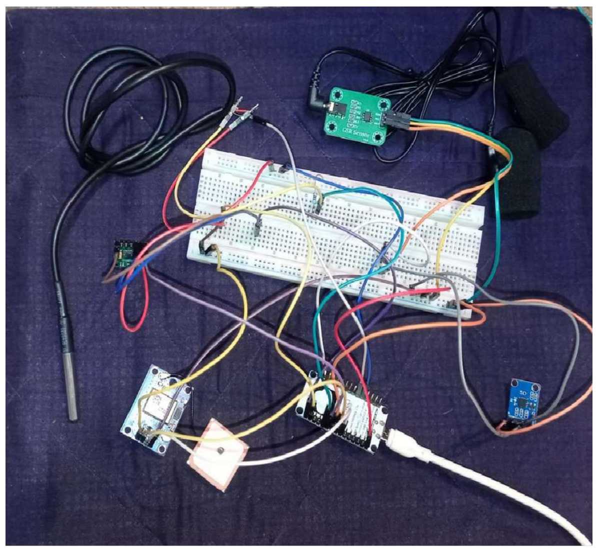

Fig 5.1 Prototype model for real-time health monitoring & Tracking

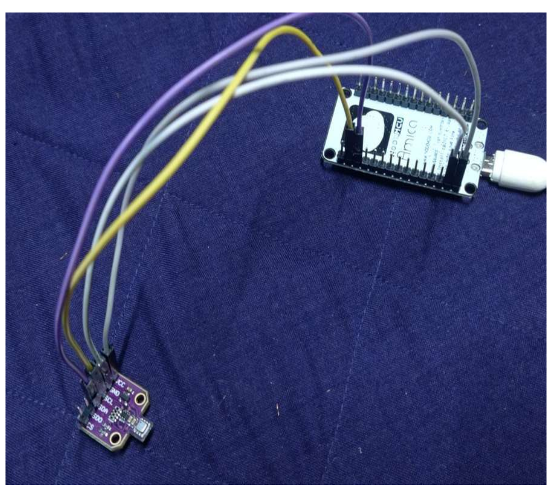

Fig 5.2: Prototype model for real-time environmental monitoring

The sensors are securely integrated into a wearable belt as shown in fig 5.3 designed for real-time health and activity monitoring. The belt is made of lightweight, durable material, ensuring comfort and ease of use for extended periods. The temperature sensor (DS18B20) is placed on the inner side of the belt to maintain contact with the body for accurate readings. The heart rate sensor (MAX30100) is positioned near the chest or wrist region, depending on the belt's design, for optimal detection of blood flow and pulse. The accelerometer (ADXL335) is centrally placed to monitor body movements and orientation effectively. The GSR sensor is placed where it can make direct contact with the skin, typically on the wrist or palm-facing area, to measure skin conductance accurately. The GPS module (NEO-6M) is mounted externally or on the belt's outer layer to ensure clear satellite signal reception. The belt is designed to hold the sensors securely while allowing flexibility and mobility, making it suitable for various activities and environments.

Fig 5.3: Cow with Monitoring Belt

5.2 Data Transmission and Cloud Integration

The data collected from the sensors is transmitted by the ESP32 to the cloud platform for storage and real-time monitoring. The ESP32 is configured with Wi-Fi credentials (SSID and password) and platform-specific details such as Template ID, Device Name, and Auth Token or API key to ensure secure communication with the cloud. Popular cloud platforms like Blynk, ThingSpeak, Firebase, or AWS IoT facilitate this communication, storing and processing the sensor data for remote access and ensuring real-time monitoring.

The user interface allows users to access and visualize the data through customized web dashboards, mobile applications, or other visualization tools provided by the IoT cloud platform. Users can design their interface with features like charts, graphs, buttons, sliders, and notifications, tailoring it to specific needs. This ensures that the sensor data is presented clearly and intuitively, enabling effective monitoring and control from anywhere.

5.3 Testing on Animals

The system successfully demonstrated its ability to track and analyze the health and environmental parameters of animals. The system was tested on multiple cows, including Cow 1 and Cow 2, with data collected at three intervals: 6:00 AM, 12:30 PM, and 6:00 PM. This analysis highlights the performance and insights gained during the monitoring process.

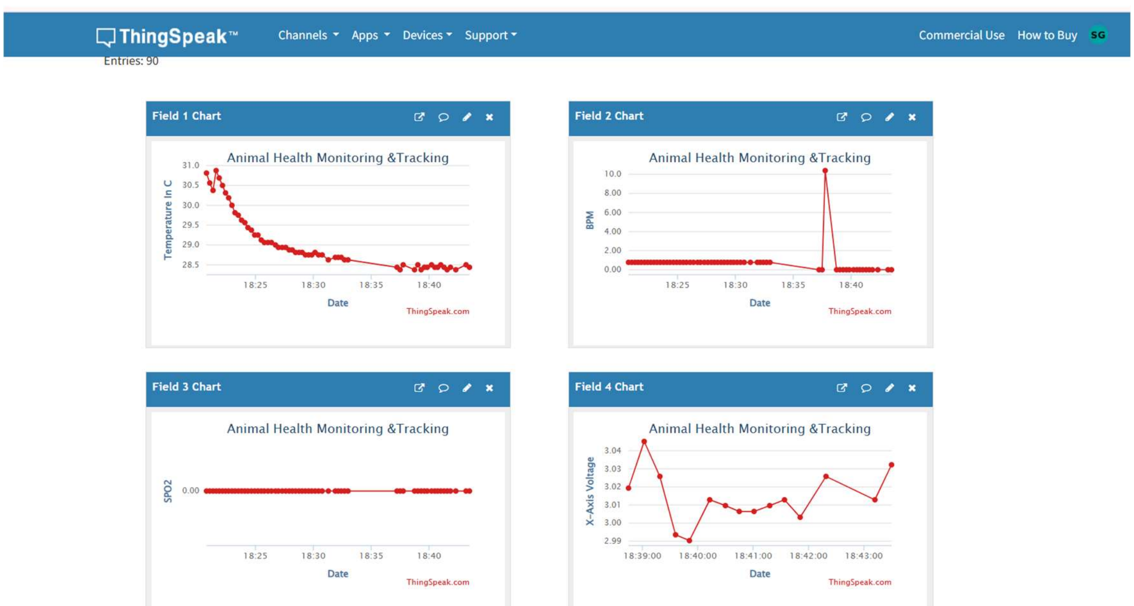

Fig 5.3.1: Real-time monitoring of health parameters using ThingSpeak

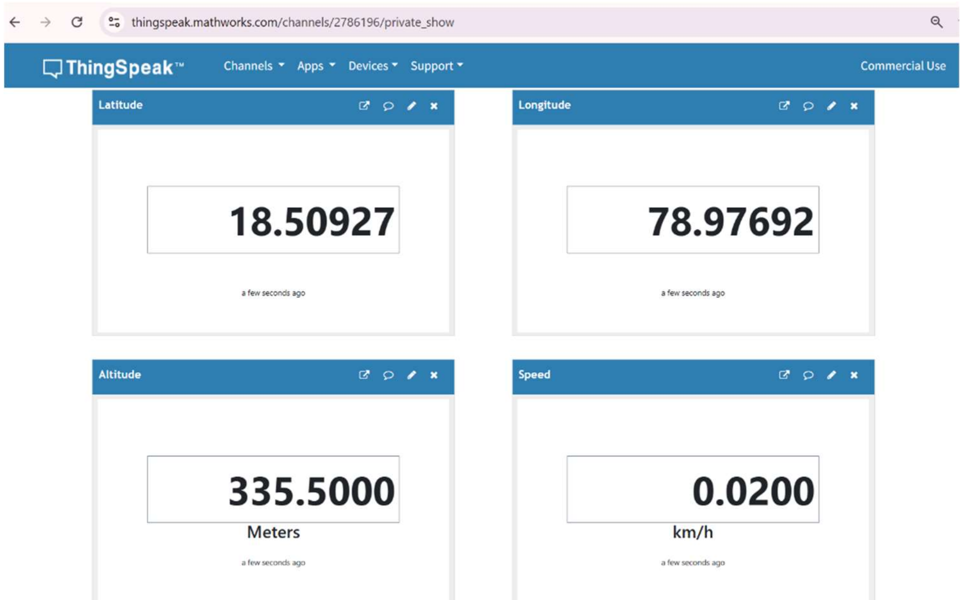

Fig 5.3.2: Tracking and Monitoring GPS Location in Real-Time using ThingSpeak

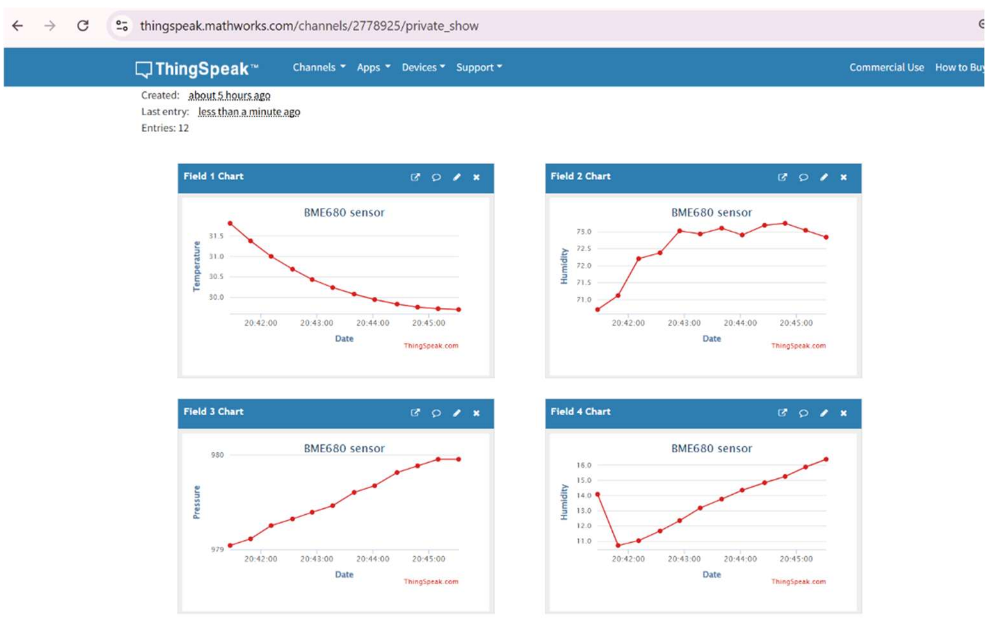

Fig 5.3.3: Monitoring Environmental Parameters using ThingSpeak

The system utilized ThingSpeak for real-time data visualization. Graphs depicting health parameters, location tracking, and environmental data were generated to provide actionable insights. Figures 5.2 and 5.4.1 demonstrated the integration of monitoring belts and real-time health tracking, while Figure 5.4.2 highlighted GPS-based movement tracking. Additionally, Figure 5.4.5 showcased environmental parameter monitoring, emphasizing the comprehensive nature of the system.

Cow-1:

Time	Temperature(C)	Heart rate (BPM)	X-Axis Voltage(V)	GSR Value	Location
6:00 AM	37.5	60	2.5	50	18.5092N,79.9769E
12.30 PM	39.0	65	2.3	45	18.5091N,78.9767E
6:00 PM	38.5	62	2.4	48	18.5092N,78.9763E

Environmental Sensor (BME680) values:

Time	Temperature(C)	Humidity (%)	Pressure (hPa)	Gas Resistance (Ohm)
6:00AM	25.77	73.45	985.57	53.82
12:30PM	38.95	50.38	959.69	50.13
6:00PM	23.14	77.64	990.44	59.58

Table 5.3.1: Daily Parameter Readings for Cow 1

Cow-2:

Time	Temperature(C)	Heart rate (BPM)	X-Axis Voltage(V)	GSR Value	Location
6:00 AM	34.76	61	2.4	55	18.5092N,78.9671E
12.30 PM	39.45	67	2.5	49	18.5091N,78.9761E
6:00 PM	36.89	62	2.2	52	18.5091N, 8.9765e

Environmental Sensor (BME680) values:

Time	Temperature(C)	Humidity (%)	Pressure(hPa)	Gas Resistance (Ohm)
6:00AM	24.73	55.81	976.34	52.23
12:30PM	40.12	61.23	950.69	50.19
6:00PM	25.27	59.78	981.44	62.86

Table 5.3.2: Daily Parameter Readings for Cow 2

CHAPTER 6

CONCLUSION

The system provides an innovative solution for improving animal welfare and management. By integrating IoT technology with advanced sensors, this system enables real-time health monitoring and location tracking for pets, livestock, and wildlife. It helps prevent animal mortality by facilitating timely medical intervention and addressing theft concerns through GPS tracking. This system offers a scalable and cost-effective approach, making it suitable for diverse applications, from small-scale pet care to large-scale livestock management and wildlife conservation. The collected data can also support long-term behavioral analysis and disease prevention strategies, contributing to the overall well-being of animals. With further advancements and field implementation, this IoT-based system has the potential to revolutionize animal care, ensuring their safety and health while empowering owners and caretakers with actionable insights.

6.1 FUTURE SCOPE

The proposed significant potential for future development and expansion. By integrating Artificial Intelligence (AI) and Machine Learning (ML), the system can predict disease outbreaks and provide personalized health recommendations. It can also be adapted for use with other species, such as poultry, swine, or aquaculture, to enhance their health and welfare. Moreover, developing mobile applications and integrating with farm management systems will allow farmers and veterinarians to remotely access animal health data and make informed, data-driven decisions. Blockchain technology can ensure secure and transparent tracking of animal health, movements, and disease outbreaks.

The wearable devices could be vulnerable to theft, a smart theft detection system or burglar alarm could be integrated into the hardware to alert users and send notifications if the device is tampered with. This advancement could revolutionize the livestock industry, making it more efficient, secure, and data-driven.

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