

# Deployment of An Intelligent Animal Monitoring System Using IOT and WSN

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**Abstract** - The deployment of an intelligent animal monitoring system using Internet of Things (IoT) and Wireless Sensor Networks focuses on improving animal health management and environmental monitoring. The system enables continuous observation of animals without manual intervention. It helps in reducing human effort and increasing monitoring accuracy. Real-time data collection ensures better decision-making. The system is designed to provide a reliable and efficient solution. It is suitable for both livestock and wildlife applications. The system uses various sensors to measure parameters such as temperature, humidity, and other health-related indicators. These sensors collect data continuously from the animals and their surroundings. The information gathered helps in identifying any abnormal conditions. Early detection of health issues becomes possible with this approach. The sensor-based system improves overall monitoring efficiency. It reduces the chances of errors compared to manual observation. This ensures better care and management of animals.

IoT technology enables remote access to the collected data through connected devices. The sensor data is transmitted to servers or cloud platforms for processing and analysis. Users can monitor the data using mobile or web applications. This allows easy access to real-time information from anywhere. It also helps in making quick decisions during emergencies. IoT ensures seamless communication between system components. This improves the responsiveness of the monitoring system. Wireless Sensor Networks (WSN) play a crucial role in connecting sensor nodes and enabling data transmission. The network eliminates the need for complex wiring and supports easy deployment. It is scalable and can be expanded based on requirements. Energy-efficient communication helps in maintaining long-term operation. The system ensures reliable and stable data transfer. It supports continuous monitoring without interruptions. This makes the system suitable for largescale applications. the intelligent animal monitoring system using IoT and WSN provides a smart and automated solution for animal care. It improves monitoring accuracy and reduces manual effort. The system ensures timely alerts and better management practices. It is cost-effective and adaptable to different environments. The integration of IoT and WSN enhances system performance. This project represents a significant advancement in modern monitoring technologies. It contributes to improved animal safety and welfare.

**Keywords** — Internet of Things (IoT), Wireless Sensor Networks (WSN), Animal Monitoring, Health Monitoring, Embedded Systems

## 1. INTRODUCTION

The integration of Wireless Sensor Networks (WSN) and the Internet of Things (IoT) has transformed modern livestock and agricultural management. Traditional animal monitoring methods depend heavily on manual observation, which is time-consuming, labour-intensive, and often inaccurate. Early detection of health issues, abnormal behaviour, or environmental risks becomes difficult when relying only on human supervision. To overcome these challenges, smart and automated monitoring solutions are required

This project focuses on the Deployment of a Wireless Sensor Network and IoT Platform for an Intelligent Animal Monitoring System. In this system, small sensor nodes are attached to animals or placed around the farm to measure parameters such as body temperature, heart rate, movement, and location. These sensors communicate wirelessly with

each other, forming a WSN capable of collecting real-time data from multiple animals simultaneously. The data is transmitted to a central gateway and uploaded to an IoT cloud platform.

The IoT platform stores, analyzes, and visualizes the sensor data through dashboards or mobile applications. Farmers can view animal activity patterns, track health conditions, and receive instant alerts in cases of abnormal temperature, reduced movement, or dangerous environmental conditions. This enables quick decision-making and early intervention, reducing the risk of disease, injury, and economic loss

In this project, a Wireless Sensor Network (WSN) is deployed on the field or animal body to collect important data such as temperature, heart rate, location, and activity level. These sensors communicate with each other and send data to a central gateway. The collected data is then uploaded to an IoT platform, where it can be stored, analyzed, and visualized through mobile or web applications. Farmers can receive alerts, monitor animal health status, and make better decisions using real-time insights.

The intelligent monitoring system enhances accuracy, reduces human effort, improves animal welfare, and promotes smarter farm management. By combining WSN and IoT technologies, the project provides a reliable, scalable, and cost-effective solution for modern livestock monitoring and precision agriculture

## 2. LITERATURE SURVEY

The literature on intelligent animal monitoring shows that Wireless Sensor Networks (WSN) and IoT platforms are widely used to track animal health, behavior, and location in real time. Earlier studies used single sensors, while recent works integrate multi-sensor nodes with temperature, motion, and environmental monitoring. Researchers also explore communication technologies like ZigBee, LoRa, and GSM to improve coverage and energy efficiency. Many studies highlight challenges such as battery life, harsh outdoor conditions, and reliable connectivity. Overall, existing work shows strong potential but also the need for more scalable, long-term, and cost-effective animal monitoring systems.

[1] "Intelligent Animal Detection System using IoT and Deep Learning" was published in April 2021 by Selvamuthukumaran, Sneha, and Thriambika K. B. in the International Research Journal of Engineering and Technology (IRJET).

Selvamuthukumaran, Sneha, and Thriambika K.B. (2021) proposed an Intelligent Animal Detection System that combines IoT technology with deep learning algorithms to monitor and detect animals in real time. Their research focuses on solving the challenges faced in traditional animal monitoring, especially in areas such as agriculture fields, forest borders, highways, and livestock farms where animal movement needs to be tracked accurately to prevent accidents and protect crops

[2] T. Todorov and J. Stoinov, "IoT-based Animal Monitoring System," vol. [volume], no. [issue], pp. [pages], 2020, doi: [DOI if available].

The IoT-based animal monitoring system is designed to track animals in real-time using IoT technology. It communicates with dedicated wireless devices to collect important data such as location, movement patterns, and vital signs of the animals. This data is then transmitted to a central system for further processing and analysis, enabling informed decision-making regarding animal management. The system provides an efficient solution for livestock management and wildlife monitoring, reducing the need for constant manual supervision. Wireless communication allows for continuous and remote monitoring, ensuring that the animals' status can be observed in realtime. However, the system's performance depends on network availability and sufficient power supply to the devices, which can be considered as its limitations. Overall, this approach demonstrates the effectiveness of IoT technology in improving animal monitoring and management practices

[3] "Development of Domestic Animals Shelter Environment Monitoring System using IoT" Mayur Pillewan, Rahul Agarwal, Nikhil Wyawahare, Laxman Thakare, 2023.

The IoT-based Domestic Animals Shelter Environment Monitoring System efficiently monitors the shelter environment by detecting movement using a PIR sensor and capturing images of any intruding animal with a Raspberry Pi camera. Upon detecting movement, the system immediately sends alerts to the authorized person, enabling real-time supervision

even from a remote location. This integration of sensors and imaging ensures the safety and security of the animals while reducing the need for continuous manual monitoring. The system also allows data storage for future analysis, helps identify unusual activity patterns, and provides a controlled environment for domestic animals. Overall, it enhances shelter management, minimizes human error, and offers a cost-effective solution for proactive animal welfare.

[4] “Systematic Review on Internet of Things in Smart Livestock Management Systems” by S. Terence, J. Immaculate, A. Raj, and J. Nadarajan was published in 2024 in the journal Sustainability (MDPI), Volume 16, Issue 10, Article 4073, DOI: 10.3390/su16104073.

The study demonstrates that IoT-based smart livestock management systems can effectively monitor and manage animals in real time. By using a PIR sensor, the system detects any movement within the livestock area and immediately sends alerts to the authorized person, enabling prompt response to unusual activity. Simultaneously, a Raspberry Pi camera captures images of any intruding animal, providing visual verification and enhancing security. This automated approach reduces the need for constant human supervision, ensures the safety and well-being of the animals, and allows for remote

[5] The paper “Wearable Wireless Biosensor Technology for Monitoring Cattle: A Review” by Mingyung Lee and Seongwon Seo was published in 2021 in the journal Animals (volume 11, issue 10, article number 2779), DOI: 10.3390/ani11102779.

The paper reviews wearable wireless biosensor technologies for cattle, focusing on various sensor form factors and their measurement accuracy. It highlights that wearable sensors can continuously monitor vital parameters such as heart rate, body temperature, and activity levels, enabling real-time health tracking. These devices provide valuable insights into cattle behavior, welfare, and early detection of health issues

[6] Precision Livestock Farming: A Global Scientometric Mapping of PLF Research Using CiteSpace Bing Jiang, Wenjie Tang, Lihang Cui, Xiaoshang Deng, 2023.

This study provides a comprehensive scientometric analysis of Precision Livestock Farming (PLF) research using CiteSpace to map global trends. The paper identifies major research clusters, leading countries, and the evolution of PLF technologies and methodologies over time. It highlights the key areas of focus such as animal health monitoring, welfare assessment, and farm management optimization. The analysis reveals which regions and institutions are driving PLF research and collaboration patterns among researchers. Overall, the study helps understand the global landscape of PLF research, guiding future studies and investments in smart livestock management technologies.

[7] A Survey on the Role of IoT in Agriculture for the Implementation of Smart Livestock Environment by Muhammad Shoaib Farooq, Osama Omar Sohail, Adnan Abid and Saim Rasheed, published in IEEE Access, 2022.

The authors describe that in some IoT-enabled livestock health architectures, on-body sensors / wearable devices e.g., collars, ear tags, etc. can capture physiological signals from animals. In their conceptual topology (the paper's diagrams), there is a module called “ultrasound signal capturing service”. This service records and stores ultrasound signals transmitted from wearable devices/sensors. Then there is a secure transmission service that ensures authenticated transfer of those signals through the Internet to a back-end/cloud. After receiving the data, a “system manager” performs feature extraction and classification, then stores the processed data (along with raw data) into a database (e.g., MySQL), before forwarding to a livestock-health directory/directory service for later retrieval/analysis

[8] Integration of Specialized Hardware with Cloud Based System” Todor Todorov & Juri Stoinov, International Journal of Electrical Engineering and Technology (IJEET), 2020.

The paper by Todor Todorov and Juri Stoinov (2020) demonstrates that an IoT-based animal monitoring system can effectively track animals in real time using a dedicated wireless communication device. The system collects data continuously from sensors attached to the animal and transmits it reliably to a monitoring unit. The authors observe that the wireless module performs stable data communication, allowing uninterrupted flow of information for further processing.

[9] S. Terence, J. Immaculate, A. Raj and J. Nadarajan, “Systematic Review on Internet of Things in Smart Livestock Management Systems,” Sustainability, vol. 16, no. 10, Art. 4073, May 2024, doi: 10.3390/su16104073.

The review highlights that temperature is one of the most commonly monitored parameters in IoT-based livestock systems. Many studies use body-temperature sensors in wearable devices such as collars, ear tags, and leg bands to continuously measure the internal temperature of cattle, goats, sheep, poultry, and even bees. Body temperature acts as an early indicator of fever, stress, infection, and overall health status, making it a crucial sensor parameter. The paper also reports that environmental temperature sensors are widely deployed in barns, sheds, and open fields to check heat stress levels, ventilation needs, and climate conditions that directly influence animal comfort and productivity.

[10] P. de Freitas Curti, A. C. B. de Almeida and F. C. L. Fernandes, "Applications of Livestock Monitoring Devices and Machine Learning for Precision Livestock Farming: A Review," *Animals* (open access), 2023.

The paper highlights that modern livestock farms increasingly use monitoring devices such as collars, accelerometers, RFID, GPS modules, microphones, and temperature sensors to continuously track animal behaviour and health. These devices help collect large amounts of realtime data on activity, feeding, movement patterns, and physical conditions. The authors emphasize that wearable technologies have become essential tools for early detection of abnormal behaviour, stress, and illness in livestock, supporting more accurate and efficient precision livestock management

### 3. PROBLEM STATEMENT

The increasing need for efficient animal monitoring has become a major concern in wildlife conservation and livestock management. Traditional monitoring methods are often manual, timeconsuming, and prone to human error. These methods fail to provide real-time data and continuous tracking of animal health and location. As a result, there is a risk of delayed response to emergencies such as illness or unusual behavior. Therefore, there is a strong need for an intelligent and automated monitoring system.

In many remote and forest areas, monitoring animals is difficult due to lack of proper infrastructure and connectivity. Researchers and caretakers face challenges in collecting accurate data about animal movement and environmental conditions. The absence of a centralized monitoring system leads to inefficiency and data loss. Additionally, harsh environmental conditions can affect manual observation methods. Hence, a reliable and scalable solution is required to overcome these limitations.

The integration of Internet of Things (IoT) and Wireless Sensor Networks (WSN) offers a promising approach to address these challenges. However, designing a system that ensures seamless communication between multiple sensor nodes is a complex task. Issues such as energy consumption, network reliability, and data accuracy must be considered. Without proper optimization, the system may fail to deliver consistent performance. Thus, there is a need to develop an efficient and robust system architecture.

Another major problem is ensuring real-time monitoring and alert mechanisms for abnormal animal behavior or health conditions. Delayed detection can lead to severe consequences, including loss of animal life. Existing systems often lack intelligent data processing and decisionmaking capabilities. There is also a need for user-friendly interfaces for monitoring and control. Therefore, the system must incorporate smart analytics and instant notification features.

Finally, the deployment cost and maintenance of such systems can be a challenge, especially in large-scale applications. The system must be cost-effective, energy efficient, and easy to maintain over long periods. Scalability is also important to accommodate a large number of animals and sensors. Without addressing these issues, implementation becomes impractical. Hence, developing an intelligent animal monitoring system using IoT and WSN is essential to ensure effective, reliable, and sustainable monitoring.

This system should also support remote access so that users can monitor animals from anywhere at any time. Data security and privacy must be ensured to protect sensitive information collected from the sensors. Integration with cloud platforms can enhance data storage and analysis capabilities. Overall, the solution must be adaptable to different environments and use cases for better efficiency.

#### 4. PROPOSED SYSTEM

The proposed system is built around the Node-MCU ESP8266 microcontroller, which acts as the central processing unit. It connects multiple sensors to collect real time data from animals. The system is designed to monitor health and environmental conditions efficiently. It reduces manual effort and ensures continuous tracking. This improves overall monitoring accuracy and reliability.

The GPS Neo-6M module is used in the system to track the real-time location of animals. It continuously sends latitude and longitude data to the Node-MCU. This helps in monitoring animal movement and preventing loss or theft. The location data can be accessed remotely through IoT platforms. It is especially useful in wildlife and livestock management.

The DHT11 sensor is integrated to measure temperature and humidity around the animal. This helps in understanding environmental conditions affecting the animal's health. Sudden changes in temperature or humidity can be detected easily. The system provides alerts if values go beyond normal limits. This ensures better care and preventive action.

The MQ135 gas sensor is used to detect harmful gases present in the surroundings. It monitors air quality and helps in identifying polluted environments. This is important for ensuring the safety and well-being of animals. Poor air quality can be detected early using this sensor. Necessary steps can then be taken to improve conditions.

The DS18B20 sensor is used to measure the body temperature of the animal accurately. It provides precise digital temperature readings. Monitoring body temperature helps in identifying fever or abnormal health conditions. Continuous tracking ensures early diagnosis of diseases. This improves the chances of timely treatment.

A pulse sensor is included in the system to measure the heart rate of the animal. It provides realtime data on the animal's cardiovascular condition. Any irregularities in heart rate can be detected quickly. This helps in identifying stress or health issues. The data is useful for maintaining overall animal health.

The system uses a lithium-ion battery as the power source to ensure portability. The battery provides sufficient energy for long-term operation in remote areas. A voltage regulator (7805) is used to maintain a stable power supply. It ensures that all components receive the required voltage. This improves system reliability and prevents damage.

The Node-MCU ESP8266 uses its built-in Wi-Fi capability to send collected data to the IoT platform. It acts as a communication bridge between sensors and the cloud. Data transmission is done in real-time for continuous monitoring. This enables users to access data from anywhere. It enhances remote monitoring capabilities.

The IoT platform (Ubidots) is used to store, visualize, and analyze the collected data. Users can monitor parameters like location, temperature, heart rate, and gas levels. The platform provides graphs and dashboards for easy understanding. Alerts and notifications can be configured for abnormal conditions. This makes the system intelligent and user-friendly. Overall, the proposed system provides a complete solution for animal monitoring using IoT and WSN. It integrates multiple sensors, communication modules, and cloud services. The system ensures real-time tracking, health monitoring, and environmental analysis. It is cost-effective, scalable, and efficient. This makes it suitable for modern animal monitoring applications.

The system can be further enhanced by adding data analytics to predict animal health trends. Machine learning algorithms can help in identifying patterns and abnormal behaviors. Integration with mobile applications allows instant access to data anytime. The system can also support geo-fencing to alert when animals move predefined areas. Future upgrades may include solar power support for better energy efficiency. Overall, the system offers a smart and advanced solution for next-generation animal monitoring.

#### 5. SYSTEM ARCHITECTURE

The system architecture is centered around the Node-MCU ESP8266 microcontroller, which acts as the core processing and communication unit. It connects all sensors and modules into a single integrated system. The architecture is designed to collect, process, and transmit real-time data efficiently. It ensures smooth communication between hardware components and the cloud platform. This centralized approach improves system coordination and performance. Overall, it forms the backbone of the entire monitoring system.

The input layer of the system consists of multiple sensors connected to the Node-MCU. These include the GPS Neo-6M, DHT11, MQ135, DS18B20, and pulse sensor. Each sensor is responsible for capturing specific parameters related to animal health and environment. The sensors continuously collect real-time data and send it to the microcontroller.

This layered approach helps in organizing data collection effectively. It also allows easy addition of new sensors in the future.

The GPS Neo-6M module plays a vital role in tracking the location of animals. It provides accurate latitude and longitude information at regular intervals. This data is processed by the Node-MCU and transmitted to the cloud. The location tracking feature is essential for monitoring movement patterns. It also helps in preventing loss or theft of animals. Thus, GPS integration enhances the system's tracking capability.

The DHT11 sensor is used to measure environmental temperature and humidity. These parameters are crucial for understanding the surrounding conditions of the animal. The sensor sends digital data directly to the Node-MCU for processing. Any abnormal environmental changes can be detected quickly. This allows timely action to protect the animal. It also helps maintain a suitable living environment.

The MQ135 gas sensor is included to monitor air quality around the animal. It detects harmful gases and pollutants in the environment. The sensor output is analyzed by the Node-MCU to determine air safety levels. Poor air quality can negatively impact animal health. Therefore, this sensor plays a critical role in ensuring a safe environment. It adds an extra layer of protection to the system.

The DS18B20 sensor is responsible for measuring the body temperature of the animal. It provides high accuracy and reliable readings. Continuous monitoring helps in identifying early signs of illness. The pulse sensor, on the other hand, measures the heart rate of the animal. Both sensors together give a clear picture of the animal's health status. This combination ensures effective health monitoring.

The power supply section of the system includes a lithiumion battery and a voltage regulator (7805). The battery provides the required energy for system operation in remote areas. The regulator ensures a stable voltage supply to all components. This prevents damage due to voltage fluctuations. It also improves the overall reliability of the system. The architecture is designed for energy efficiency and long-term use.

The communication layer is handled by the Node-MCU's built-in Wi-Fi module. It transmits the processed data from sensors to the IoT platform. This wireless communication eliminates the need for complex wiring. Data is sent in realtime for continuous monitoring. The system ensures secure and reliable data transfer. This layer connects the physical system to the digital world.

The cloud layer uses the Ubidots IoT platform for data storage and visualization. It provides dashboards, graphs, and alert systems for users. The data can be accessed remotely through mobile or web applications. Users can monitor animal health and environmental conditions easily. The architecture supports real-time alerts for abnormal situations. Overall, the system architecture ensures a complete, smart, and efficient monitoring solution.

## 6. BLOCK DIAGRAM REPRESENTATION

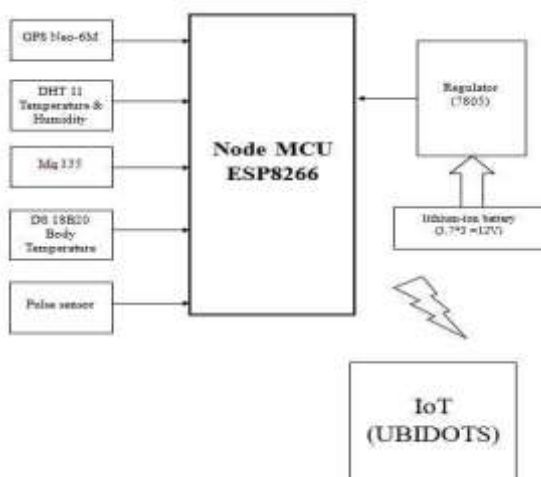


Figure 8.1.1: Block Diagram

The given block diagram represents an Intelligent Animal Monitoring System built using the NodeMCU ESP8266 as the central controller. All the sensors are connected to this microcontroller, which collects and processes the data. The system is designed to monitor both the health and location of animals in real time. It integrates hardware components with IoT technology for efficient data handling. The Node-MCU also enables wireless communication through its built-in WiFi module. This makes the system compact, efficient, and easy to deploy in remote areas.

On the input side, various sensors such as GPS Neo-6M, DHT11, MQ135, DS18B20, and a pulse sensor are connected. The GPS module tracks the real-time location of the animal by providing latitude and longitude values. The DHT11 sensor measures environmental temperature and humidity conditions. The MQ135 sensor detects harmful gases and monitors air quality around the animal. The DS18B20 sensor measures the body temperature accurately. The pulse sensor continuously monitors the heart rate, giving insights into the animal's health condition.

The power supply section includes a lithium-ion battery and voltage regulator. The battery provides the necessary power for system operation, especially in remote or outdoor environments. The voltage regulator ensures a constant and stable 5V supply to the Node-MCU and sensors. This prevents damage caused by voltage fluctuations and improves system reliability. The design ensures energy efficiency so that the system can run for longer durations. This makes it suitable for continuous monitoring applications.

Finally, the processed data is transmitted to the IoT platform, specifically Ubidots, using the Wi-Fi capability of the Node-MCU. The cloud platform stores and visualizes the data in the form of graphs and dashboards. Users can access this data remotely through mobile or web applications. Alerts and notifications can be generated if abnormal conditions are detected. This allows quick action to ensure animal safety and health. Overall, the system provides a smart, real-time, and user-friendly monitoring solution.

## 7. METHODOLOGY

The methodology of the proposed system begins with the design and integration of hardware components. The Node-MCU ESP8266 is selected as the main controller due to its built-in Wi-Fi capability. Various sensors are interfaced with the microcontroller to collect real-time data. Proper circuit connections are established to ensure accurate data acquisition. The system is designed to be compact and energy efficient. This forms the foundation for reliable system operation.

In the next step, sensors such as GPS Neo-6M, DHT11, MQ135, DS18B20, and pulse sensor are configured. Each sensor is calibrated to ensure accurate readings of parameters like location, temperature, and heart rate. The sensors continuously monitor the animal and surrounding environment. Data from these sensors is sent to the Node-MCU for processing. This ensures that all important parameters are captured in real time. Calibration improves the precision and reliability of the system.

The collected data is then processed by the Node-MCU ESP8266 microcontroller. It converts raw sensor data into meaningful values for analysis. The controller filters noise and ensures that only valid data is transmitted. This step is important to maintain data accuracy and consistency. The processed data is formatted for easy transmission. Efficient processing helps in reducing system delays.

The communication phase involves transmitting the processed data to the cloud platform using Wi-Fi. The Node-MCU establishes a connection with the internet to send data to the IoT platform. Data transmission is done at regular intervals for continuous monitoring. This allows users to access real-time information remotely. Secure communication protocols are used to protect the data. This ensures reliable and safe data transfer.

The cloud platform, such as Ubidots, is used for data storage and visualization. The received data is stored in databases for future analysis. Graphs and dashboards are generated to help users understand the data easily. Historical data can also be analyzed to identify trends and patterns. The platform supports alert generation for abnormal conditions. This enhances the decision-making process.

An alert mechanism is implemented to notify users when abnormal conditions are detected. If any parameter exceeds predefined thresholds, alerts are triggered immediately. Notifications can be sent via mobile apps, SMS, or email. This helps in taking quick action to prevent serious issues. The alert system ensures continuous monitoring without manual intervention. It improves the overall safety of animals.

Finally, the system is tested and validated under different conditions to ensure proper functioning. Performance analysis is conducted to evaluate accuracy, reliability, and efficiency. Necessary improvements are made based on test results. The system is optimized for low power consumption and longterm use. This ensures that it can be deployed in real-world scenarios effectively. The methodology provides a complete approach for developing a smart monitoring system.

## 8. HARDWARE REQUIREMENTS

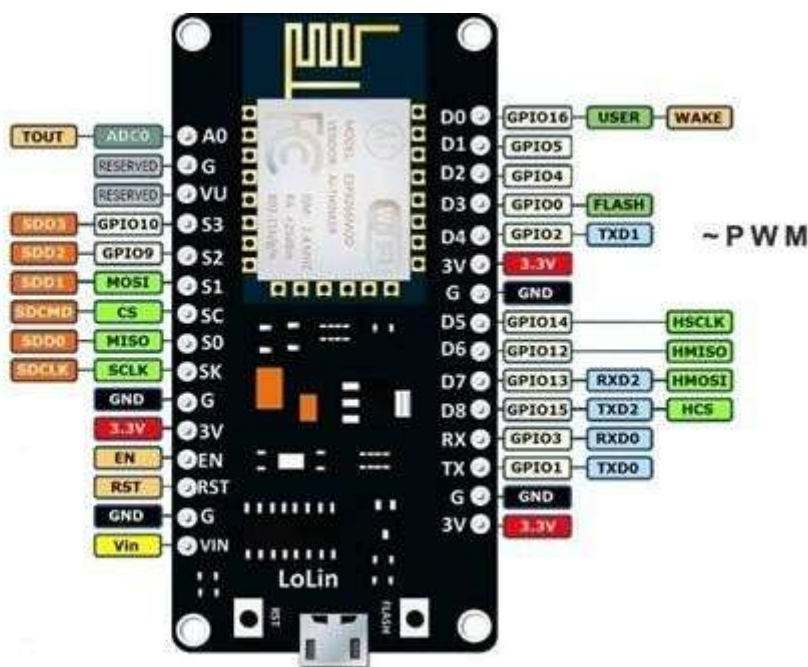


Figure 8.1.1: Node-MCU ESP8266

The system requires a Node-MCU ESP8266 microcontroller to control all operations and enable Wi-Fi communication. Sensors like GPS Neo-6M, DHT11, MQ135, DS18B20, and a pulse sensor are used to collect location, environmental, and health data. A lithium-ion battery is used as the power source to support portable operation. A voltage regulator ensures a stable power supply to all components. Additional components like connecting wires, resistors, and a breadboard are used for proper circuit connections.



**Figure 8.1.2: NEO- 6M GPS Module**

The NEO-6M GPS module offers a high position accuracy of 2.5 meters, ensuring reliable location tracking for outdoor applications. It supports an update rate of 1–5 Hz, allowing the system to refresh animal coordinates multiple times per second for real-time monitoring. With a high sensitivity of  $-161$  dBm, the module performs efficiently even in weak signal environments such as dense vegetation or remote areas. Communication with the microcontroller is handled through the UART interface, making integration simple and stable.

As shown in Figure 8.1.2, the NEO-6M GPS module is used to provide continuous GPS coordinates for cattle (animal) tracking. This enables effective monitoring of animal movement, helps prevent loss or straying beyond designated boundaries, and improves overall animal security through geofencing-based alerts.

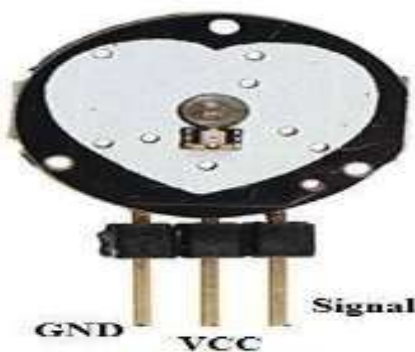


**Figure 8.1.3: Pulse Sensor**

The Pulse Sensor operates within a voltage range of 3.3–5V and provides an analog output signal that can be directly read by a microcontroller. It consumes only 4mA of current, making it suitable for low power, continuous monitoring applications. The sensor works on the principle of optical sensing (Photoplethysmography – PPG), where variations in light reflection caused by blood flow are measured to determine the pulse rate.

As shown in Figure 8.1.3 the Pulse Sensor is used to capture the real-time heart rate of the animal by detecting subtle changes in blood circulation. This enables continuous monitoring of physiological stress, fatigue, and early indicators of illness. Regular heartrate tracking supports timely health intervention, improves animal welfare, and helps identify abnormal conditions such as fever, dehydration, or anxiety at an early stage.



**Figure 8.1.4:** Gas Sensor (MQ135)

The MQ135 Gas Sensor is designed to detect a range of harmful gases, including CO<sub>2</sub>, NH<sub>3</sub>, benzene, and other air-pollution gases commonly found in livestock barns. It operates at a 5V supply voltage and provides an analog output, which allows the microcontroller to continuously monitor changing gas concentrations. As a metal-oxide-based sensor, it requires a warm-up time of 24–48 hours to achieve optimal sensitivity and accurate readings.

As shown in Figure 8.1.4, the MQ135 gas sensor is used in the system to assess barn air quality and identify the presence of hazardous gas buildup. By continuously monitoring environmental conditions, it helps prevent respiratory problems, suffocation risks, and lung-related health issues in animals. This contributes to better air circulation, healthier living conditions, and early detection of potentially dangerous environmental changes.



**Figure 8.1.5:** DHT11 Temperature & Humidity Sensor

The DHT22 Temperature and Humidity Sensor provides reliable environmental monitoring with a temperature accuracy of  $\pm 0.5^{\circ}\text{C}$  and the ability to measure humidity across a wide 100% RH range. It operates on a 3.3V–5V supply, making it compatible with most microcontrollers, and outputs data as a digital signal, ensuring stable and noise-free measurements. This makes the DHT22 suitable for continuous monitoring in livestock environments. As shown in Figure 8.1.5, the DHT22 sensor is used to track the temperature and humidity levels inside the animal shed, helping maintain a comfortable and healthy environment for the animals. By monitoring these parameters, the system can prevent issues such as respiratory diseases, heat stress, and discomfort caused by extreme weather conditions, thereby supporting better animal welfare and farm productivity.



**Figure 8.1.6:** DS18B20 Body temperature sensor

The DS18B20 Body Temperature Sensor is designed for precise thermal measurement across a wide temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . Within the most common operating range of negative  $10^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ , it provides an impressive accuracy of  $\pm 0.5^{\circ}\text{C}$ , making it highly suitable for health-related monitoring. The sensor uses a 1-Wire digital communication interface, allowing multiple sensors to be connected using a single microcontroller pin. It operates on a 3.0V to 5.5V supply and supports an adjustable resolution between 9 and 12 bits, offering flexibility in measurement

accuracy and response time. As shown in Figure 8.1.6, the DS18B20 sensor is used to measure the body temperature of humans or animals and convert the detected heat into a readable electrical signal. Its accurate and continuous monitoring capability makes it highly useful in IoT based health systems and wearable devices. This helps track health conditions, identify early signs of illness, and support timely medical intervention. The Li-ion 18650 battery with a regulator board is used as the primary power source for the portable collar and attached sensors. It provides a stable 5V or 3.3V output, making it compatible with various microcontrollers and sensor modules used in animal monitoring systems. With a capacity range of 2200–5000 mAh, the battery supports long-duration operation, ensuring uninterrupted monitoring even in outdoor or remote environments. Its high energy density and low charge cycle requirement make it ideal for continuous, low-power IoT applications.

## 9. SOFTWARE REQUIREMENTS

The intelligent animal monitoring system utilizes advanced software tools to manage sensor data, device programming, and cloud connectivity. These software platforms enable real-time data visualization, alert generation, and seamless communication between hardware nodes and the IoT cloud. Ubidots serves as the central IoT platform for storing, processing, and displaying animal health parameters on interactive dashboards. The Arduino IDE is used to develop and upload embedded code that controls sensors, microcontrollers, and communication modules. Together, these software components ensure efficient monitoring, automation, and intelligent decision-making within the system.

### IoT Platform Used – UBIDOT

Ubidots is a cloud-based IoT platform used to visualize, store, and analyse real-time sensor data. The platform allows farmers to monitor livestock health, location, and environmental conditions remotely from any device. Dashboards provide live charts, gauges, maps, alerts, and automated notifications for abnormal conditions. It supports data logging, real-time alerts, and analytics for better decision-making in livestock management.

### ARDUINO IDE

Arduino IDE (Integrated Development Environment) is an open-source software used to write, compile, and upload code to microcontroller boards such as Arduino, ESP8266, and ESP32. It provides a simple and user-friendly interface where programs are written in a language based on C and C++. The IDE includes built-in libraries that allow easy interfacing with sensors, modules, and IoT components. The editor window supports writing sketches, while the compiler converts the code into machine instructions for the microcontroller. It also features a Serial Monitor that allows real-time communication and debugging by viewing sensor outputs and system messages. Arduino IDE supports multiple boards through Board Manager extensions, making it suitable for a wide range of embedded and IoT applications.

## 10. SYSTEM IMPLEMENTATION

The system implementation begins with assembling the hardware components based on the designed architecture. The Node-MCU ESP8266 is used as the main controller to interface all sensors. Each component is carefully connected using appropriate pins and communication protocols. Proper wiring ensures accurate data transmission between sensors and the controller. The setup is tested initially to verify all hardware connections. This step ensures a stable foundation for further implementation.

The GPS Neo-6M module is connected to the Node-MCU using serial communication. It continuously provides location data in the form of latitude and longitude. The Node-MCU reads and processes this data for tracking purposes. The GPS module is tested to ensure accurate positioning. Proper placement of the module is important for better signal reception. This enables real-time tracking of the animal's movement.

The DHT11 sensor is interfaced with the Node-MCU to measure temperature and humidity. It is connected to a digital pin and programmed using appropriate libraries. The sensor readings are taken at regular intervals. The data is validated to avoid incorrect values. This helps in monitoring environmental conditions effectively. The implementation ensures stable and consistent readings.

The MQ135 gas sensor is connected to detect air quality around the animal. It is calibrated to sense harmful gases in the environment. The analog output from the sensor is processed by the NodeMCU. Threshold values are set to identify unsafe conditions. This helps in generating alerts when pollution levels are high. The sensor plays a key role in environmental monitoring.

The DS18B20 temperature sensor is used for measuring body temperature. It communicates with the Node-MCU using the OneWire protocol. The sensor provides accurate digital readings with minimal error. Regular data collection ensures continuous health monitoring. The implementation focuses on precise measurement. This helps in early detection of abnormal body conditions.

The pulse sensor is implemented to monitor the heart rate of the animal. It is connected to an analog input pin of the Node-MCU. The sensor detects pulse signals and converts them into readable data. The NodeMCU processes this data to calculate beats per minute (BPM). This information is useful for analyzing animal health. Proper placement of the sensor ensures accurate readings.

The power supply system is implemented using a lithiumion battery and a 7805 voltage regulator. The battery provides portable power for the entire system. The regulator maintains a constant voltage level to protect components. This prevents damage due to voltage fluctuations. The system is tested for efficient power consumption. This ensures long-term operation in remote areas.

The software implementation is carried out using Arduino IDE for programming the NodeMCU. Required libraries for sensors and Wi-Fi communication are included. The code is written to read sensor data, process it, and send it to the cloud. Proper debugging is done to remove errors. The program is optimized for efficient performance. This ensures smooth system operation.

The communication system is implemented using the NodeMCU's Wi-Fi module. It connects to the internet and sends data to the IoT platform (Ubidots). Data is transmitted in real time at regular intervals. Secure communication protocols are used to protect the data. This allows remote monitoring from anywhere. The implementation ensures reliable connectivity.

Finally, the system is integrated and tested as a complete unit. All components work together to provide real-time monitoring and alerts. Data is visualized on the IoT dashboard for user access. The system performance is evaluated under different conditions. Necessary improvements are made for better efficiency. This completes the successful implementation of the project.

## 11. RESULTS AND DISCUSSION



**Figure 11.1.1: Cow Belt**



**Figure 11.1.1: Dashboard of the system**

The implemented system successfully monitored multiple parameters such as animal body temperature, heart rate, environmental conditions, and location in real time. All sensors worked together with the Node-MCU ESP8266 to provide continuous data. The integration of different modules was stable and efficient. Data transmission to the IoT platform was achieved without major delays. The system demonstrated reliable performance during testing. This confirms the feasibility of the proposed design.

The GPS Neo-6M module provided accurate location tracking of the animal. The latitude and longitude values were updated regularly on the IoT dashboard. This helped in observing movement patterns effectively. The tracking feature proved useful in preventing loss and monitoring large areas. Minor signal issues occurred in indoor conditions. However, overall performance was satisfactory in open environments.

The health monitoring sensors such as DS18B20 and pulse sensor showed consistent results. Body temperature readings were accurate and stable over time. The pulse sensor provided real-time heart rate data with acceptable accuracy. These parameters helped in identifying the health status of the animal. Any abnormal changes could be easily detected. This proves the effectiveness of the health monitoring system.

Environmental monitoring using the DHT11 and MQ135 sensors also produced useful results. Temperature and humidity data were recorded continuously. The MQ135 sensor detected variations in air quality effectively. These readings helped in understanding the surrounding conditions of the animal. Alerts were generated when values exceeded normal limits. This ensures better environmental safety for animals.

The IoT platform (Ubidots) displayed the collected data in the form of graphs and dashboards. Users were able to access real-time and historical data remotely. The alert system worked efficiently by notifying abnormal conditions instantly. This improved response time and reduced risks. The user interface was simple and easy to understand. Overall, it enhanced the usability of the system.

In conclusion, the system performed well in terms of accuracy, reliability, and real-time monitoring. It reduced manual effort and improved efficiency in animal monitoring. Some limitations such as network dependency and sensor calibration were observed. These can be improved in future enhancements. The system proves to be a cost-effective and scalable solution. It is suitable for both livestock management and wildlife monitoring applications.

## 12. ADVANTAGES AND LIMITATIONS **Advantages:**

### **Provides real-time monitoring of animal health and location:**

The system continuously monitors important parameters such as body temperature, heart rate, and location of the animal in real time. This helps in identifying any abnormal conditions immediately without delay. It enables quick response in emergency situations, improving animal safety. Caretakers can track animals remotely without physical presence. Overall, it reduces risks and ensures better health management.

### **Reduces manual work through automation and smart sensing:**

The use of sensors and IoT technology automates the data collection and monitoring process. It minimizes the need for constant human supervision and reduces manual effort. Automation also decreases the chances of human error in observation. This allows caretakers to focus on other important tasks. As a result, the system becomes more efficient and reliable.

**Enables remote access to data using IoT technology:** The system sends collected data to a cloud platform, allowing users to access it remotely. Users can monitor animal conditions using smartphones or computers from anywhere. Instant alerts and notifications help in taking timely action. This improves convenience and decision-making. It also ensures continuous monitoring without geographical limitations.

### **Supports scalability for monitoring multiple animals efficiently:**

The system can be easily expanded to monitor a large number of animals by adding more sensors. It supports both smallscale and large-scale applications effectively. Centralized monitoring makes management easier and more organized. The flexible design allows future upgrades without major changes. This makes the system adaptable and suitable for various environments.

## **Limitations:**

**Requires stable internet connectivity for proper functioning:** The system depends on internet connectivity for transmitting data to the cloud platform. In remote or rural areas, network availability may be weak or unstable. This can

cause delays in data updates and affect real-time monitoring. In case of network failure, data transmission may stop completely. This reduces the overall efficiency of the system.

**Sensors may need regular calibration and maintenance:** Sensors used in the system may lose accuracy over time due to continuous usage. Regular calibration is required to maintain correct readings. Maintenance increases the effort and operational cost of the system. Faulty or damaged sensors can provide incorrect data. This may lead to wrong decisions and reduced system reliability.

**Power supply constraints in remote or outdoor areas:** The system relies on battery power for operation, especially in remote locations. Batteries need to be recharged or replaced regularly. Power failure can interrupt system functionality. Managing energy consumption becomes important for longterm use. This creates challenges in areas where power resources are limited.

**Environmental conditions can affect sensor accuracy and performance:** Harsh environmental conditions such as extreme temperature, humidity, and dust can impact sensor performance. Sensors may produce inaccurate readings under such conditions. Physical damage to components is also possible. Protective measures are required to ensure proper functioning. This increases system complexity and cost.

### 13. APPLICATIONS

#### **Livestock Management:**

The system is widely used in farms to monitor the health and location of livestock such as cows, goats, and sheep. It helps farmers track vital parameters like temperature and heart rate in real time. Early detection of diseases reduces losses and improves productivity. Automated monitoring reduces manual effort and saves time. This leads to better farm management and increased efficiency.

#### **Wildlife Conservation:**

The system plays an important role in monitoring wild animals in forests and protected areas. It helps researchers track animal movements and behavior without disturbing them. Real-time location tracking prevents poaching and illegal hunting. Environmental data helps in maintaining suitable habitats. This supports effective wildlife conservation and protection efforts.

#### **Animal Health Monitoring:**

Animal owners can use this system to monitor the health and activity of their pets. It provides realtime updates on vital signs and location. This is useful for ensuring the safety of pets when they are outdoors. Alerts can notify owners about unusual behaviour or health issues. It improves pet care and strengthens the bond between pets and owners.

#### **Veterinary Healthcare:**

Veterinarians can use this system for continuous monitoring of animals under treatment. It helps in tracking recovery progress and detecting complications early. Real-time data assists in accurate diagnosis and treatment planning. Remote monitoring reduces the need for frequent visits. This improves the quality of veterinary care and service.

#### **Animal Research and Behaviour Analysis**

Researchers can use the system to study animal behavior and movement patterns over time. Data collected helps in analyzing habits, migration, and environmental impact. Continuous monitoring provides more accurate and detailed information. It reduces dependency on manual observation. This contributes to better scientific research and findings.

#### **Smart Farming and Agriculture:**

The system supports modern smart farming techniques by integrating animal monitoring with other IoT solutions. It helps in managing farm resources efficiently. Farmers can make data-driven decisions to improve productivity. Automation reduces labour and operational costs. This leads to sustainable and advanced agricultural practices.

#### **Zoo and Sanctuary Management:**

Zoos and animal sanctuaries can use this system to monitor animals in controlled environments. It ensures proper health tracking and safety of animals. Caretakers can receive alerts in case of abnormal conditions. It also helps in managing large numbers of animals efficiently. This improves overall animal welfare and management.

#### 14. CONCLUSION

The proposed system successfully demonstrates the use of IoT and Wireless Sensor Networks for efficient animal monitoring. It integrates multiple sensors to track health, environment, and location in real time. The system reduces manual effort and improves accuracy in monitoring. Continuous data collection helps in early detection of issues. This ensures better safety and management of animals. The use of Node-MCU ESP8266 and cloud platforms enables seamless communication and remote access to data. Users can monitor animals from anywhere using mobile or web applications. The alert system provides timely notifications for abnormal conditions. This improves response time and prevents serious problems. Overall, the system enhances decision-making capabilities. The system is designed to be cost-effective, scalable, and energy-efficient for real-world applications. It can be used in farms, wildlife monitoring, and research environments. Despite some limitations like network dependency and sensor maintenance, the system performs reliably. Future improvements can overcome these challenges. This makes the system more robust and adaptable. In conclusion, the Intelligent Animal Monitoring System offers a smart and modern solution for animal care. It combines technology and automation to improve monitoring efficiency. The system supports sustainable and advanced animal management practices. It has the potential to transform traditional monitoring methods. Thus, it is a valuable contribution to the field of IoT-based solutions.

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