



Iot Based Livestock Monitoring With Location Tracking And Smart Feeding

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Abstract: The agricultural sector is changing as a result of the incorporation of advanced technologies, which aims to increase productivity and efficiency. This study proposes an Internet of Things (IoT)-based cattle monitoring system with intelligent feeding. The intention is to provide livestock farmers with an all-inclusive solution for real-time tracking of their animals, welfare assurance, and optimal feeding protocols. The proposed approach gathers and transmits critical data from the cattle environment to a central server by using Internet of Things (IoT) devices, such as sensors. Two factors that are crucial for assessing the behavior and general health of the animals in the data are temperature and humidity. The main purpose of the system is to assess the collected data and provide farmers with relevant information. This gives farmers the ability to stop illnesses from spreading by taking preventative steps. The Smart Feeding mechanism, which combines data analytics with automated feeding systems, is one of the novel aspects of the suggested system. This minimizes food waste while also guaranteeing that every animal gets the right nutrients, which promotes healthier growth rates and general wellbeing. By giving farmers a strong tool to improve their decision-making processes, the adoption of an Internet of Things-based livestock monitoring system has the potential to completely transform conventional agricultural methods. Farmers and the agricultural sector as a whole stand to gain from a more sustainable and effective livestock management system thanks to the real-time data access and analytics capabilities.

Index Terms - Animal health monitoring, Cloud computing, Internet of Things (IoT), Livestock, Location tracking, Precision livestock farming, Smart feeding.

I. INTRODUCTION

IoT technology has transformed many industries, including agriculture. Livestock monitoring is an important use case for IoT in agriculture, assuring animal well-being and productivity. This project develops and implements an innovative IoT-based Livestock Monitoring System with smart feeding mechanisms for optimal care and resource management. Livestock production contributes to the worldwide agricultural landscape by producing critical resources including meat, milk, and other byproducts. Managing a big animal population presents considerable issues for farmers. Traditional livestock monitoring approaches sometimes lack real-time data and insights needed for informed decisions. The suggested IoT-based system tackles these difficulties by using connected devices to gather, process, and transmit data in real time. The Smart Livestock Management System utilizes cutting-edge technologies to enhance livestock management by monitoring health and providing intelligent feeding. This cutting-edge system uses sensors and modules to combine three vital modules: health monitoring, smart feeding, and animal care. This guarantees proper monitoring and care for animals. The Health Monitoring Module uses a DHT11 sensor for external temperature and humidity, an MLX90614 sensor for cow body temperature, a KG0114 sensor for heartbeat and pulse detection, and a three-axis accelerometer for motion recording. The Arduino Uno is the core processing unit, with the ESP8266 Wi-Fi module.

The Arduino Uno classifies the health state of the cattle by analyzing sensor data, comparing it with a prepared dataset, and sending the results to a central system for additional analysis. Ultrasonic sensors for level sensing, a load cell with a HX711 amplifier for feed quantity measurement, a servo motor for regulated dispensing, and an additional Arduino Uno for processing are all included in the Smart Feeding Module. The load cell precisely measures feed weight, and the ultrasonic sensors keep an eye on feed levels. With this information, the Arduino Uno can regulate the servo motor to dispense the right amount of feed. This controlled and automated feeding system guarantees effective management of the cattle.

These components work together to create a comprehensive Smart Livestock Management System that offers precise, automated feeding and real-time health status updates, improving the cattle's general wellbeing through smooth data flow and communication.

II. RELATED WORKS

Qazi et al. [1] It focuses on creating a secure zone for cattle through IoT and GPRS, enabling remote monitoring without physical intervention. Emphasizing challenges in livestock management, the study highlights IoT's transformative potential and reviews applications like GPS, RFID, and wireless sensor networks. The proposed system gathers data on location and health, reducing costs and facilitating remote monitoring. The research outlines practical implementation, including open-source health frameworks and wireless sensing systems, integrating GPS, IoT, GPRS, and satellite navigation for effective livestock monitoring and decision support. The study contributes to smart farming, addressing challenges and offering a comprehensive, sustainable livestock management solution.

J. S. Eik et al. [2] developed a smart feeder system for livestock farming, using IoT and smartphone apps to automate feeding and monitoring. It tackles issues like labor shortages and adherence to feeding schedules, focusing on cows. Features include setting schedules, monitoring food levels, and receiving notifications. Hardware includes sensors, load cells, and a servo motor connected to Arduino WeMos D1R2. The Blynk app allows smartphone control. Testing and optimization ensure practicality, addressing real farming challenges.

T. Vigneswaria et al. [3] focus on precision livestock farming (PLF) to boost animal health and farm efficiency. Their system integrates IoT and Cloud Computing to monitor livestock health, track locations, and implement smart feeding. It employs IoT devices for health monitoring, smart feeding, and continuous assessment of critical parameters, utilizing various sensors, microcontrollers, and communication protocols. Cloud-based services enable real-time access, while wearable collars and smart identification are incorporated. Machine learning analyzes health data, offering a comprehensive approach to advanced livestock monitoring and management.

Jehangir Arshada et al. [4] introduces a Cattle Health Monitoring System (CHMS) utilizing wireless sensor networks and IoT technology to monitor livestock health and predict diseases, achieving a 98% accuracy with an artificial neural network (ANN) model. The system includes a web-based application for end-users to monitor cattle behavior and disease predictions, implementing security measures like two-factor authentication. The CHMS aims to enhance meat and dairy product quality, addressing global food insecurity. The methodology involves using a balanced dataset from Punjab, Pakistan, preprocessing with scikit library, and training the ANN model for efficient disease prediction while ensuring data integrity through security measures.

Lisette M.C. et al. [5] developed a prototype integrated automated system for simultaneous monitoring of barn environment and cow behavior. It incorporates various sensors, an external weather system, and video recording. The system's architecture enables real-time data processing and transmission, demonstrating high stability and reliability on three dairy farms. Further development is advocated, including milking parlour data integration and algorithm incorporation for comprehensive cow welfare, health, and production monitoring. The methodology emphasizes an open and customizable framework for research-based data integration in automatic, remote, and real-time monitoring to improve livestock management.

Cristian P. Perez-Granados et al. [6] focus on monitoring illegal cattle activity in the Brazilian Pantanal using passive acoustic monitoring and automated signal recognition software. They identify a peak in cattle occurrences at the end of the dry season when pastures are abundant. The software, Kaleidoscope Pro, efficiently detects cow calls. The methodology includes deploying acoustic recorders at various Pantanal sites, analyzing recordings with the automated software, and conducting statistical analyses to identify diel and seasonal variations in cow occurrence. Their findings provide valuable insights into addressing illegal cattle activities in the region.

S. Benaissaa et al. [7] combine accelerometer and Ultra-Wideband (UWB) location data to enhance dairy cattle behavior monitoring. Their research aims to design a robust system for tracking specific behaviors like feeding, lying, drinking, and eating concentrates. Integration of location and accelerometer data improves behavior classification accuracy, offering valuable insights. Methodology involves collecting on-cow sensor data in indoor environments, using a decision tree algorithm for energy efficiency. Performance assessment via Bland-Altman plots shows improved accuracy and precision. The study highlights benefits like tracking social interactions and reducing power consumption in monitoring systems.

Anderson da Silva Santos et al. [8] emphasize continuous cattle behavior monitoring using sensors and machine learning. Their research aims to identify behavior classes, assess monitoring capabilities, and evaluate accessories, sensors, and algorithms. Through a systematic review, they address challenges in data acquisition and classification, aiming to provide an overview of techniques and challenges in livestock behavior monitoring.

Chokri Jebali et al. [9] develop a prototype cattle monitoring system using RFID technology to address challenges during transport. They analyze mechanical vibrations' impact on RFID detection, aiming to enhance system performance. The study evaluates RFID reader efficiency and identifies parameters affecting detection rates, aiming for a cost-effective solution in accurate cattle monitoring during transport. Additionally, it highlights RFID technology's potential for automating product identification in the supply chain.

Jai Ganesh Rajendran et al. [10] emphasize the global importance of dairy cow health monitoring and introduce a wireless sensor-based system for continuous monitoring, accessible locally and remotely. Their system collects and stores health data for effective farm management, showcasing the potential of low-cost wireless sensor networks in agricultural automation. Using Arduino devices and sensors, the IoT-based health monitoring system provides precise health criteria and utilizes wireless networks for continuous monitoring in real and virtual farm sites, aiming for comprehensive and cost-effective dairy cattle health management.

Abdul Aziz Chaudhry et al. [11] propose a real-time cattle monitoring system using IoT and cloud-based technology, focusing on disease prediction and behavioral analysis. Their methodology involves a custom-designed multi-sensor board and a camera for data collection, with machine learning-based health predictions sent to a server. A web portal and mobile app offer data visualization, aiming to contribute to precision farming and livestock disease prediction in Pakistan.

Joshitha C et al. [12] propose a "LoRaWAN based Cattle Monitoring Smart System" for livestock monitoring in countries like India. The system utilizes LoRaWAN technology, GPS modules, and environmental sensors for data collection. Methodology involves developing transmitter nodes on cattle collars and receiver ends with Raspberry Pi modules. Aimed at improving productivity and protection, it has potential applications in animal tracking and wildlife conservation.

A. Kumar et al. [13] present an Animal Health Monitoring System (AHMS) using Zigbee devices and a PIC18F4550 microcontroller compliant with IEEE802.15.4 and IEEE1451.2 standards. The system tracks physiological parameters like rumination, body temperature, and heart rate, with real-time monitoring via LabVIEW 9.0 GUI on PC. Methodology ensures energy efficiency and portability with high accuracy results, suggesting future research directions towards ultra-wideband radio-based wireless sensor networks for increased transmission range. AHMS aims for cost-effective livestock healthcare, advancing animal health monitoring technologies.

Sai Ma et al. [14] develop a noncontact body temperature monitoring and prediction system for livestock cattle using environmental parameters and infrared images. The system estimates deep body temperature without contact, and proposes a method to estimate cattle movement distance and trajectory. Experimentation reveals improved accuracy in deep body temperature estimation, showing potential for long-term remote monitoring and early disease detection.

Muhammad Shoaib Farooq et al. [15] explore IoT's role in agriculture, focusing on smart livestock environments. Their survey covers IoT applications in cattle, sheep, goat monitoring, smart poultry farms, and pets management. They discuss IoT network infrastructure, communication protocols, and technologies in livestock management, highlighting efforts and prototypes in the sector. The conclusion addresses security, challenges, and suggests future research directions in IoT-enabled livestock.

III. PROPOSED SYSTEM

The model consists of the two main parts:

- Heath Monitoring
- Smart Feeding

A. Heath Monitoring

Figure 1 shows the block diagram of the animal monitoring device, which adheres to IEEE 802.11 and 802.15 standards. The equipment detects physiological data such as body temperature, physical gestures, and heartbeat, as well as environmental parameters such as relative humidity and air temperature. The Temperature Humidity Index (THI) is calculated in real-time based on ambient conditions. The output data from the manufactured device is communicated to the user terminal via the wireless communication module. Smartphones and cloud-based IoT platforms can display data such as body temperature, humidity, heart rate, and physical gestures. The animal monitoring device's self-contained architecture makes it simple to add new monitoring parameters to the sensor modules as required.



Figure 1: Heath Monitoring Module

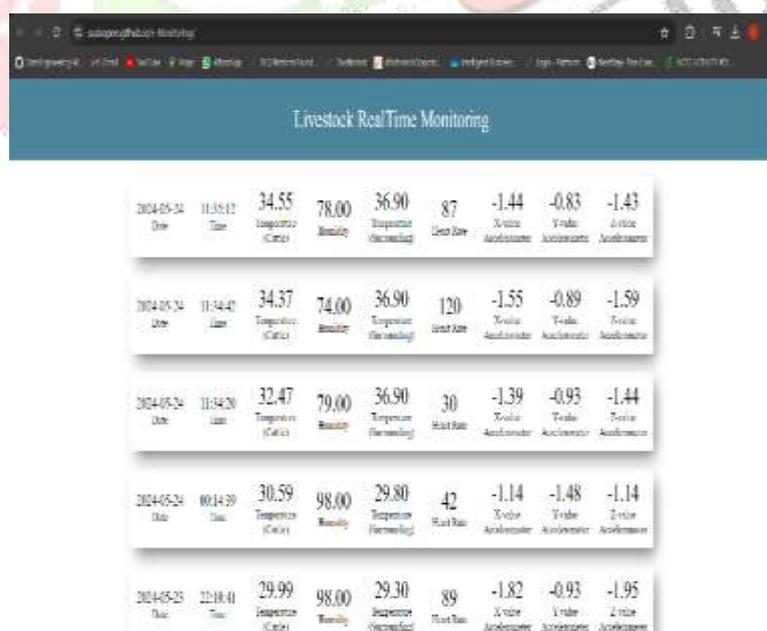


Figure 2: Livestock Monitoring Dashboard

The animal monitoring system with a wearable collar device to track the animal's status is shown in Figure 2. The animal monitoring gadget measures the animal's body temperature, heart rate, ambient temperature, humidity, and movements such as eating, sitting, and standing. Data from this device were routed to a cloud-based gateway, from whence they were subsequently sent to a cloud-based server for an

IoT analytics platform. With this cloud-based, Internet of Things-based animal monitoring system, you may examine and analyze the animal's health at any time and from any location. Through a mobile interface, the veterinary hospital, health professional, and owner of the animal can all view the animal's health. Since the animal is under constant observation, any problems with its health can be quickly and readily detected.

B. Smart Feeding

The block diagram for this project's hardware-software system link is displayed in Figure 3. It is divided into two sections: software (Blynk app) and hardware (ultrasonic sensor, load cell, and Arduino). Installing the Blynk app from the phone's Apps store comes first. The Arduino IDE software can then be used to program the Arduino. We can establish a direct connection to the Blynk using this program. This system can monitor and manage the hardware it uses with the help of Blynk. Through the use of a smartphone application, users will be able to manage when to feed their cattle (cows), as well as keep an eye on the quantity of food in the container, the level of food in the hopper storage, and the presence of cattle (cows) close to the food container.

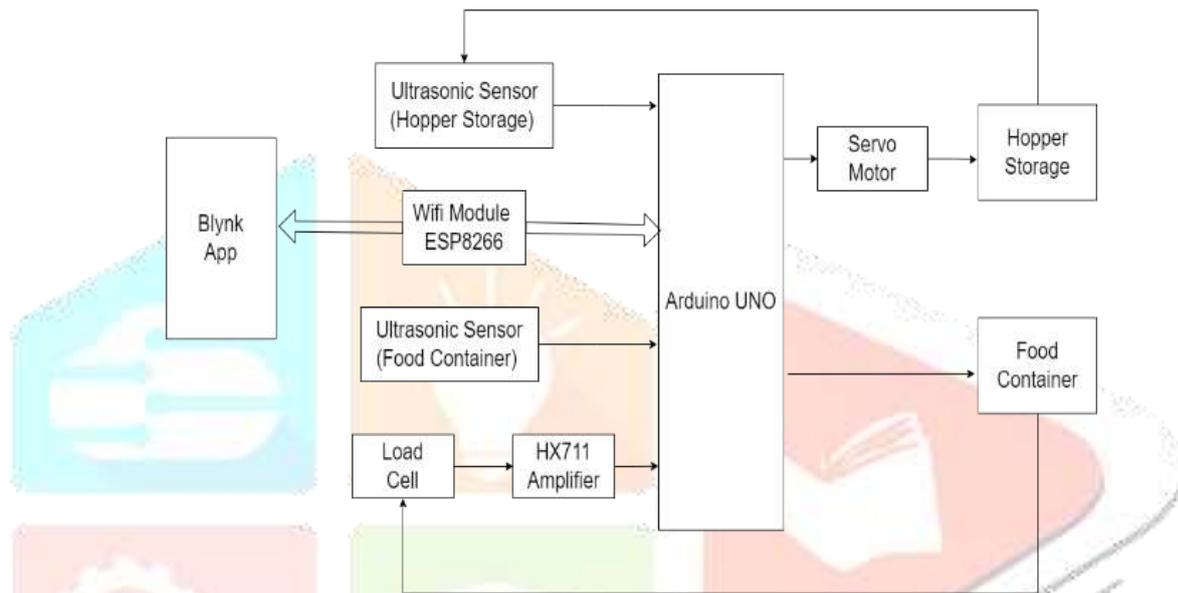


Figure 3: Block Diagram of Smart Feeding

Operation of the system:

1. Set time using the smartphone application.
2. When the time is reached, the actuator of the hopper storage will open to drop the food on the food container of the livestock.
3. User can also manually control the actuator using the app.
4. The ultrasonic sensor in the hopper storage will sense the level of food and send a notification through the app to user so that user can monitor the level of food present.
5. The ultrasonic sensor at the food container is used to sense the presence of livestock while the load cell will.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The primary purpose of animal health monitoring is to identify and prevent disease symptoms. The cow's average body temperature is 38.5°C -39.5°C, while the dog's typical body temperature is 38.3°C-39.2°C. When an animal's body temperature exceeds the above-mentioned average temperature, it indicates that the animal is unhealthy. Detecting estrus is usually challenging. The animal monitoring equipment works by constantly monitoring the cow's body temperature to determine whether it is in heat.

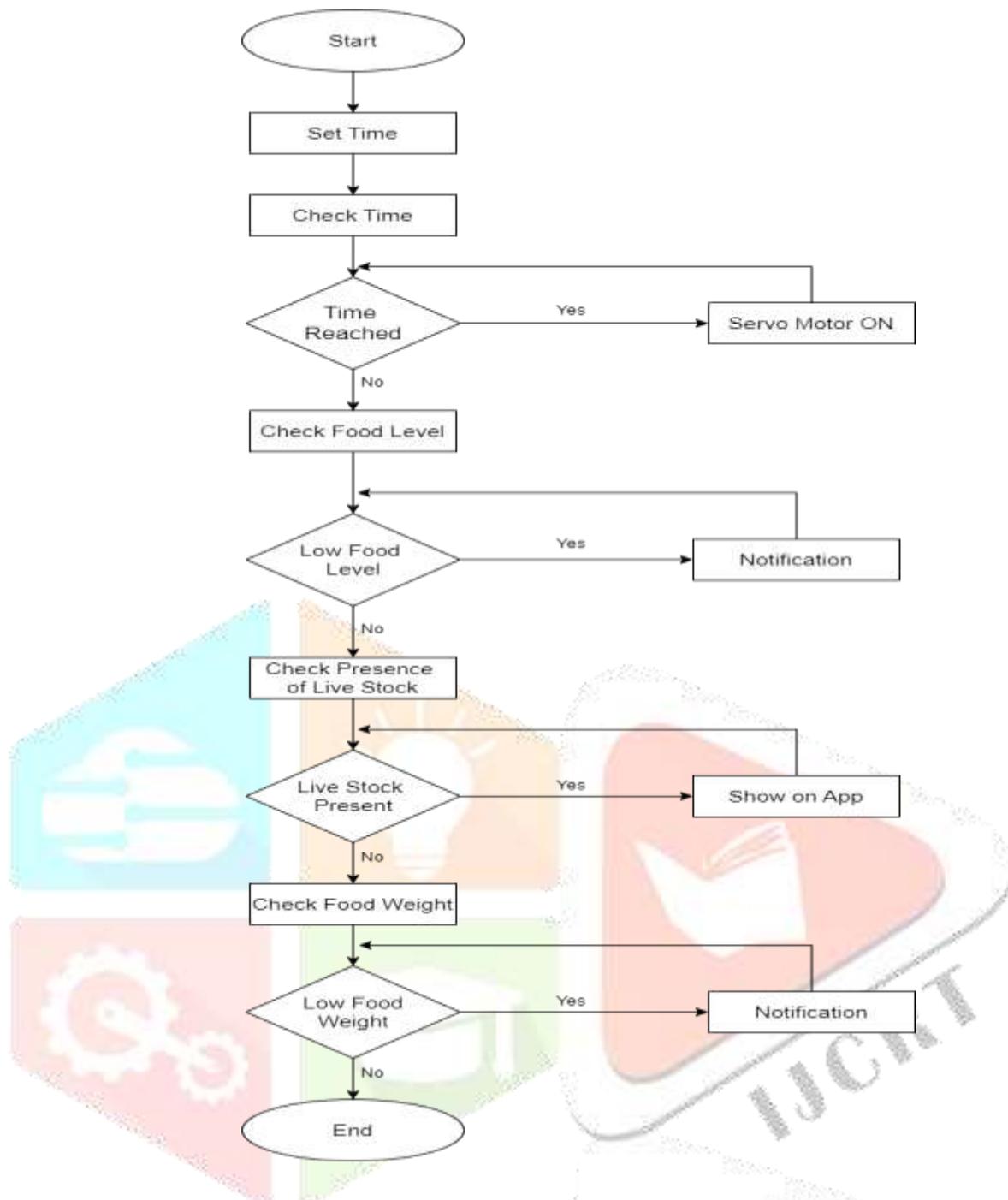


Figure 4: Flowchart of the smart feeder system



Figure 5: Prototype design (a) Smart Feeding Module (b) Health Monitoring Module

4.1 Smart Feeding Module

Figure 5(a) demonstrates how an ultrasonic sensor situated at the food container is utilized to detect the presence of cattle and if they are approaching the food. Because the system is used in outdoor farming, it is critical to monitor the presence of livestock for food in order to avoid food waste and financial loss. The load cell is coupled to a HX711 module. The HX711 module is used to extract quantifiable data from a load cell and a strain gauge. When food is dropped into the container, the load cell detects and measures the weight of the food within.

4.2 Health Monitoring Module

Figure 5(b) shows an animal monitoring belt module with hardware and sensors such as an IR temperature sensor, a three-axis accelerometer sensor, a pulse rate heart beat sensor, a humidity sensor, an ESP2866 Wi-Fi module, and a power supply unit. When the animal is connected to the wearable collar monitoring device and the power is turned on, the sensors activate. The sensor then captures and transmits the data to the cloud, where it may be further examined.

Figure 6 displays the Sensor readings based on collected data provide critical insights into many characteristics of the monitored environment. These measurements include a variety of metrics, including temperature and humidity data from the DHT11 sensor, which provides information about the surrounding ambient conditions. The MLX90614 sensor contributes by measuring the body temperature of cattle, providing important health monitoring measures. Additionally, the KG011 Heart Beat Pulse sensor provides real-time pulse rate data, allowing for continuous monitoring of the animals' cardiovascular health. Furthermore, the 3-axis accelerometer records the livestock's bodily gestures, which provides useful information about their activity levels and behaviour patterns. Collectively, these sensor values serve as the foundation for comprehensive health monitoring and control of the monitored cattle environment. The animal monitoring gadget is integrated with the Thing Speak IoT analytics platform, allowing it to aggregate, visualize, and analyse live sensor data. This platform analyses, stores, and visualizes data collected over a channel from animal monitoring equipment. Channels retain all data, including the animal's body temperature, the humidity and temperature of its surroundings, and its physical actions.



Figure 6: Chart showing the Data of Health Monitoring System



Figure 7: User interface of Blynk IOT App

The first step is to allow users to input feeding time; there are two time slots available, so customers can select two times each day to feed the cattle automatically via the app. Users can configure the time slot for feeding the cattle by hour, minute, second, and AM/PM. When the moment comes, the servo motor, which serves as the actuator, will be activated to drop the food into the container. In this project, the food is repurposed as pet bedding. In this project, the bedding is employed as "food" because its size is almost identical to that of the cow.

The ultrasonic sensor in the hopper storage can detect the level of food, which is considered high when it is between 0 and 2 centimetres from the sensor, and low when it is between 0 and 2 centimetres. The feed pallet is 2 centimetres in size and costs less than the budgeted amount. The actuator is set to open in one second and has a degree of 90 degrees when it is open. The parameters for high and low food levels can be set using Arduino code. The ultrasonic sensor situated at the food container detects the presence of livestock and whether they are approaching the food. Because the system is used in outdoor farming, it is critical to monitor the presence of livestock for food in order to avoid food waste and financial loss. The load cell is coupled to a HX711 module. The HX711 module is used to extract quantifiable data from a load cell and a strain gauge. When food is dropped into the container, the load cell detects and measures the weight of the food within.



Figure 8: Health Monitoring Belt worn by cow



Figure 9: Implementation of the Health Monitoring

V. CONCLUSION

Agriculture is about to undergo a major transformation thanks to the Internet of Things-based Livestock Monitoring System and Smart Feeding. This creative solution offers a complete strategy to improve both overall farm efficiency and animal welfare, addressing the many issues that livestock farmers encounter. Farmers are able to make well-informed decisions quickly thanks to the real-time monitoring of critical environmental data made possible by the integration of IoT devices, including sensors. The real power of the system is found in its data analytics capabilities, which give farmers useful insights from the information gathered. This gives farmers the ability to prevent disease in particular by acting proactively. A paradigm shift in feeding techniques is represented by the Smart Feeding mechanism. The initiative maximizes the delivery of nutrients, minimizes feed waste, and eventually enhances the animals' general health and development rates.

It could bring in a new era of precision agriculture by widely modernizing conventional farming methods. In addition to enjoying the benefits of enhanced decision-making and simpler procedures, farmers that adopt this technology also help to build a more productive and sustainable agriculture industry.

This Internet of Things (IoT)-based Livestock Monitoring System is a prime example of how technology and agriculture can work together to ensure food security, environmental sustainability, and the welfare of farmers and their livestock. Innovation will play a critical role in these endeavors going forward. Thus, this project represents a critical turning point in the continuing evolution of agriculture and portends a day when technological advancement will be essential to farming's continued success.

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