

Smart Wearable Band for Proactive Bovine Health and Breeding Cycle Monitoring

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Abstract

The Smart Wearable Band for Proactive Bovine Health and Breeding Cycle Monitoring is an IoT-based device. It is designed to address the major issues in cow health and its breeding cycle tracking. Traditional methods for livestock monitoring are manual. They're slow and can cause errors. Manual observation of the breeding cycle is especially prone to mistakes. It also causes unnecessary pain to the cows. To address all the above mentioned issues, a flexible, wearable health band that can be attached to the tail of the cow is proposed in the study. It's comfortable and avoids the need for manual observation. The band tracks vital signs like body temperature, heart rate, humidity, and activity levels. If there are any abnormalities seen, it sends an SMS alert to the farmer immediately. This lets farmers take quick action to prevent health issues. The device also helps to monitor and predict the cow's breeding cycle. It makes breeding timing more accurate and less stressful for the cow. Early diagnosis shows a drop in disease caused and better milk production. The Bovine Health Plus Band is a cost-effective and efficient smart livestock management system.

Keywords: IoT, Livestock, Health Monitoring, Wi-Fi Module, Sensors, Real-Time Alerts, Cattle Tracking, Breeding Cycle, Smart Farming, Productivity,

1. Introduction

The Health Plus Band is an IoT-based device designed to solve the problems identified in cattle farming. It's all about health monitoring and breeding management. Traditional methods in cattle farming, whether for dairy or meat production, have always been slow and

ineffective. These are manual checks that are expensive and prone to errors. Health problems, especially in cattle, often go unnoticed until it's too late, resulting in high treatment costs as well as the spreading of disease. So, the Health Plus Band is proposed to have the complete details of body temperature, heart rate, activity levels, and environmental factors like temperature and humidity. The sensors to monitor the above-mentioned vitals will be attached to the tail of the cattle with a silicon band without causing any disturbance to the animal. With continuous monitoring, the device helps in collecting the vital signs in real time and sends an alert to the farmer's mobile through a Wi-Fi module in case of an emergency. Additionally, the farmers are also alerted with the breeding time of the cows. Thus, the health band enables the farmer to have real-time updates about the cattle and an efficient as well as a cost-effective cattle farming.

2. Related Works

Thailand's tropical climate poses a challenge to dairy farming due to heat stress. Holstein-Friesians, a cold-tolerant breed, are crossbred with local cows to improve immunity and weather resistance. However, heat stress affects milk production and health. To address this, farmers can monitor cow behavior, measure temperature, and reduce stress through ventilation fans and roughage. A system for automatic thermal stress measurement using the Temperature Humidity Index (THI) equation can be developed to alert farmers in real time [1].

The last ten years have seen an increase of machine learning models and the development of machine learning techniques, which have created a variety of opportunities for their application across all fields of study. Deep learning techniques are among the most effective tools, especially with the vast expansion of the amount of data that has been collected and made available in all fields, as well as the substantial advancements in image processing technology and related research. To determine the quantitative description of the important parameters in breeding tasks, this study intends to investigate the possibilities of using machine learning in dairy cattle breeding by examining comparable real-world examples and taking into account the potential selection of a dataset for model training. [2]

The study aims to reduce labor costs and improve the health status of dairy cows by designing a cow activity monitoring and early warning system. The system consists of a Wi-Fi module, activity detection, GPS module, main controller, alarm control, and PC terminal. The

main controller processes data from the activity sensor, obtains GPS positioning data, and judges abnormal cow activity. The alarm is activated when cow activity is outside the normal range, indicating the cow's health status. This system is suitable for small-scale dairy farms and can help improve production performance and economic benefits, promoting modern dairy farming in China. [3]

As China's dairy genetics and breeding enterprises face challenges like irregular production management, disordered data records, and incomplete data, hindering healthy development. To address these issues, a system involving basic data management, production data management, pedigree data management, data query, and statistics is being developed. This system aims to improve information management, promote sustainable development, and enhance the quality of dairy cow breeds. [4]

This research proposes an innovative ways to bridge the gap between stakeholders in animal husbandry and dairy development in rural India. It proposes a collaborative approach using web services and Services Oriented Architecture (SOA) to manage cattle health care services. This approach aims to improve milk production, breed quality, and create lucrative business opportunities for young rural people. [5]

The research presents a cow behavioral recognition method using dynamic analysis for large-scale dairy cattle breeding. It focuses on identifying abnormal behaviors like estrus and hoof disease, improving the accuracy of identification, saving breeding staff time, and enhancing management efficiency in large-scale breeding [6].

India's mobile data usage is second globally, with IoT growth in agriculture and animal health care. Veterinary science seeks IoAHT technologies for monitoring animal health. Artificial insemination in dairy relies on correct estrus detection for success. IoT and analytics are used to identify cattle diseases affecting the estrus cycle [7].

The dairy cow cattle industry uses Artificial Insemination (AI) to increase pregnancy rates during the estrous cycle. A balanced plan between AI needs and stud semen stock is crucial for dairy cow management. A dataset of 1,790 cows is used for training and testing data. The Multiple Logistic Regression method is used to predict the estrous cycle, with model accuracy of over 80% and multinomial calculations of 83.2%. This approach reduces missed

estrus events, optimizing AI timing and cutting costs linked to unsuccessful breeding attempts. It makes the entire process data-driven, improving fertility rates and farm efficiency [8-10].

Based on the study conducted, the proposed method aims to develop a simple healthcare band that could monitor all the vital signs of the cattle and alert the farmer on the anomalies observed.

3. Proposed Work

3.1 Cattle Health Monitoring System Block Diagram

This system employs a multifaceted approach to bovine health monitoring, integrating various sensors for comprehensive assessment. A temperature sensor monitors the body temperature, while a heart rate sensor identifies potential cardiac irregularities. Environmental humidity is analyzed to ensure optimal conditions, and oral pH levels are measured to identify potential gastrointestinal disturbances. Hydration is monitored through a water flow sensor, tracking consumption patterns. An ESP32 a embedded microcontroller, processes the collected sensor data, comparing it against the normal parameters. In the event of abnormal readings, the system promptly initiates an alert. Data is transmitted through Wi-Fi to cloud-based ThingSpeak platform for secure storage and historical analysis. Farmers receive SMS notifications upon the detection of critical deviations, enabling swift intervention and proactive health management, ultimately contributing to the preservation of bovine well-being. Figure 1 shows the block diagram of the bovine health monitoring.

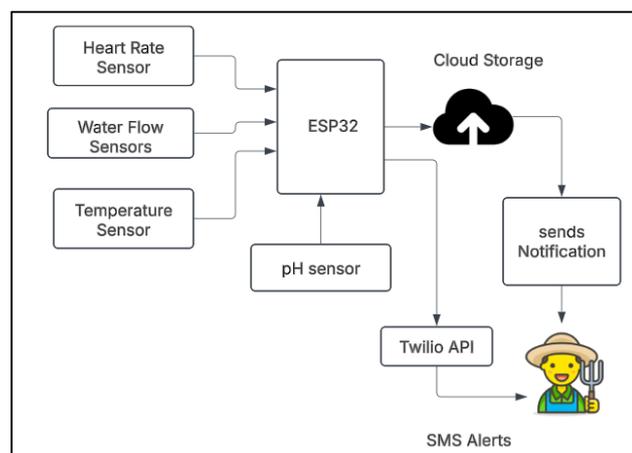


Figure 1. Block Diagram for Bovine Health Monitoring

3.2 Components and Working

A temperature sensor monitors the body temperature of the cattle. By detecting any deviation above the normal range, it aids in the early identification of fever or temperature-related disease. The temperature sensor transmits the monitored temperature level continuously to the microcontroller. If the body temperature increases above a predetermined threshold. The microcontroller, which processes the data, identifies the anomalous condition and initiates an alert, notifying the farmer through SMS using the Twilio API. This continuous monitoring ensures the cow's health is assessed for fever and temperature-related diseases.

Similarly, a pH sensor measures the salivary pH levels of the cattle. Salivary pH provides valuable insights into the cattle's digestive health. Significant fluctuations in pH may indicate digestive disorders or other disease processes. These anomalous pH readings trigger an alert, notifying the farmer to assess the cattle's health. The pH sensor is crucial for detecting potential digestive problems before they escalate, enabling early disease diagnosis and treatment. A heart rate sensor monitors the cattle's heart rate, and a water flow sensor measures the saliva flow rate of the cattle. The coding, responsible for sensor regulation and ESP32 operation, is developed using C++. Currently, the system transmits SMS alerts to farmers via the Twilio API. Future development will integrate the ThingSpeak cloud platform for comprehensive sensor data storage.

The Figure .2 below shows the flowchart of the proposed bovine health monitor.

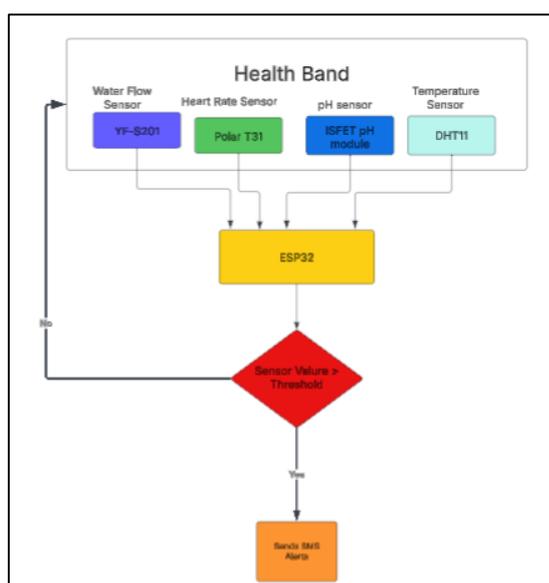


Figure 2. Flowchart of the Proposed Bovine Health Monitor.

The system starts by initiating the Temperature, DHT11, pH, and Heart Rate Sensors to monitor the cow's health and environmental conditions. The sensors are connected to a microcontroller, ESP32, which processes the data from each sensor. The microcontroller continuously reads values and compares them with threshold limits. If any sensor detects abnormal readings, such as a high temperature or irregular heart rate, the microcontroller triggers an alert system. When abnormal readings are detected, the system sends automated SMS alerts to the farmer. This alert system ensures that farmers are notified immediately if a cow's health parameters exceed safe thresholds. These alerts provide important information, including which parameter is abnormal and the exact value, allowing farmers to respond quickly to potential health issues. The system also supports multiple message delivery methods, ensuring alerts reach the farmer through SMS, even if other communication channels fail. Additionally, the system is planned provide a two-way

communication, in future allowing farmers to respond to alerts and request updated data from the sensors. This would enable continuous monitoring and rapid action to protect the cattle's health. This overall system provides a real-time, automated solution for monitoring cattle health, allowing farmers to address problems promptly and increase the overall productivity and well-being of their livestock.

4. Advantages of the Proposed Bovine Health Monitoring Band

4.1. Improving Health Monitoring

A big advantage of smart wearable bands is that they let farmers monitor an animal's health continuously without needing to watch them all the time. These wearables track key factors like body temperature, heart rate, activity level, and rumination. If anything goes wrong, the system can alert the farmer in real-time. 4.2. Better Breeding Cycle Management

Efficient breeding is a crucial one for better production. In the past, farmers had face some difficulties to rely on watching cattle's closely to spot their breeding time, which can take a lot of time and sometimes lead to mistakes. The Smart wearables tracks the changes in their behaviour, movement, and even hormones, making it easier for the farmer to detect the cattle's breeding time.

These wearables help predict the best time for artificial insemination (AI) or natural mating, improving pregnancy rates and reducing the time between calving. This helps manage the breeding schedule better, leading to healthier calves and better overall herd management.

4.2 Cost-Effectiveness and Efficiency

Initial cost of these smart wearable devices might be high. These devices reduce the need for constant monitoring, track the health issues early, and help avoid expensive treatments. More accurate breeding predictions lead to better reproductive success, which improves farm productivity. For large farms where keeping track of each cattle individually is difficult, wearables offer an efficient solution. With automatic data collection, farmers can easily manage the entire herd and focus on particular animal that needs attention, instead of constantly watching each cattle.

5. Result and Discussion

The wearable band successfully collects vital signs of the cattle. It tracks body temperature, heart rate, and activity. The real-time alerts are sent to the farmer when any abnormality is detected. This helps farmers act quickly and efficiently. The system monitors cattle without needing constant observation. The prototype image in Figure 3 shows the wearable band that can be fixed to the tail of the cattle (cow)

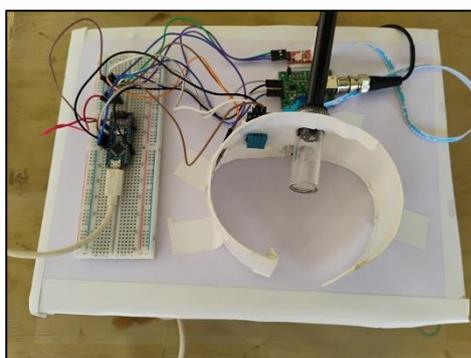


Figure 3. Hardware Prototype

The band ensures that farmers can track the cow's health continuously without being physically present. The continuous monitoring of the health band data such as temperature and heart rate readings are shown in Figure 4. By attaching the band to the cow's tail, the data collection process begins.

The system is effective in monitoring health parameters continuously. Farmers can now monitor the complete herd using this device. The wearable band gives accurate readings and helps in tracking the health issues before the condition of the cattle becomes worse. Figure 5 shows the SMS alert send to the farmer.

```
Project: final_code.py
1 #include <SPI.h>
2 #include <GSM.h>
3 #include <WiFi.h>
4 #include <Arduino.h>
5
6 const char* ssid = "Bovine_BSSID";
7 const char* password = "Bovine_Cattle_Bovine";
8
9 #define DHTPIN 4
10 #define DHTTYPE DHT11
11 #define PULL_UP_RESISTOR_PIN 32
12 #define PULL_UP_RESISTOR 10K
13 #define PULL_DOWN_RESISTOR_PIN 34
14
15 DHT dht(DHTPIN, DHTTYPE);
16
17 const float TEMP_THRESHOLD = 40.0;
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Figure 4. Readings of Cow’s Health Parameters using Health Plus Band

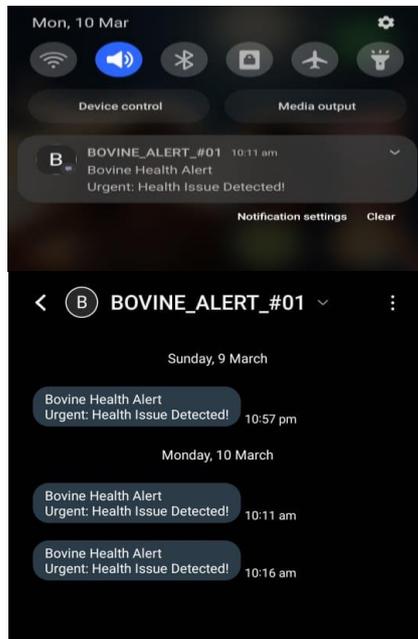


Figure 5. Alert Message to Farmer through SMS

6. Conclusion

The IoT-based cattle healthcare monitoring system is providing effective data to farmers for managing their livestock's and offering an efficient approach to health monitoring and breeding cycle management. The old traditional methods of checking cattle's health are often time-consuming, costly, and lead to errors. Farmers usually do visual inspections and manual checks, which can lead to miss early signs of health problems and leading to the spread

of disease and higher veterinary costs. This system uses various sensors to track the vital health indicators of the cattle, such as body temperature, heart rate, activity levels, and environmental conditions like humidity in real-time. These parameter readings are gathered by some sensors are designed to be comfortable for the animals, ensuring that the sensors are not disrupting their daily activities. The continuous monitoring enables farmers to detect health issues early, before they become serious, giving them the opportunity to take swift action and significantly reduce the risk of diseases spreading through the herd, improving overall health and minimizing treatment costs. Moreover, the IoT-based system enhances breeding management, which is often challenging to monitor with traditional methods. By tracking the behavioral changes of a cow, like activity levels in day and night and temperature analysis. The system can help farmers determine the optimal time for breeding. This leads to better reproductive outcomes, healthier calves, and an overall increase in farm productivity. In addition to improving the health and breeding cycle management, the IoT based developed system helps farmers to reduce the need for manual monitoring. It also improves cattle health management, it enhances breeding cycle tracking, and it reduces costs and boosts the productivity. In future, the system would be integrated with the ThingSpeak cloud platform, including the machine learning methods to have a proper prediction of the sensor data collected. If farmers adopt this technology, it will become a key tool in the future of smart farming and make livestock management more efficient, sustainable, and profitable.

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