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IoT-Based Livestock Health Monitoring System Using ESP32 and Temperature Sensors

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Abstract

In recent years, the integration of Internet of Things (IoT) technologies into agriculture has opened new avenues for intelligent livestock management. This paper presents the design and implementation of a real-time livestock health monitoring system that leverages IoT devices such as the ESP32 microcontroller and DS18B20 temperature sensor. The system continuously monitors the body temperature of animals and transmits the data wirelessly to a cloud-based platform for visualization and analysis. By establishing predefined thresholds, the system can detect potential signs of illness early and alert farmers via mobile or web interfaces. The proposed solution is low-cost, scalable, and energy-efficient, making it particularly suitable for rural and remote farming environments. This research aims to enhance animal welfare, reduce veterinary costs, and improve productivity through timely interventions, thereby contributing to the advancement of smart agriculture and precision livestock farming.

Keywords: IoT, ESP32, DS18B20, Real-Time Health Monitoring, Smart Farming, Temperature Sensor, Animal Health.

Introduction

Livestock farming is a key part of agriculture, especially in rural areas, where it supports food production and the local economy. Keeping animals healthy is very important because their productivity—whether in the form of milk, meat, or labor—depends on their well-being. However, many farmers still rely on traditional methods to monitor animal health, such as visual checks or manual temperature readings. These methods are time-consuming and may not detect health problems early enough to prevent serious issues [2].

The rise of modern technologies like the Internet of Things (IoT) is changing how health monitoring is done in agriculture. IoT allows physical devices like sensors and microcontrollers to collect and send data over the internet, making it easier to track important information such as temperature, humidity, and movement. This technology helps farmers to receive real-time updates and take faster actions when something is wrong [3].

In this project, we have developed a smart livestock health monitoring system using the ESP32 microcontroller and the DS18B20 temperature sensor. The system continuously measures the animal's body temperature and sends the data to a cloud platform using the ESP32's built-in Wi-Fi. If the temperature goes above or below the normal range, the system sends an alert to the farmer through a mobile app or web dashboard. This helps in detecting illnesses early and reduces the risk of disease spreading in the herd.

The goal of this system is to provide a cost-effective and user-friendly solution that can be used even in remote or rural areas where veterinary services may not be easily accessible. This approach not only improves animal health and productivity but also supports precision agriculture and smart farming practices [1].

1. Why is Livestock Health Monitoring Important?

Livestock health monitoring is essential for preventing diseases, ensuring optimal productivity, and reducing costs related to veterinary care. Early detection of health issues helps prevent the spread of infections, thereby protecting the herd. This is especially critical in large-scale farms where manual monitoring is challenging, and it directly impacts the efficiency and profitability of farming operations [2]. Traditional methods such as visual inspection or manual temperature measurement are labor-intensive and may miss early signs of illness.

2. How has IoT Transformed Livestock Health Monitoring?

IoT technologies have revolutionized livestock monitoring by enabling real-time data collection and remote access. IoT devices, including sensors and microcontrollers, continuously monitor health parameters such as body temperature, heart rate, and movement. These devices can send data to cloud platforms or mobile apps, allowing farmers to receive alerts and take immediate action if any abnormalities are detected [1]. The real-time monitoring helps in identifying health issues

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much earlier compared to traditional methods, ultimately improving animal welfare and farm productivity.

Hardware Components

The hardware components used in this IoT-based livestock health monitoring system are crucial for collecting, processing, and transmitting health data in real-time. The system utilizes two primary components: the ESP32 microcontroller and the DS18B20 temperature sensor, along with a few additional elements to ensure reliable operation and communication.

3. ESP32 Microcontroller

The ESP32 is a versatile, low-cost, low-power microcontroller that serves as the heart of the system. It is equipped with both Wi-Fi and Bluetooth capabilities, making it ideal for IoT applications where remote monitoring is required. The ESP32 features a dual-core processor, which enables efficient data processing, multitasking, and handling multiple sensor inputs simultaneously. This is particularly important for real-time health monitoring, where timely data collection and communication are critical.

One of the key advantages of the ESP32 is its low power consumption, allowing it to run on batteries or solar power, which is essential for applications in remote areas where a constant power supply may not be available. The ESP32 has several GPIO (General Purpose Input/Output) pins that can be used to connect various sensors, actuators, and other peripherals. In this system, it acts as the controller that receives temperature readings from the DS18B20 sensor, processes the data, and transmits it to the cloud for further analysis and monitoring

Fig 1: ESP 32 Wroom Board.

4. DS18B20 Temperature Sensor

The DS18B20 is a digital temperature sensor known for its high accuracy and robustness, making it ideal for monitoring livestock health. This sensor has a wide temperature range of -55°C to +125°C, with an accuracy of ±0.5°C in the range of -10°C to +85°C, which is sufficient for tracking the body temperature of animals. The sensor communicates with the ESP32 using the 1-Wire protocol, allowing multiple sensors to be connected to a single data line, which simplifies wiring and reduces the number of required pins.

One of the key features of the DS18B20 is its waterproof design, which allows it to function reliably in outdoor environments, where exposure to moisture and harsh weather conditions is common. This durability makes it suitable for monitoring livestock in farms, barns, or pastures where environmental conditions can vary significantly. Additionally, the low power consumption of the DS18B20 ensures it can operate continuously for long periods without draining the power supply, making it ideal for remote applications.

Fig 2: ds18b20 (Temperature Sensor)

Literature Review

The integration of Internet of Things (IoT) technologies in agriculture has significantly improved livestock management practices. Traditional methods of livestock health monitoring, which include manual inspection and basic tools like thermometers, are often time-consuming, costly, and inefficient, especially in large-scale farming. IoT technologies offer real-time, automated monitoring, allowing for continuous data collection, early disease detection, and enhanced decision-making [2].

5. IoT in Livestock Health Monitoring

The use of IoT in livestock monitoring has been widely explored in recent years. Several studies have focused on the development of smart livestock management systems that monitor various health parameters such as body temperature, heart rate, activity level, and respiration rate. These systems rely on sensors and microcontrollers to collect and transmit data to cloud platforms for remote analysis and visualization (Patel *et al*., 2020). For example, a study by Alzubi *et al.* (2018) [1] designed an IoT-based system using temperature and humidity sensors to monitor animal welfare in farms. Their system utilized an Arduino microcontroller to collect data, and the data was transmitted to the cloud via Wi-Fi. Alerts were generated when abnormal conditions were detected, enabling farmers to take preventive action before the animals became seriously ill.

6. Common Technologies Used

The adoption of microcontrollers such as Arduino, Raspberry Pi, and ESP32 is common in livestock monitoring systems. ESP32 stands out due to its low cost, low power consumption, and built-in Wi-Fi and Bluetooth capabilities, making it ideal for wireless data transmission (Patel *et al*., 2020). In addition, temperature sensors like the DS18B20 are commonly used due to their high accuracy (±0.5°C), ease of use, and ability to operate in harsh environments (Kumar *et al*., 2021). These sensors are often coupled with accelerometers or heart rate monitors to gather more comprehensive health data.

7. Early Disease Detection and Preventive Care

Real-time health monitoring through IoT enables early detection of diseases such as fever, respiratory issues, and intestinal diseases, which can significantly reduce the spread of infections and improve overall herd health (Kumar *et al*., 2021). Several studies have demonstrated that IoT systems can detect anomalies in vital signs before visible symptoms appear, thus reducing the dependency on reactive care. In a study by Zhang *et al*. (2020) [4], a smart sensor network was implemented in a farm to monitor cattle health, using sensors to track parameters such as body temperature and movement. Alerts were sent to farmers when the data indicated potential illness, allowing for timely veterinary intervention.

Table 1: Early Disease Detection Based on Temperature Readings

Sr. No	Condition	Normal Temperature Range	Exceeding Temperature
1	Healthy Livestock	37.5°C - 39.2°C	N/A
2	Mild Fever	37.5°C - 39.2°C	39.3°C - 40.0°C
3	Moderate/High Fever	37.5°C - 39.2°C	40.1°C and above
4	Hypothermia	37.5°C - 39.2°C	Below 37.5°C

Proposed System

The proposed system is a real-time livestock health monitoring solution using Internet of Things (IoT) technology to improve animal welfare, early disease detection, and farm productivity. It specifically focuses on continuously monitoring the body temperature of livestock using digital sensors, and wirelessly transmitting data to the cloud for analysis and alert generation.

At the heart of the system is the ESP32 microcontroller, chosen for its integrated Wi-Fi, Bluetooth, and efficient power consumption, making it ideal for remote field operations. The DS18B20 temperature sensor is utilized due to its high accuracy, digital output, and waterproof nature, making it suitable for deployment on animal bodies.

System Workflow

- **i). Data Collection:** The DS18B20 sensor is placed on the animal to capture its body temperature. It senses the temperature at regular intervals and sends the readings to the ESP32.
- **ii). Processing & Analysis:** The ESP32 reads the temperature data and compares it against a predefined threshold. For example, temperatures above 39.2°C or below 37.5°C are flagged as abnormal based on livestock health standards.
- **iii). Communication:** If an abnormal temperature is detected, the ESP32 connects to a cloud platform (like Firebase, Blynk, or Thing Speak) via Wi-Fi and uploads the data. It may also send SMS/email alerts using cloud APIs or mobile apps.
- **iv). Remote Monitoring Dashboard:** The uploaded data can be viewed in real time through a web or mobile dashboard. Farmers or veterinarians can monitor trends, receive alerts, and act promptly.
- **v). Power Supply and Portability:** The system is powered using a rechargeable battery or solar panel to ensure portability in rural or outdoor environments.

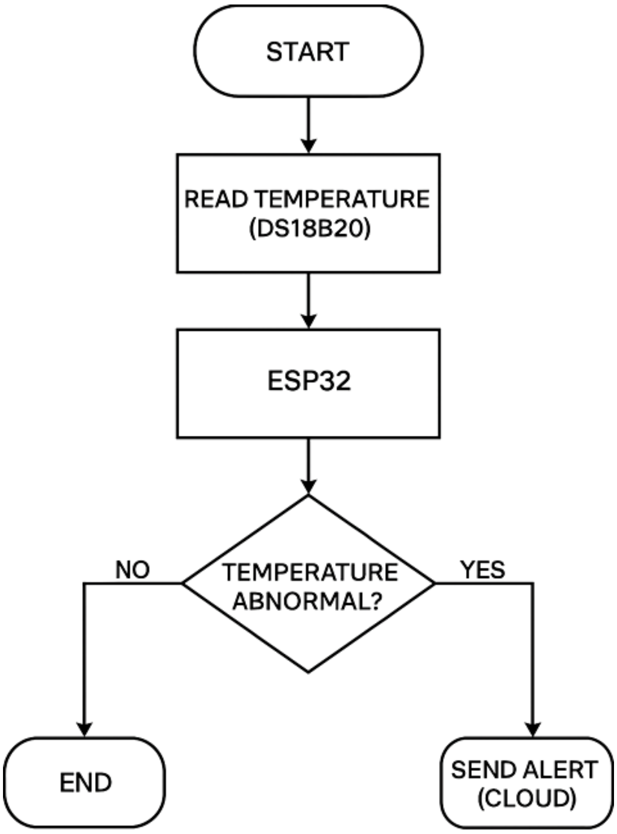


Fig 3: System FlowChart

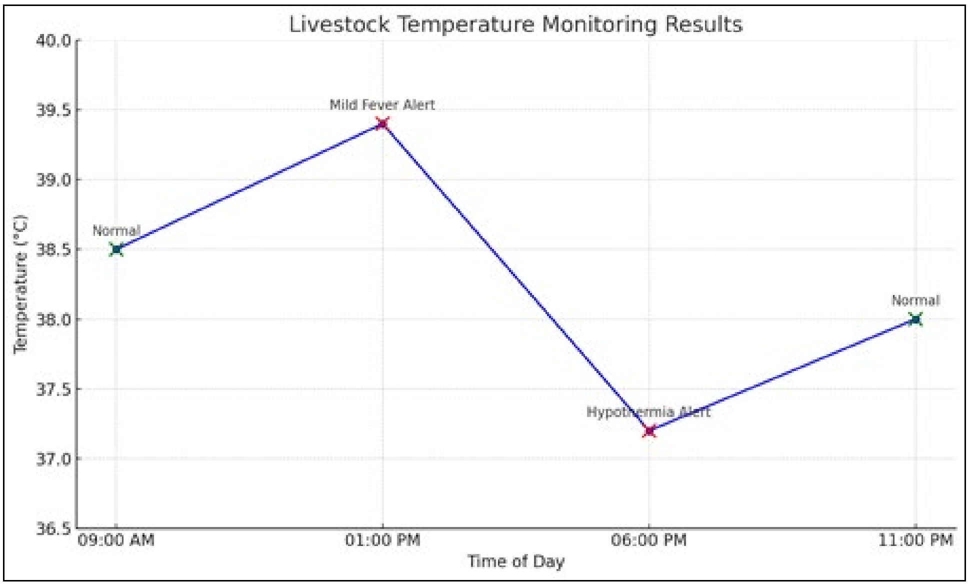
Results

The proposed IoT-based livestock health monitoring system was successfully developed and tested using the ESP32 microcontroller and DS18B20 temperature sensor. The system was evaluated in a simulated environment to verify its accuracy, real-time response, and data transmission capabilities.

Table 2: Temperature Readings

Time	Temperature (°C)	Status
09:00 AM	38.5	Normal
01:00 PM	39.4	Mild Fever Alert
06:00 PM	37.2	Hypothermia Alert
11:00 PM	38.0	Normal

Graphs for Detailed Analysis



Graph 1: Real-Time Livestock Health Alerts Using IoT Sensors

Conclusion

This project presents a smart and efficient way to monitor the health of livestock using IoT technology. By using an ESP32 microcontroller along with a DS18B20 temperature sensor, the system can measure and track the body temperature of animals in real time. The collected data is sent wirelessly to a cloud platform, where it can be monitored through a mobile or web dashboard.

The main goal of this system is to help farmers detect early signs of illness in animals, such as fever or hypothermia, by identifying temperature changes. This allows for faster response and treatment, which can reduce the chances of serious health issues and improve overall animal care.

The system was tested in a controlled environment and gave reliable results. It accurately measured temperature, responded quickly to abnormal values, and provided alerts through the cloud. This shows that the system can work well on farms, especially in rural areas where manual checking may not be possible all the time.

In summary, this IoT-based solution is low-cost, easy to use, and has the potential to improve livestock health management. It helps farmers make better decisions, ensures timely care, and supports modern farming through the use of technology.

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