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SMART POULTRY FEED MANAGEMENT AND ENVIRONMENTAL MONITORING SYSTEM USING RFID AND IOT

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ABSTRACT
The increasing demand for poultry products necessitates the adoption of smart farming technologies to enhance productivity, reduce manual labour, and ensure animal welfare. This project presents the design and implementation of an Internet of Things (IoT)-based automated system for real-time monitoring and control of a poultry farm environment.This project proposes an IoT-based automated system for monitoring and controlling a poultry farm environment. The system integrates multiple sensors including a DHT11 for temperature and humidity, an MQ135 for ammonia detection, a load cell (HX711) for bird weight measurement, and an MFRC522 RFID module for individual bird identification. An ESP32 microcontroller processes sensor data and triggers actuators (heater, fan, humidifier, and sprinkler) to maintain optimal conditions: temperature between 32–35°C, humidity between 60–70%, and ammonia below 50 ppm. Environmental parameters and bird-specific data are transmitted via Wi-Fi to a Google Sheets web app for remote logging and analysis. The system enables real-time environmental control, automated corrective actions, and individual bird tracking, aiming to improve poultry health, reduce manual intervention, and enhance farm productivity.

Keywords:
Internet of Things (IoT), Poultry Farm Automation, Smart Farming, Environmental Monitoring, RFID Identification, Load Cell Weight Measurement, ESP32, Ammonia Detection.

INTRODUCTION

Poultry farming plays a vital role in meeting the global demand for protein-rich food. However, traditional farming methods often rely on manual monitoring and control of environmental parameters, leading to inefficiencies, increased labour costs, and potential health risks for the birds. Suboptimal temperature, humidity, and ammonia levels can cause respiratory diseases, heat stress, reduced feed conversion, and increased mortality rates. Furthermore, individual bird health tracking—such as weight monitoring and identification—is rarely implemented in small to medium-scale farms due to the lack of affordable automation solutions and tracking.

The advent of the Internet of Things (IoT) has enabled the development of low-cost, real-time monitoring and control systems for agricultural applications. By integrating sensors, microcontrollers, actuators, and cloud connectivity, farmers can remotely monitor farm conditions and receive automated responses to environmental deviations. This project proposes an IoT-based automated poultry farm monitoring and control system using an ESP32 microcontroller. The system continuously measures temperature, humidity, and ammonia levels, activates corrective actuators (heater, fan, humidifier, sprinkler) when thresholds are exceeded, and logs all data to Google Sheets. Additionally, the system incorporates RFID-based individual bird identification and load cell-based weight measurement, enabling per-bird growth tracking. The objective is to

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reduce manual intervention, improve bird welfare, and provide farmers with actionable data for decision-making.

OBJECTIVES

The main objective of the study is

- To develop an IoT-based automated poultry farm monitoring system for tracking environmental conditions and bird health parameters in real time.
- To monitor and control key parameters such as temperature, humidity, ammonia levels, and bird weight using sensors and an ESP32 microcontroller.
- To enable automated environmental control and remote data monitoring through actuators and cloud-based logging (Google Sheets) to improve poultry health and farm productivity.

LITERATURE REVIEW

The integration of Internet of Things (IoT) technology in poultry farming has significantly improved environmental monitoring, automation, and farm productivity. Several researchers have proposed smart poultry management systems using sensors, cloud platforms, and automated control mechanisms to ensure optimal living conditions for poultry.

Suresh et al. (2019) proposed an IoT-based poultry monitoring system that measures temperature and humidity using DHT sensors and automatically controls ventilation systems. Their study demonstrated that automated environmental control improves poultry health and reduces manual labor in farm management.

Kumar and Singh (2020) developed a smart poultry farming system using wireless sensor networks to monitor environmental parameters such as temperature, humidity, and gas concentration. The system enabled real-time monitoring through a cloud platform and provided alerts when environmental conditions exceeded safe thresholds.

Rahman et al. (2021) introduced an IoT-based poultry farm monitoring framework that integrates gas sensors to detect ammonia levels, which are harmful to poultry health. Their results showed that continuous ammonia monitoring helps reduce respiratory diseases and improves overall farm productivity.

Patel and Shah (2022) designed an automated poultry monitoring system using microcontrollers and cloud-based data logging. The proposed system allowed farmers to remotely monitor farm conditions through mobile applications and automatically activate ventilation and cooling systems when required.

Lee et al. (2020) developed a smart poultry farming system using IoT sensors and machine learning techniques to predict poultry health conditions. Their system analyzed environmental data and bird behavior to identify potential health risks, enabling farmers to take preventive actions.

Ali et al. (2021) proposed a cloud-connected poultry monitoring system that integrates RFID technology for individual bird identification and tracking. The system helped farmers monitor bird growth patterns and health conditions more effectively.

Zhang et al. (2022) presented an intelligent poultry farm management system that combines IoT sensors and data analytics for real-time environmental monitoring. The study demonstrated that automated systems significantly reduce mortality rates and improve feed efficiency in poultry farms.

Sharma and Gupta (2023) developed a smart IoT-based poultry monitoring and control system that integrates temperature, humidity, and gas sensors with automated actuators. Their work emphasized the importance of real-time monitoring and automated environmental control to maintain optimal poultry conditions.

Previous studies highlight the use of IoT-based systems for monitoring environmental parameters such as temperature, humidity, and gas levels in poultry farms to improve productivity and animal welfare. Several researchers have integrated wireless sensors, cloud platforms, and automation technologies to enable real-time monitoring and farm management. However, many existing systems lack a unified framework that combines environmental monitoring, automated control, bird identification, and weight tracking, which the proposed system aims to address.

METHODOLOGY

The proposed system is an IoT-based smart poultry farm monitoring and control system designed to automate environmental management and enable real-time monitoring of poultry health parameters. The system integrates environmental sensors, bird identification modules, weight measurement devices, actuator control mechanisms, and cloud communication technologies into a unified platform. The main objective is to maintain optimal

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poultry house conditions while reducing manual intervention and enabling remote monitoring of farm conditions.

The architecture of the system consists of five major modules: environmental sensing, bird identification and weight measurement, actuator control, local monitoring, and cloud-based data logging. An ESP32 microcontroller acts as the central processing unit that coordinates communication between sensors, actuators, and the cloud platform shown in the below figure 1.

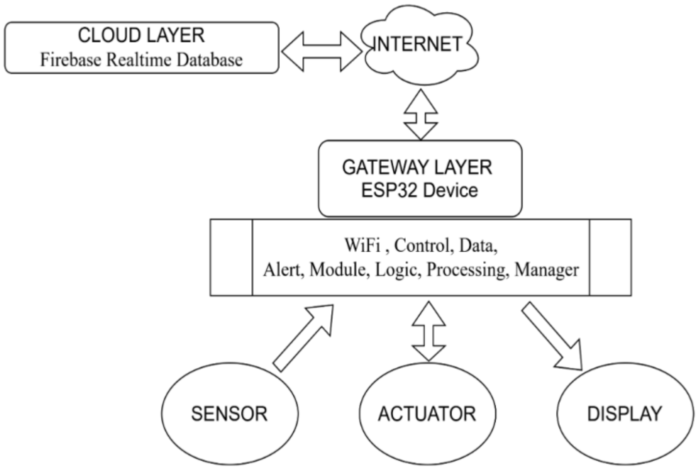

Figure 1 Overall Proposed architecture

The proposed system follows a continuous sensing–decision–control cycle. Environmental parameters such as temperature, humidity, and ammonia concentration are monitored using sensors installed within the poultry house. These readings are processed by the ESP32 microcontroller, which evaluates the values against predefined threshold limits. When environmental conditions deviate from the optimal range, the controller activates actuators such as fans, heaters, humidifiers, or sprinklers to restore suitable conditions. In addition, RFID technology and load cell sensors are used to identify individual birds and measure their weight for growth monitoring. All collected data is transmitted to a cloud database for storage and analysis.

System Architecture

The system architecture integrates sensing devices, processing units, actuator modules, and wireless communication components to create an automated poultry farm monitoring system. The ESP32 microcontroller serves as the core controller responsible for sensor data acquisition, control logic execution, and communication with the cloud platform shown in the below figure 2.

Environmental monitoring is achieved using a DHT11 sensor for temperature and humidity measurement and an MQ135 sensor for detecting ammonia concentration in the poultry house. Bird identification is performed using an MFRC522 RFID reader, where each bird is equipped with a unique RFID tag. The weight of individual birds is measured using a load cell integrated with an HX711 amplifier.

All sensor readings are processed by the ESP32 and displayed locally on a 16×2 LCD display. The system also connects to a Wi-Fi network and transmits environmental and bird-related data to a Google Sheets cloud database using HTTP communication. Based on the sensed environmental conditions, the ESP32 automatically controls actuators such as heaters, exhaust fans, humidifiers, and water sprinklers through relay modules to maintain optimal poultry house conditions.

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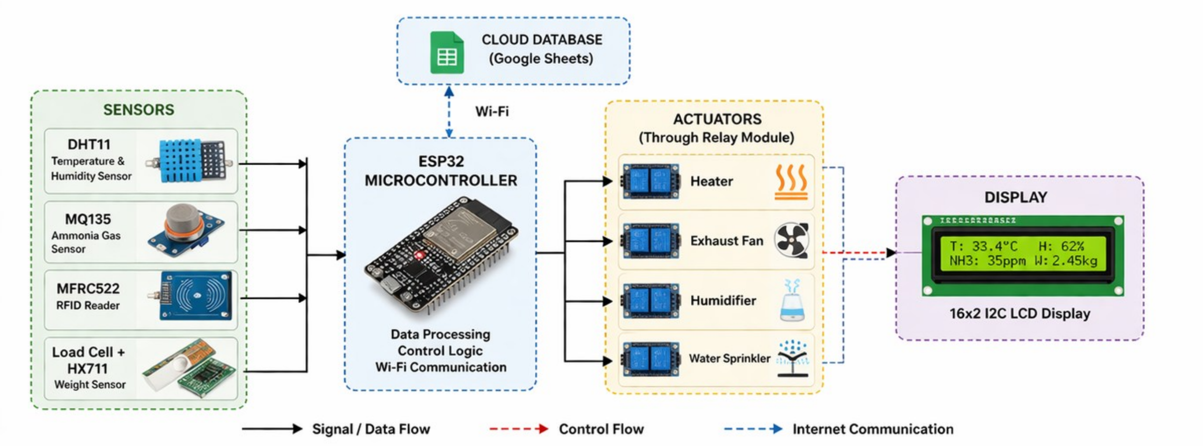

Figure 2 Proposed System Architecture

Hardware Components

The hardware components were selected based on reliability, cost-effectiveness, and suitability for poultry farm environments.

ESP32 Microcontroller

The ESP32 microcontroller acts as the central controller of the system. It reads sensor data, processes environmental parameters, controls actuators, and transmits information to the cloud database. The ESP32 supports Wi-Fi connectivity and multiple communication interfaces such as SPI, I2C, UART, and ADC, enabling easy integration with various sensors and modules.

DHT11 Temperature and Humidity Sensor

The DHT11 sensor measures ambient temperature and relative humidity inside the poultry house. These parameters are critical for maintaining a healthy poultry environment. The sensor communicates with the ESP32 through a digital interface and provides real-time environmental data.

MQ135 Gas Sensor

The MQ135 gas sensor is used to detect ammonia and other harmful gases present in the poultry environment. High ammonia levels can negatively affect poultry health. The sensor provides an analog output proportional to gas concentration, which is processed by the ESP32 to monitor air quality.

MFRC522 RFID Module

The MFRC522 RFID reader is used to identify individual birds in the poultry farm. Each bird carries an RFID tag containing a unique identification number. When the tag is detected, the system records the bird's identity and associates it with its weight measurement.

HX711 Load Cell Weight Measurement

A load cell is used to measure the weight of poultry birds. The load cell converts mechanical force into an electrical signal, which is amplified and digitized by the HX711 module. The ESP32 reads this signal and calculates the bird’s weight.

LCD Display

A 16×2 LCD display with an I2C interface is used for local monitoring of system parameters such as temperature, humidity, ammonia concentration, and bird weight.

Relay Modules

Relay modules are used to control high-power devices such as heaters, fans, humidifiers, and water sprinklers. These relays allow the ESP32 to switch electrical appliances safely.

Software Implementation

The system software is responsible for sensor data acquisition, environmental control, and cloud communication.

Arduino IDE

The ESP32 microcontroller is programmed using the Arduino Integrated Development Environment (IDE). The program consists of two main functions:

- **setup()** – initializes sensors, LCD display, Wi-Fi connection, and system components.

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- **loop()** – continuously reads sensor data, executes environmental control logic, and sends data to the cloud database.

Google Apps Script

Google Apps Script is used to receive data transmitted from the ESP32 and store it in a **Google Sheets database**. The ESP32 sends HTTP POST requests containing environmental parameters and bird data. The script processes the received data and logs it into the spreadsheet for monitoring and analysis.

Environmental Control Logic

The system maintains optimal poultry farm conditions based on predefined environmental thresholds.
The control rules implemented in the system are:

- If temperature falls **below 32°C**, the heater is activated.
- If temperature exceeds **35°C**, the exhaust fan and sprinkler system are activated.
- If humidity falls **below 60%**, the humidifier is activated.
- If ammonia concentration exceeds **50 ppm**, the exhaust fan is forced ON.

This automated control mechanism helps maintain a safe and stable poultry environment.

Bird Identification and Weight Measurement

The system also enables monitoring of individual bird growth. When a bird with an RFID tag approaches the reader, the RFID module detects the tag and retrieves the unique identification number. The load cell then measures the bird's weight, and multiple readings are averaged to improve measurement accuracy.
The bird ID and weight are displayed on the LCD screen and transmitted to the cloud database. This allows farmers to track the growth of individual birds and detect abnormal weight variations.

Data Transmission and Remote Monitoring

The ESP32 connects to a Wi-Fi network and periodically sends environmental and bird-related data to a Google Sheets cloud database. Environmental data such as temperature, humidity, and ammonia levels are transmitted at regular intervals, while bird data is transmitted whenever an RFID tag is detected.
The stored data can be accessed remotely, allowing farmers to monitor poultry house conditions and analyze farm performance trends.

RESULTS AND DISCUSSION

The developed IoT-based poultry monitoring system was tested to evaluate its ability to monitor environmental conditions, control farm equipment automatically, and record bird-related data. The system successfully integrated multiple sensors, actuators, and wireless communication modules to create a reliable smart poultry monitoring platform.The experimental Setup is shown in the below figure 3.

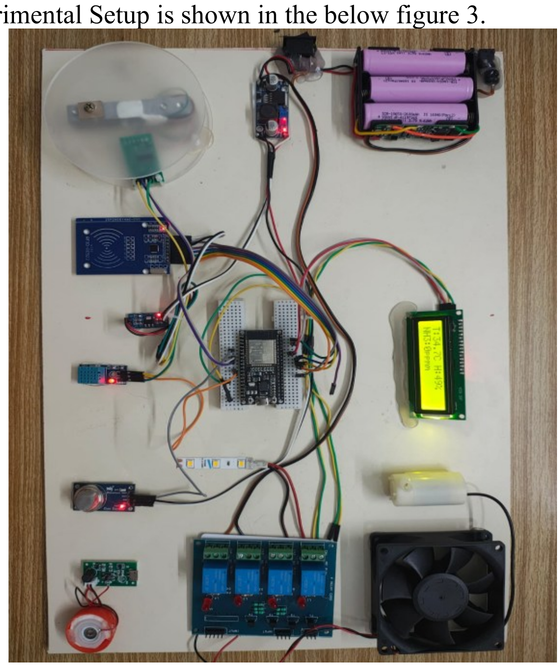

Figure 3 Proposed Model Experimental Setup

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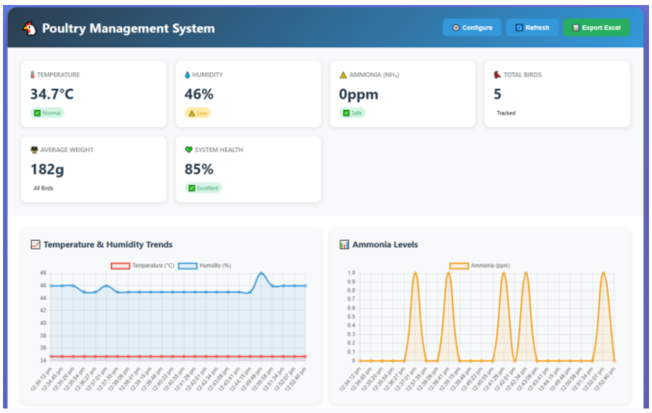
System Operation Flow

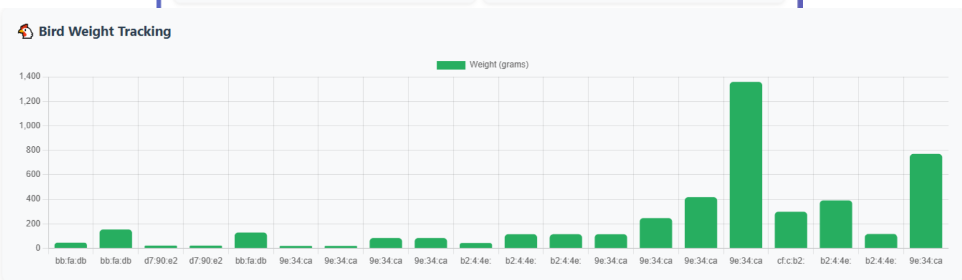
The operation of the system follows a continuous monitoring and control cycle. Initially, the ESP32 microcontroller performs system initialization by configuring sensors, relay modules, LCD display, RFID reader, load cell, and Wi-Fi connectivity. Serial communication is also established for debugging and monitoring purposes.

During operation, the system runs a continuous loop that performs sensor data acquisition, decision-making, and actuator control. Every 100 milliseconds, the ESP32 reads environmental parameters such as temperature and humidity from the DHT11 sensor and ammonia concentration from the MQ135 gas sensor. The ammonia sensor output, which ranges from 0–4095 in analog values, is mapped to an approximate concentration range of 0–100 ppm.

The collected data is processed using predefined environmental thresholds. Based on these values, the control logic determines whether corrective actions are required. For example, if the temperature exceeds the safe limit, the system activates cooling mechanisms such as fans and sprinklers. Similarly, if humidity levels fall below the required range, the humidifier is activated.

The system also updates environmental readings on the LCD display to provide real-time local monitoring. Environmental data is transmitted to a Google Sheets cloud database every 30 seconds through Wi-Fi communication. In addition, the system continuously scans for RFID tags at intervals of approximately 500 milliseconds. When an RFID tag is detected, the system reads the bird identification number and measures the bird’s weight using the load cell.





Environment Data | Bird Records | Alerts

Timestamp	Bird ID	Weight (g)	Temp (°C)	Humidity (%)	Status
5/4/2026, 12:31:46 pm	**9e:34:ca:6**	770.37g	34.7°C	46%	Scanned
4/4/2026, 8:05:25 pm	**b2:4:4e:6**	117.68g	36.9°C	45%	Scanned
4/4/2026, 8:05:07 pm	**b2:4:4e:6**	391.25g	36.9°C	45%	Scanned
4/4/2026, 7:56:30 pm	**cf:c:b2:dd**	298.6g	39°C	41%	Scanned
4/4/2026, 7:55:31 pm	**9e:34:ca:6**	1358g	41.6°C	37%	Scanned
4/4/2026, 7:55:06 pm	**9e:34:ca:6**	417.61g	43°C	34%	Scanned
4/4/2026, 3:35:01 pm	**9e:34:ca:6**	246.81g	37.2°C	39%	Scanned
4/4/2026, 3:34:51 pm	**9e:34:ca:6**	115.49g	37.5°C	39%	Scanned
4/4/2026, 3:34:28 pm	**b2:4:4e:6**	115.31g	37.4°C	39%	Scanned
4/4/2026, 3:34:03 pm	**b2:4:4e:6**	115.6g	37.4°C	39%	Scanned

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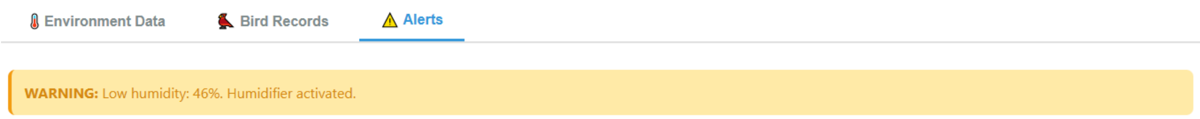

Figure 4 Results

Basic error handling is also implemented within the system. If the DHT11 sensor fails to return valid readings, the system skips the faulty sensor data while continuing overall operation. Debug messages are displayed through serial communication to help identify sensor failures.

System Performance Evaluation

The experimental setup demonstrated stable and reliable performance under different environmental conditions. The DHT11 sensor successfully monitored temperature and humidity levels within the poultry environment, while the MQ135 sensor detected variations in ammonia concentration.Temperature Monitoring Data is shown in the below table 1.

Time (min)	Temperature (°C)	Fan Status	Heater Status
0	31.8	OFF	ON
5	32.4	OFF	OFF
10	33.1	OFF	OFF
15	34.0	OFF	OFF
20	35.2	ON	OFF
25	34.5	ON	OFF
30	33.6	OFF	OFF
35	32.9	OFF	OFF
40	32.3	OFF	OFF
45	31.9	OFF	ON
50	32.7	OFF	OFF
55	33.2	OFF	OFF
60	34.1	OFF	OFF

Table 1 Temperature Monitoring Data

Discussion

The temperature monitoring results show that the system successfully maintained environmental temperature within the optimal poultry range of 32–35°C. When the temperature exceeded 35°C, the exhaust fan was automatically activated to reduce heat. Similarly, when the temperature dropped below 32°C, the heater was activated. This demonstrates the effectiveness of the automated environmental control logic implemented in the ESP32 microcontroller.

The Humidity Monitoring Data is shown in the below table 2

Time (min)	Humidity (%)	Humidifier Status
0	62	OFF
5	64	OFF
10	66	OFF
15	65	OFF
20	63	OFF
25	61	OFF
30	59	ON
35	60	OFF
40	62	OFF
45	64	OFF
50	65	OFF

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Time (min)	Humidity (%)	Humidifier Status
55	67	OFF
60	66	OFF

Table 2 Humidity Monitoring Data

Discussion

The humidity monitoring results indicate that the system-maintained humidity levels within the recommended poultry range of 60–70%. When humidity dropped below 60%, the humidifier was automatically activated to restore moisture levels. The automated response ensures a stable environment that supports bird health and growth.

Ammonia Monitoring

Time (min)	Ammonia (ppm)	Fan Status
0	18	OFF
10	22	OFF
20	28	OFF
30	34	OFF
40	45	OFF
50	52	ON
60	40	OFF

Table 3 Ammonia Monitoring Data

Discussion

The ammonia monitoring results demonstrate that the system effectively detected harmful gas concentrations. When ammonia levels exceeded the safety threshold of 50 ppm, the exhaust fan was automatically activated to improve air circulation and reduce gas concentration.

Result Summary

The experimental evaluation confirms that the proposed system:

- Maintains temperature between 32–35°C
- Maintains humidity between 60–70%
- Keeps ammonia below 50 ppm
- Automatically activates fans, heaters, humidifiers, and sprinklers
- Successfully records environmental and bird data in Google Sheets

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CONCLUSION

This project successfully developed an IoT-based automated poultry farm monitoring and control system using an ESP32 microcontroller. The system integrates multiple sensors, including DHT11 for temperature and humidity monitoring, MQ135 for ammonia detection, MFRC522 for RFID-based bird identification, and a load cell with HX711 for bird weight measurement.

The implemented control logic effectively maintains optimal environmental conditions by automatically activating heaters, fans, humidifiers, and sprinklers when environmental parameters deviate from predefined thresholds of 32–35°C temperature, 60–70% humidity, and ammonia levels below 50 ppm.

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The system demonstrated reliable performance with rapid actuator response times and successful wireless data transmission to a Google Sheets cloud platform. Individual bird tracking through RFID identification and weight measurement allows farmers to monitor bird growth and detect potential health issues at an early stage.
By automating environmental monitoring and control, the proposed system significantly reduces manual labor, improves farm management efficiency, and enhances poultry health and productivity. The cloud-based data logging system also provides accessible historical data for analysis and decision-making.
The low-cost and scalable architecture of the proposed system makes it suitable for small and medium-scale poultry farms, contributing to the advancement of smart farming and precision livestock management in resource-constrained environments .

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