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SMART POULTRY FARM AUTOMATION & MONITORING SYSTEM

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Abstract: The rapid growth of the Internet of Things (IoT) has opened new opportunities for improving agricultural and livestock management through automation and intelligent monitoring. Traditional poultry farming requires continuous human supervision to maintain optimal conditions for bird health, growth, and productivity. Factors such as temperature, humidity, feed levels, and water supply need constant regulation, and manual control often results in inefficiencies or losses. This study presents the design and implementation of a smart poultry farm automation and monitoring system that utilizes IoT-enabled sensors and microcontrollers to ensure real-time environmental control and data analysis. The system measures key parameters such as temperature, humidity, light intensity, ammonia levels, and feed status, transmitting data to a cloud platform for continuous monitoring. Farmers can access real-time information via a web or mobile interface, receive alerts, and remotely adjust conditions. Automated actuators control fans, heaters, lights, and feeders based on sensor feedback to maintain an ideal environment. By integrating low-cost hardware such as the STM32 or Arduino microcontroller with Wi-Fi connectivity modules and cloud databases, the proposed system ensures scalability, affordability, and reliability. This approach minimizes manual intervention, reduces operational costs, and enhances poultry health and productivity. The solution represents a step toward smart agriculture, enabling data-driven decision-making and sustainable livestock management through IoT-based automation and monitoring.

Keywords: IoT, Automation, Poultry Farm, Microcontroller, Sensors, Cloud Monitoring, Smart Agriculture, Temperature and Humidity Control

I INTRODUCTION

Poultry farming plays a vital role in global food production, providing a major source of protein through eggs and meat. With the rapid increase in demand for poultry products, modern farms face significant challenges related to maintaining environmental stability, ensuring bird health, and optimizing production efficiency. Traditional poultry management heavily relies on manual labor for feeding, watering, temperature regulation, and disease monitoring, which can be inefficient, time-consuming, and prone to human error. Moreover, fluctuating environmental conditions such as temperature, humidity, and air quality directly affect the health and productivity of poultry. Therefore, the need for intelligent and automated monitoring systems in poultry farms has become increasingly important.

The integration of the Internet of Things (IoT) into poultry farming offers a transformative solution to these challenges. IoT technology enables real-time data acquisition, transmission, and analysis from multiple sensors installed in the farm environment. These sensors continuously monitor key parameters such as temperature, humidity, ammonia gas concentration, light intensity, feed and water levels, and bird movement patterns. Data collected from the sensors are transmitted to a cloud-based platform or local server, where it is processed and visualized for farmers through mobile or web applications. This continuous data flow allows for real-time monitoring and automated control of farm conditions, thereby minimizing human involvement while maximizing accuracy and consistency.

In a Smart Poultry Farm Automation and Monitoring System, various components work together to maintain optimal conditions. Microcontrollers such as STM32, Arduino, or ESP32 are commonly used as the core processing units, interfacing with temperature and humidity sensors (like DHT22), gas sensors (MQ-series), light sensors (LDR), and ultrasonic sensors for feed-level detection. Based on sensor readings, the system automatically triggers actuators such as fans, heaters, humidifiers, feeders, and lighting systems to stabilize the environment. Cloud-based platforms and wireless communication protocols, such as Wi-Fi or LoRa, ensure remote accessibility and data storage for trend analysis and decision support. Farmers receive alerts in case of abnormal conditions, such as excessive temperature or gas levels, enabling timely intervention and reducing the risk of disease outbreaks or mortality.

II LITERATURE SURVEY

The integration of automation and Internet of Things (IoT) technologies in poultry farming has been the focus of numerous research efforts in recent years. Several studies have explored different aspects of environmental monitoring, system automation, and intelligent data management to enhance poultry health, productivity, and operational efficiency.

According to Rupali B. Mahale and Dr. S. S. Sonavane (2016), traditional poultry farming can be improved using IoT and embedded technology. The proposed smart system monitors and controls key environmental factors such as temperature, humidity, air quality, and lighting through wireless sensors. This allows farmers to supervise and manage their farms remotely, reducing time, labor, and costs.[1]

According to Tran Ngoc Son, Le Thi Hoan, Nguyen Cao Cuong, Pham Van Minh, and Roan Van Hoa (2020), the IoT-based poultry farm monitoring system successfully helps farmers manage and control farm conditions remotely. It allows continuous observation of temperature, humidity, and chicken activity through sensors and cameras, while also automating light control to maintain the right temperature in the barn. The system provides alerts when someone enters the poultry area, improving security and hygiene. Because it uses low-cost electronic components, this solution is practical and affordable for small and large farms. Overall, it makes poultry management easier, safer, and more efficient, ensuring healthier livestock and better productivity. large-scale deployment or long-term stability under real farm conditions.[2]

conclusion, according to Rakhee Patil, Vandana K., Mekala Anusha, Rajarajeshwari M., Ramya G., and published in

August 2020, is that this automated system is highly beneficial for farmers. The system allows farmers to easily access and control the system remotely using their handheld mobile devices. Furthermore, it saves time, optimizes resource utilization, and increases poultry production. The authors suggest that in the future, by using more advanced sensors and technological concepts, all environmental output data could be collected in a more reliable state. This advancement, they conclude, will enable anyone with minimum farming knowledge to start a poultry business, which will hugely benefit the future demand for chicken-meat and the economic growth of any nation. [3]

R. Sasirekha and her colleagues, in their 2023 paper, conclude that the Smart Poultry House Monitor is a reliable and effective Internet of Things (IoT)-based technology that enables temperature, water, and humidity monitoring from a smartphone. The system is an effective solution for automating the opening and closing of chicken coop doors, providing convenience and safety for the chickens while reducing the farmer's workload. It is also environmentally friendly. Future enhancements suggested include implementing an emergency shutdown for hazards, using enhanced feeding techniques, and improving the range of the sensors. Ultimately, the technology has the potential to be used to monitor any controlled environment and is expected to become an increasingly important tool for the poultry industry.[4]

Kale et al. (2024) developed an IoT-based smart poultry farm monitoring and controlling system utilizing a dual-controller architecture to automate farm management. The system employs an Arduino Uno to gather real-time environmental data—including temperature, humidity, brightness, and air quality—from sensors such as the DHT11 and MQ-135. The system supports both automatic and manual control modes, allowing the Raspberry Pi to regulate devices like fans and lights via relays to maintain optimal environmental conditions within the poultry farm. This integration enables remote management and provides real-time information and alerts via a user-friendly webpage accessible on various devices like computers and smartphones, ultimately enhancing efficiency, reducing costs, and improving the overall well-being and productivity of the poultry.[5]

Authors and Publication: S. T. Naphade and S. G. Badhe published this study in 2021 in the Journal of Scientific Research, Volume 65, Issue 6. The researchers found that technology-driven poultry farming clearly outperforms traditional methods. Their comparison across Aurangabad district farms showed that automated systems create healthier birds and more efficient operations. The authors believe smart management isn't just beneficial—it's becoming

necessary for the industry's future. Farmers who adopt digital monitoring and control technologies will see better production outcomes while reducing waste and labor costs. Essentially, they're arguing that modernization through automation is the path forward for sustainable and profitable poultry farming.[6]

III PROPOSED METHODOLOGY

The proposed system aims to develop an **IoT-based Smart Poultry Farm Automation and Monitoring framework** that ensures optimal environmental conditions, automates feeding and watering, and provides real-time monitoring through cloud integration. The methodology combines embedded hardware, sensor networks, and data analytics to achieve intelligent, efficient, and reliable farm management.

A. System Overview

The system integrates environmental sensors, actuators, a microcontroller (e.g., STM32/ESP32), and a cloud-based monitoring platform. Sensors continuously measure parameters such as temperature, humidity, light intensity, and ammonia gas concentration. Based on these readings, the controller automatically adjusts farm equipment like fans, heaters, and feeders to maintain ideal living conditions for poultry.

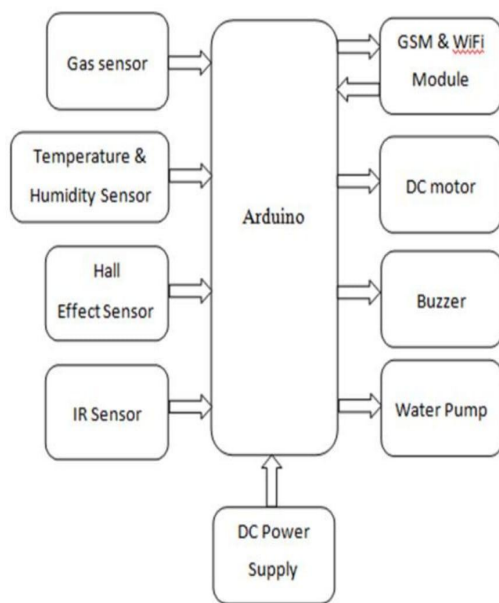


Fig.1. block diagram of smart poultry farm

B. Hardware Architecture

Key Components:

- **Microcontroller Unit:** STM32 or ESP32 board serves as the system's control center, processing sensor data and executing control logic.

• Sensors:

- DHT22 or SHT31 for temperature and humidity measurement.
- MQ-135 for ammonia gas detection.
- LDR for light intensity monitoring.
- Ultrasonic sensor for feed/water level detection.

• Actuators:

- DC fans and heaters for temperature control.
- Servo or motorized feeders for automatic feeding.
- Water pumps for drinker refilling.

- **Power Supply:** Solar or battery backup ensures continuous operation in case of power failure.

C. Software Architecture

Key Steps

1. **Sensor Data Acquisition:** Sensors periodically collect real-time environmental and feeding parameters.
2. **Data Processing:** The microcontroller filters, calibrates, and analyzes the sensor data using embedded algorithms.
3. **Decision-Making Logic:** Based on predefined thresholds or adaptive control algorithms, the system automatically activates the corresponding actuators (fan, heater, feeder, etc.).
4. **Data Transmission:** Processed data are transmitted via Wi-Fi (ESP8266/ESP32) to a cloud platform such as Firebase or ThingSpeak for remote monitoring.
5. **User Interface:** A mobile or web dashboard displays live data, historical trends, and system alerts for farmers to make timely decisions.

D. Cloud Integration and Data Analytics

All collected data are uploaded to the cloud for storage and analysis. The system supports:

- **Real-Time Visualization:** Displays temperature, humidity, feed level, and air quality in an interactive dashboard.
- **Historical Data Logging:** Enables performance tracking and analysis of poultry growth patterns.
- **Alert and Notification System:** Sends SMS or app notifications when parameters exceed safe limits.

E. Communication Protocols

The system employs **MQTT** or **HTTP** protocols for efficient and secure communication between the microcontroller and the cloud platform. Data packets are optimized to reduce latency and bandwidth usage.

F. System Advantages

- **Fully Automated:** Reduces manual labor through automatic control of feeding, ventilation, and temperature.
- **Real-Time Monitoring:** Cloud-based access allows farmers to monitor the farm remotely from any device.
- **Scalability:** Modular design supports easy expansion for multiple poultry sheds.
- **Cost-Effective:** Uses low-power microcontrollers and affordable sensors.
- **Sustainability:** Supports renewable power and data-driven efficiency optimization.

G. Flow of Operation

1. Sensors collect data from the poultry environment.
2. Microcontroller processes and compares values with standard thresholds.
3. Appropriate actuators are triggered to maintain ideal conditions.
4. Data and control logs are sent to the cloud for visualization and storage.
5. Farmers receive alerts for abnormal conditions or system faults.

IV APPLICATIONS

The proposed Smart Poultry Farm Automation and Monitoring system has numerous applications in modern agricultural and livestock management. One of its primary applications is in maintaining optimal living conditions within poultry farms by automatically controlling temperature, humidity, ventilation, and lighting. Through continuous environmental monitoring, the system ensures that poultry are kept under ideal conditions, which leads to improved growth rates, enhanced egg production, and reduced mortality. The integration of IoT technology enables farmers to observe and manage these parameters remotely, eliminating the need for constant on-site supervision and thereby saving time and labor costs.

Another significant application of this system lies in the automation of feeding and watering processes. By monitoring feed and water levels in real time, the system can automatically activate dispensers when necessary, ensuring that poultry always have adequate nutrition and hydration. This minimizes wastage, prevents feed spoilage, and reduces the chances of human error. Additionally, the automation of these critical functions supports large-scale poultry operations, where manual management becomes difficult and inefficient.

The system also finds application in data-driven decision-making for farm management. Continuous data collection from sensors allows for trend analysis and performance evaluation of poultry over time. Farmers can utilize these insights to optimize feeding schedules, improve energy efficiency, and identify early signs of environmental stress or disease outbreaks. The inclusion of cloud-based data storage ensures that historical data can be easily accessed and analyzed for future planning and productivity improvement.

Furthermore, the system contributes to biosecurity and animal welfare management. Real-time alerts notify farmers of abnormal environmental conditions, such as excessive ammonia levels or sudden temperature fluctuations, which may endanger the birds. Early detection and automated responses prevent potential health risks and economic losses. In addition, integrating surveillance cameras and health-monitoring sensors extends the application of the system to behavioral analysis, allowing the detection of unusual movement patterns or reduced activity that could indicate illness.

In addition to large commercial poultry houses, this system can also be applied in small and medium-scale farms due to its cost-effective design and scalability. The use of affordable IoT components and renewable energy options makes it suitable for rural areas with limited technical infrastructure.

V CONCLUSION

The implementation of Smart Poultry Farm Automation and Monitoring systems represents a significant advancement in modern agricultural technology. Through the integration of Internet of Things (IoT), embedded systems, and cloud computing, poultry farming can be transformed from a labor-intensive, manually managed process into an intelligent, data-driven operation. The proposed system effectively automates essential farm functions such as temperature and humidity regulation, feed and water distribution, and environmental monitoring, ensuring that poultry are raised in optimal conditions with minimal human intervention.

This study has demonstrated that automation not only reduces the dependency on manual labor but also increases operational accuracy, consistency, and efficiency. By employing IoT-based sensors and microcontrollers, real-time data can be continuously collected and analyzed, providing farmers with valuable insights into farm performance. The ability to remotely monitor and control the environment through cloud platforms and mobile applications enhances decision-making and enables timely responses to potential hazards such as temperature fluctuations, gas build-up, or feed shortages. This approach contributes directly to improving poultry welfare, maximizing productivity, and

minimizing losses caused by environmental or management issues.

In addition to its technical benefits, the system contributes to the broader goals of sustainable agriculture and food security. By improving efficiency and reducing resource wastage, it supports environmentally responsible farming. Furthermore, real-time health and environmental monitoring aligns with the growing emphasis on animal welfare and quality assurance in food production. As the global demand for poultry products continues to rise, such intelligent systems will be vital for meeting production needs while maintaining ethical and sustainable practices.

In conclusion, the Smart Poultry Farm Automation and Monitoring system provides a comprehensive, reliable, and efficient solution for modernizing poultry management. It bridges the gap between traditional farming and digital agriculture by leveraging IoT, automation, and data analytics to create a connected, intelligent farming environment. Future work can focus on integrating advanced artificial intelligence algorithms for disease prediction, behavior analysis, and energy optimization, further enhancing the system's performance. Ultimately, the adoption of such technologies will play a crucial role in building resilient, productive, and sustainable poultry farming systems for the future.

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