IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, May 2026
Impact Factor: 8.2

Smart IoT-Based Poultry Farm Monitoring with AI-Based Disease Detection

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Abstract: *Poultry farming is an important part of agriculture, but traditional methods have many problems. Farmers usually depend on manual checking, which takes a lot of time and is not always accurate. They cannot constantly monitor the farm, and this can lead to issues like sudden temperature changes, high humidity, and harmful gases such as ammonia. These conditions can harm the birds, increase death rates, and cause financial losses. Also, diseases can spread very quickly in poultry farms, and without early detection, they become hard to control. To solve these problems, this project introduces a smart poultry farm monitoring system using IoT (Internet of Things) and AI (Artificial Intelligence). The system uses sensors to continuously check important factors like temperature, humidity, gas levels, and water availability. These sensors are connected to an ESP32 microcontroller, which sends the data to the cloud so farmers can monitor everything in real time. A camera is also used to capture images of the birds. AI analyzes these images to detect early signs of disease or unusual behavior. If anything abnormal is found, the system immediately sends an alert to the farmer. It can also automatically control equipment like fans, heaters, and water pumps to maintain a healthy environment inside the farm. Overall, this system makes poultry farming easier and more efficient. It reduces manual work, allows real-time monitoring, and helps detect diseases early. This leads to healthier birds, lower death rates, and higher productivity. It is a smart, affordable, and sustainable solution for modern poultry farming.*

Keywords: Smart poultry farming, IoT system, Artificial Intelligence, real-time monitoring, disease detection in birds, ESP32 controller, cloud monitoring, temperature and humidity control, gas level monitoring, farm automation, sensors, early disease detection, poultry health, mobile alerts

I. INTRODUCTION

Poultry farming is an important part of agriculture, as it provides a large portion of the world's meat and eggs. With the growing population, the demand for poultry products is increasing quickly. Because of this, farmers need to use modern technology to improve productivity and manage farms more efficiently. However, traditional poultry farming mostly depends on manual work for feeding, checking the environment, and monitoring bird health. This takes a lot of effort and can lead to mistakes, which may cause poor management and financial losses.

Keeping the farm environment stable and healthy is very important for the birds' growth and well-being. Things like temperature, humidity, air quality, lighting, and cleanliness have a direct impact on their health and productivity. Even small changes in these conditions can stress the birds, weaken their immunity, and increase the chances of disease.

In traditional systems, farmers usually notice diseases only after clear symptoms appear. By that time, the disease may have already spread, leading to high death rates and making it difficult to control infections among the birds. To solve these problems, modern poultry farming is now using technologies like IoT (Internet of Things) and AI (Artificial Intelligence). IoT helps by using sensors to monitor farm conditions in real time, while AI helps analyze the data and make smart decisions. Together, these technologies can turn a traditional poultry farm into a smart system that can automatically control conditions and detect diseases early.

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DOI: 10.48175/IJARSCT-34720

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In this system, sensors are used to continuously check important factors like temperature, humidity, and gas levels. At the same time, a camera captures images of the birds. These images are analyzed using AI, specifically a method called Convolutional Neural Networks (CNN), to identify signs of disease based on how the birds look and behave. By combining sensor data and image analysis, the system can detect diseases more accurately.

All the collected data is stored and analyzed on a cloud platform. Farmers can access this information anytime through a mobile app or website. If any abnormal condition or possible disease is detected, the system sends instant alerts. This reduces the need for constant manual checking and helps farmers take action quickly, preventing losses and improving productivity.

The main goal of this project is to create a smart poultry monitoring system that automates farm operations and improves disease detection using AI. This helps farmers maintain better control over farm conditions, keep their poultry healthy, and increase overall production. It is a step toward smart agriculture, where technology makes farming more efficient and sustainable.

II. LITERATURE SURVEY

In recent years, poultry farming has seen a major shift from traditional practices to smart and technology-driven systems. This change is mainly due to the increasing demand for poultry products and the need to improve efficiency, reduce losses, and ensure better animal health. Researchers across the world have explored the use of modern technologies such as IoT (Internet of Things), Artificial Intelligence (AI), machine learning, and computer vision to make poultry farming more intelligent and automated.

Many studies show that IoT plays a key role in smart farming by enabling real-time monitoring of environmental conditions like temperature, humidity, air quality, and feed levels. These systems use sensors to collect continuous data, which helps farmers maintain a healthy environment for poultry. At the same time, AI techniques are used to analyze this data, detect patterns, and predict potential problems such as diseases or abnormal behavior. According to recent research, the use of AI in animal farming has increased significantly after 2016, especially in areas like behavior detection, disease monitoring, and productivity improvement .

A study by R. Singh et al. (2020) proposed an IoT-based monitoring system that focuses on maintaining proper environmental conditions inside poultry farms. The system uses sensors such as DHT11 for temperature and gas sensors for air quality, connected to a microcontroller for real-time data transmission. While this system helps in monitoring farm conditions effectively, it does not include automation or intelligent decision-making. This means farmers still need to manually take action based on the data, which limits its efficiency.[1]

Ahmed and Khan (2021) introduced a system that uses GSM technology to send SMS alerts to farmers when abnormal conditions are detected. This improves response time and helps farmers take quick action. However, the system still depends heavily on human intervention and lacks automatic control mechanisms. Additionally, it uses a limited number of sensors, so it cannot provide a complete picture of farm conditions.[2]

Li et al. (2022) focused on automating environmental control in poultry farms, especially in broiler houses. Their system automatically controls fans and ventilation based on temperature levels. This reduces the need for constant monitoring and helps maintain a stable environment. However, the system is limited to temperature control and does not include advanced features like disease detection, feeding automation, or intelligent analysis.[3]

Patil and More (2023) developed a feed monitoring system using IoT technology. It uses load cell sensors to measure feed levels and sends updates to a mobile application. This helps farmers manage feed efficiently and avoid wastage. While useful, the system only focuses on one aspect (feed management) and does not consider other important parameters like environmental conditions or poultry health.[4]

Sharma et al. (2024) proposed an AI-based disease prediction model that uses machine learning algorithms to analyze environmental data and predict possible disease outbreaks. This approach improves early detection and helps in taking preventive measures. However, the system is not connected to real-time hardware or automation systems, so it cannot directly control farm conditions or respond automatically.[5]

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More advanced research combines IoT with computer vision to improve poultry monitoring. For example, recent systems use cameras to observe bird behavior and detect abnormalities such as reduced movement, unusual posture, or feeding issues. These systems apply deep learning models like CNNs to analyze images and identify early signs of disease. Such approaches are more accurate because they consider both environmental data and visual information .

In addition, a comprehensive review of smart poultry farming technologies highlights that modern systems use multiple technologies together, including IoT sensors, AI models, cloud computing, and even sound analysis. These systems can monitor bird health, detect diseases early, estimate weight, and analyze feeding behavior. As a result, they reduce manual work and improve productivity and farm profitability.

Recent studies also show that AI-based poultry farming systems focus mainly on improving animal welfare, increasing production efficiency, and reducing costs. Many systems use computer vision and machine learning to monitor bird health and behaviour continuously. However, most of these solutions are still in the experimental stage and face challenges such as high cost, lack of integration, and limited real-world implementation. .

III. SYSTEM ARCHITECTURE

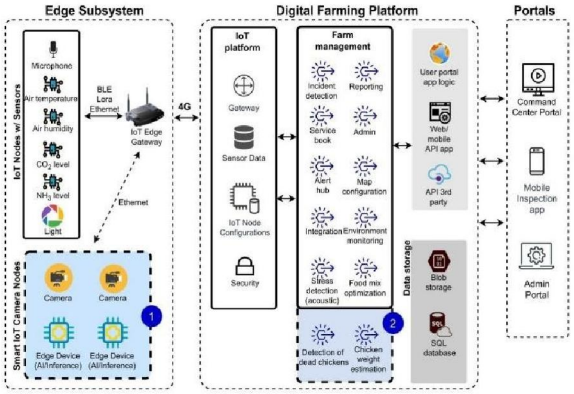

Fig.1. System Architecture

The proposed system, called “Smart IoT-Based Poultry Farm Monitoring with AI Disease Detection,” is designed in different layers to work smoothly and efficiently.

First, in the sensing layer, sensors are used to collect real-time data such as temperature, humidity, and harmful gas levels inside the poultry farm. This helps in continuously keeping track of the farm environment. Next, in the processing layer, a microcontroller like Arduino or ESP32 processes the data collected from the sensors. At the same time, a camera captures images of the birds, which are also sent for further analysis. In the communication layer, all this data is transmitted to the cloud using technologies like Wi-Fi or GSM. This allows the system to store and access data from anywhere. Then comes the cloud and AI layer, where the collected data and images are analyzed using machine learning techniques. This helps in detecting diseases early and identifying any abnormal conditions in the farm. Finally, in the application layer, farmers can use a mobile app or web interface to monitor the farm in real time. They can receive alerts if something goes wrong and can also control devices like fans, heaters, or water systems remotely.

Overall, this layered design makes the system organized, efficient, and easy to manage.

A. Working Principle

The proposed system works by continuously monitoring the poultry farm, analyzing the data, and taking automatic actions when needed. Sensors are used to regularly check important conditions like temperature, humidity, and gas levels inside the farm. This data is processed by a controller such as Arduino or ESP32. If any of these values go beyond the safe limit, the system treats it as a warning.

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At the same time, a camera captures images of the birds. These images are analyzed using AI techniques to detect early signs of disease. All the collected data is then sent to a cloud platform using Wi-Fi or GSM, where farmers can view it through a mobile app or web interface.

If the system detects any abnormal condition, it immediately sends an alert to the farmer. It can also automatically control devices like fans or heaters to bring the environment back to normal.

B. System Modules

The proposed system, "Smart IoT-Based Poultry Farm Monitoring with AI Disease Detection," is divided into different modules which helps the system work smoothly and intelligently.

1. Sensor Module

This module includes sensors that measure temperature, humidity, and harmful gases inside the poultry farm. These sensors continuously collect real-time data, which is very important for maintaining a healthy environment for the birds.

2. Data Processing Module

In this module, a microcontroller like Arduino or ESP32 receives data from the sensors. It processes the data and compares it with preset safe limits. If the values are normal, the system continues monitoring. If not, it identifies the situation as abnormal.

3. Communication Module

This module is responsible for sending data from the microcontroller to the cloud. It uses technologies like Wi-Fi or GSM, allowing the system to transfer data in real time and enabling farmers to monitor the farm from anywhere.

4. Cloud Storage and Management Module

All the collected data is stored on a cloud platform or database in this module. It keeps both real-time and past data secure and organized, so farmers can easily access it whenever needed for monitoring or analysis.

5. AI Disease Detection Module

This module uses a camera and AI techniques like machine learning or deep learning. It analyzes images or videos of the birds to detect early signs of diseases by observing unusual behavior or physical changes.

6. User Interface Module

This module provides a mobile app or web dashboard for the farmer. It displays real-time data, alerts, and reports in an easy- to-understand format. Farmers can monitor and even control the system remotely using this interface.

7. Alert and Notification Module

Whenever the system detects any abnormal condition—such as high temperature or signs of disease—this module sends instant alerts to the farmer through a mobile app or SMS. This helps in quick action.

C. Hardware And Software Description

The system uses the following hardware components to work properly:

1. Microcontroller (Arduino/ESP32)

This is the main control unit of the system. It receives data from sensors, processes it, and controls other components.

2. DHT11 Sensor

This sensor measures temperature and humidity inside the poultry farm, which are important for maintaining a healthy environment.

3. MQ135 Sensor

This sensor detects harmful gases like ammonia in the air, helping to monitor air quality inside the farm.

4. Camera Module

The camera captures images of the poultry birds. These images are later used for detecting diseases using AI.

5. Wi-Fi/GSM Module

This module sends the collected data to the cloud, allowing farmers to monitor the farm remotely.

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6. Relay Module

The relay module is used to control electrical devices like fans and heaters by turning them ON or OFF automatically.

7. Fan/Heater

These devices help maintain proper temperature and ventilation inside the poultry farm.

8. Power Supply

This provides the required electrical power for all the components in the system.

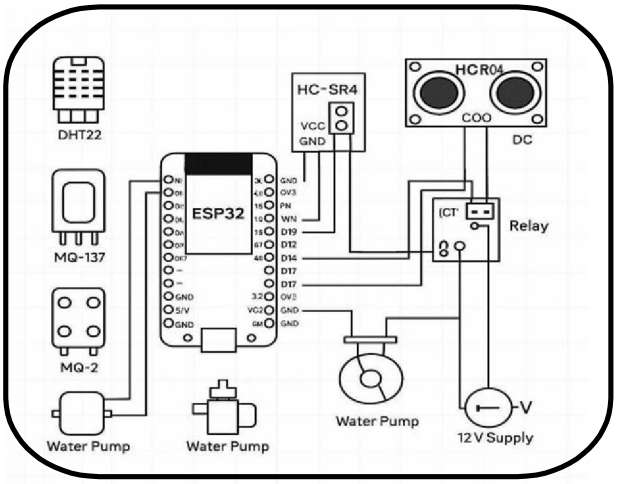

Fig.2. Hardware Circuit

The system uses the following software components:

1. Arduino IDE

This software is used to write and upload code to the microcontroller (Arduino/ESP32). It controls how the hardware components work.

2. Cloud Platform

The cloud platform is used to store all the collected data from sensors and the system. It also helps in accessing data from anywhere in real time.

3. Web Dashboard

This is a user interface that displays live data, alerts, and system status in an easy-to-understand format for the farmer.

4. AI/ML Algorithms

These algorithms are used to analyze images and data to detect diseases and identify abnormal conditions in poultry birds.

5. Database

The database stores all historical and real-time records of sensor readings, alerts, and analysis results for future reference.

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DOI: 10.48175/IJARSCT-34720

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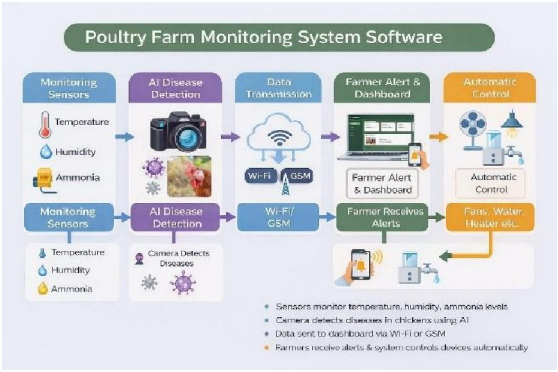

Fig.3. Monitoring System Software

The disease detection process in the proposed system starts with a camera placed inside the poultry farm. This camera continuously captures images of the birds, which are used as the main input for detecting diseases.

Before analysis, these images are first processed to improve their quality. This step is important because real-world images may have noise, poor lighting, or unnecessary background objects. During preprocessing, the images are resized to a fixed size, pixel values are adjusted for consistency, and noise is reduced to make the images clearer and more suitable for analysis.

After this, the processed images are sent to a deep learning model, usually a Convolutional Neural Network (CNN). This model automatically learns and extracts important features from the images, such as shape, texture, and visual patterns. Unlike traditional methods, CNN does not require manual feature selection, which makes it more accurate and efficient. The extracted features are then used to classify the bird's condition. The system decides whether the bird is healthy or showing signs of disease. In more advanced systems, it can also identify different types of diseases based on the training data. If any disease or abnormal condition is detected, the system immediately sends an alert to the farmer through a mobile app or SMS so that quick action can be taken. The images, results, and predictions are also stored in a cloud database for future use and analysis.

In addition, the system can be improved further by adding suggestions or recommendations for treatment and prevention based on the detected disease. This makes the system smarter over time and helps in better decision-making for poultry farm management.

D. System Advantages

• Real-Time Monitoring

The system continuously checks temperature, humidity, and gas levels to maintain a healthy environment for the birds at all times.

• Early Disease Detection

AI-based image analysis helps detect diseases at an early stage, which reduces bird mortality and improves overall health.

• Automation of Farm Operations

Devices like fans, heaters, and water systems are controlled automatically, reducing the need for manual work.

• Remote Access and Control

Farmers can easily monitor and control the poultry farm from anywhere using a mobile app or web dashboard.

• Improved Productivity

By maintaining ideal environmental conditions, the system helps improve bird growth, egg production, and overall farm output.

• Reduced Labor Cost

Since many tasks are automated, the need for continuous human supervision is reduced, saving both time and money.

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• Instant Alerts and Notifications
The system immediately sends alerts when it detects any abnormal condition or disease, allowing quick response.
• Data Storage and Analysis
All data is stored in the cloud, which helps farmers analyze past records and make better decisions in the future.
• Scalable and Flexible System
The system can be easily expanded by adding more sensors or improving AI features when needed.
• Enhanced Farm Safety
Continuous monitoring of harmful gases like ammonia helps ensure a safe environment for both birds and farm workers.

IV. APPLICATIONS

The proposed smart IoT-based poultry farm system with AI disease detection can be used in many areas of modern farming.

It can be easily implemented in large commercial poultry farms to maintain proper environmental conditions and improve productivity through continuous monitoring and automation. It is also very useful for small and medium farmers, as it reduces manual work and helps manage farm activities more efficiently even with limited resources. The system plays an important role in disease detection and prevention. By using AI, it can identify early signs of diseases, which helps prevent large outbreaks and reduces financial losses for farmers. It can also be connected with smart agriculture systems, where different farming activities are controlled and monitored using advanced technologies. This makes farming more organized and technology-driven.

In addition, the system is useful for research and educational purposes. Researchers and students can use the collected real- time data to study poultry behavior, environmental effects, and disease patterns. Veterinary doctors can also benefit from this system, as it provides accurate data and alerts that help in faster diagnosis and better treatment of diseases.

Furthermore, the system can support fully automated farm management, including control of feeding, watering, ventilation, and lighting without constant human supervision. It also allows remote monitoring, so farmers or authorities can manage multiple farms from one place.

Overall, this system helps make poultry farming more efficient, smart, and sustainable by using data and technology effectively.

V. CONCLUSION

The proposed system, “Smart IoT-Based Poultry Farm Monitoring with AI Disease Detection,” provides an efficient and smart way to manage modern poultry farms. It combines IoT-based monitoring with AI-based disease detection to continuously check farm conditions and identify health problems at an early stage. This helps reduce manual work and supports faster and better decision-making. The system also uses automation to control devices like fans, heaters, and water supply based on real-time sensor data. This ensures that the poultry birds always stay in a healthy and suitable environment. In addition, farmers can monitor and control the farm remotely using a mobile app or web application, making farm management more flexible and convenient.

Overall, this system helps improve productivity, reduce losses, and maintain better animal health. It is a reliable and scalable solution for smart poultry farming and can be further improved in the future by using more advanced AI models and additional sensors.

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