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IoT Based Poultry Farm Monitoring and Disease Detection System

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Abstract: ***The "IoT Based Poultry Monitoring and Disease Detection System" is an innovative and intelligent solution designed to enhance poultry farm monitoring through the integration of IoT (Internet of Things), robotics, and wireless communication technologies. This project introduces a Raspberry Pi-based robotic surveillance unit that moves autonomously under the poultry area to monitor bird health and environmental conditions. Traditional poultry farms rely heavily on manual inspection and human supervision, which are time-consuming, labour-intensive, and prone to human error.***
To overcome these limitations, the proposed system employs a mobile robot equipped with multiple. In addition to visual monitoring, the system is capable of detecting harmful gases, such as ammonia (NH_3) and carbon dioxide (CO_2), which often accumulate in closed poultry environments and pose serious health risks to the birds. A gas sensor installed on the robot continuously measures air quality, and when gas exceed safe limits, the system automatically triggers an alert.
All collected data, including gas readings, disease alerts, and camera feed information, is transferred from the poultry area to the main monitoring room using LoRa (Long Range) communication, ensuring efficient and reliable data transmission over long distances with minimal power consumption. The ESP32 module assists in data communication and interface control for peripheral devices, while a 16×2 LCD display shows real-time data locally.
Furthermore, the Raspberry Pi acts as the central processing and control unit, hosting a web-based dashboard that displays live video, gas level graphs, and disease detection alerts. This enables remote access from any device connected to the internet, providing farm owners with a comprehensive, real-time overview of their poultry environment.
Keywords: IoT, ESP32, Raspberry Pi, LoRa, UART, MQTT, Artificial Intelligence, Real-Time Monitoring, Disease Detection.

I. INTRODUCTION

The poultry industry plays a crucial role in the global agricultural economy, providing a consistent source of food and livelihood to millions of farmers worldwide. However, maintaining poultry health and maximizing productivity requires continuous monitoring of both environmental and biological factors within poultry houses. Traditional poultry management practices largely depend on manual observation, where farm workers physically inspect birds, check temperature and humidity, and ensure cleanliness. Such manual approaches are time-consuming, labour-intensive, and prone to human error, often leading to delayed detection of diseases and environmental hazards. This lack of timely intervention can result in disease outbreaks, reduced productivity, and significant economic losses.

With the rising need for automation and smart farming, researchers have focused on developing intelligent, technology-driven poultry monitoring systems. Several studies have demonstrated the potential of IoT-based environmental sensing and real-time data visualization for poultry welfare and farm optimization. However, many existing systems rely on fixed sensor networks that cannot adaptively monitor dynamic farm conditions or provide close-range visual inspection of birds.

To overcome these limitations, the Smart Poultry Management System proposed in this work integrates Raspberry Pi computing, robotic automation, and IoT-based wireless communication to create a fully automated and self-sufficient poultry monitoring environment. The system employs a mobile robotic unit that navigates autonomously beneath poultry sheds using DC motors controlled through a motor driver. The robot's movement is guided by IR sensors for line following and ultrasonic sensors for obstacle detection, ensuring smooth navigation and collision avoidance. A Raspberry Pi camera module mounted on the robot captures real-time video of the poultry environment. The video stream is transmitted to a surveillance control room, where farm managers can monitor flock behaviour and detect diseased birds using visual pattern recognition techniques, similar to the robotics-based approach discussed earlier.

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II. PROBLEM STATEMENT

Traditional poultry farms require continuous manual monitoring of environmental conditions and bird health. Delayed detection of diseases, improper temperature control, and poor air quality can lead to high bird mortality, reduced productivity, and economic losses. Farmers need an affordable and automated solutions that can continuously monitor poultry farm conditions and provide early warnings during abnormal situations.

III. OBJECTIVES

The main objective of this project is to develop a Smart Poultry Management System that integrates Raspberry Pi, robotic surveillance, and LoRa communication to automate poultry monitoring. The system will be capable of detecting diseased birds, monitoring harmful gases, and providing real-time live video streaming and environmental data visualization through a web-based dashboard, ensuring improved poultry health management with minimal human intervention.

1) Development of an Autonomous Robotic Monitoring Unit:

To design and develop a Raspberry Pi-based robotic platform capable of autonomous navigation inside poultry sheds using IR and ultrasonic sensors for smooth movement and obstacle detection.

2) Implementation of Visual Surveillance for Disease Detection:

To integrate a Raspberry Pi camera module to capture and transmit live video streams for real-time observation and detection of diseased or inactive birds, enabling remote monitoring through a web interface.

3) Environmental Sensing and Air Quality Monitoring:

To deploy gas sensors (MQ-135/MQ-137) and a DHT22 sensor to continuously measure and monitor harmful gases such as ammonia (NH_3), methane (CH_4), and carbon dioxide (CO_2), along with temperature and humidity levels, ensuring a healthy poultry environment.

4) Long-Range Communication and Real-Time Data Alert:

To employ LoRa (Long Range) communication technology for efficient, low-power, longdistance data transfer between the robotic unit and the control room, and to develop a web-based dashboard that displays live video feeds, gas level graphs, and automated alert notifications. Additionally, to display real-time sensor readings and robot status locally on a 16×2 LCD display for on-site monitoring.

IV. LITERATURE SURVEY

Various commercial manufacturers and agricultural technology providers such as SKOV, Big Dutchman, Munters, and V-Tech Argo have developed Environmentally Controlled (EC) Poultry Shed Systems that automate climate regulation and ventilation in modern poultry farm [3].

1) Objectives:

Environmentally Controlled (EC) poultry sheds aim to provide an optimal environment for poultry by automatically regulating temperature, humidity, ventilation, and airflow. These systems use industrial controllers, cooling pads, exhaust fans, and fixed environmental sensors to ensure that the birds grow in stable climatic conditions. The main objective of EC sheds is to maximize bird productivity, reduce heat stress, and maintain uniform temperature across the poultry house. They rely on exhaust fans, foggers, cooling pads, and air inlets to manage airflow and cooling, thereby improving feed conversion ratio (FCR) and reducing mortality. EC sheds continuously monitor environmental variables, but they primarily focus on climate control and do not incorporate bird health surveillance or Realtime gas detection. Their aim is limited to providing controlled environmental conditions rather than detecting disease or monitoring flock behaviour.

2) Outcomes:

EC poultry systems successfully maintain controlled environmental conditions using fixed sensors and automated mechanisms. They achieve stable temperature and humidity levels even during extreme weather and reduce heat-related bird mortality significantly. The automated controllers respond to changes in temperature by adjusting fan speeds or activating cooling pads. These systems improve overall poultry growth rate and ensure uniformity in bird weight. Many EC systems also include data loggers that allow farmers to check historical temperature trends. However, their functionality is limited to climate regulation. They cannot identify localized gas buildup, detect diseased birds, or provide 9 visual surveillances. Their fixed sensors cannot inspect every corner of the shed, leaving blind spots that may contain ammonia pockets or sick birds.

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3) Research Gap:

Despite providing efficient climate control, EC poultry systems exhibit several shortcomings:

- Lack of Disease Detection: EC systems cannot detect sick, inactive, or injured birds since they do not include cameras or behavioural monitoring.
- No Gas Monitoring: They do not measure ammonia (NH_3), methane (CH_4), or CO_2 levels, which are critical for preventing respiratory issues.
- Fixed Sensor Limitations: Since sensors are stationary, they fail to capture localized environmental variations or hotspots within the shed.
- High Installation and Maintenance Cost: EC sheds require expensive industrial hardware, making them unaffordable for small farmers.
- Dependency on Stable Power and Internet: Most EC controllers depend on uninterrupted electricity and Wi-Fi/GSM, which is unreliable in rural areas.



Fig. 1. Modern EC Sheds

V. SYSTEM ARCHITECHTURE

Block Diagrams of System:

1) Functional Block Diagram: The functional block diagram of the system consist of how the system's functionality work when it fully integrate with other modules like different sensors, controllers, and web application

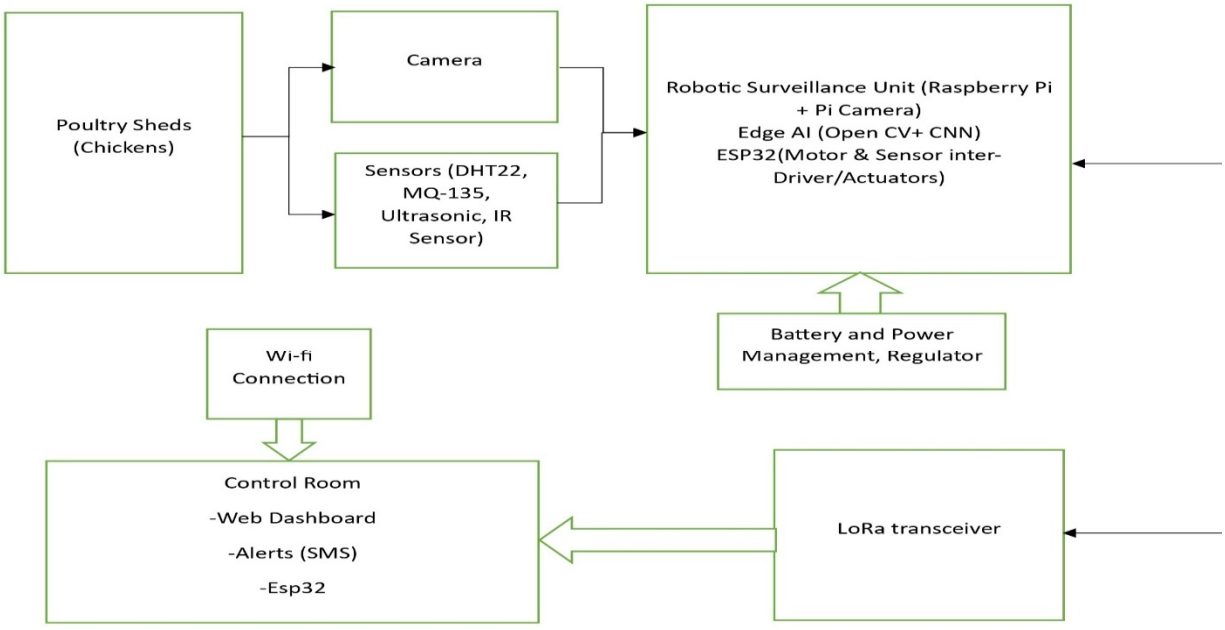


Fig. 2. Functional Block Diagram of System

2) Visual Block Diagram: The visual block diagram of the system shows the exact integration of all the modules like different sensors, cameras, actuators, microcontrollers with each other.

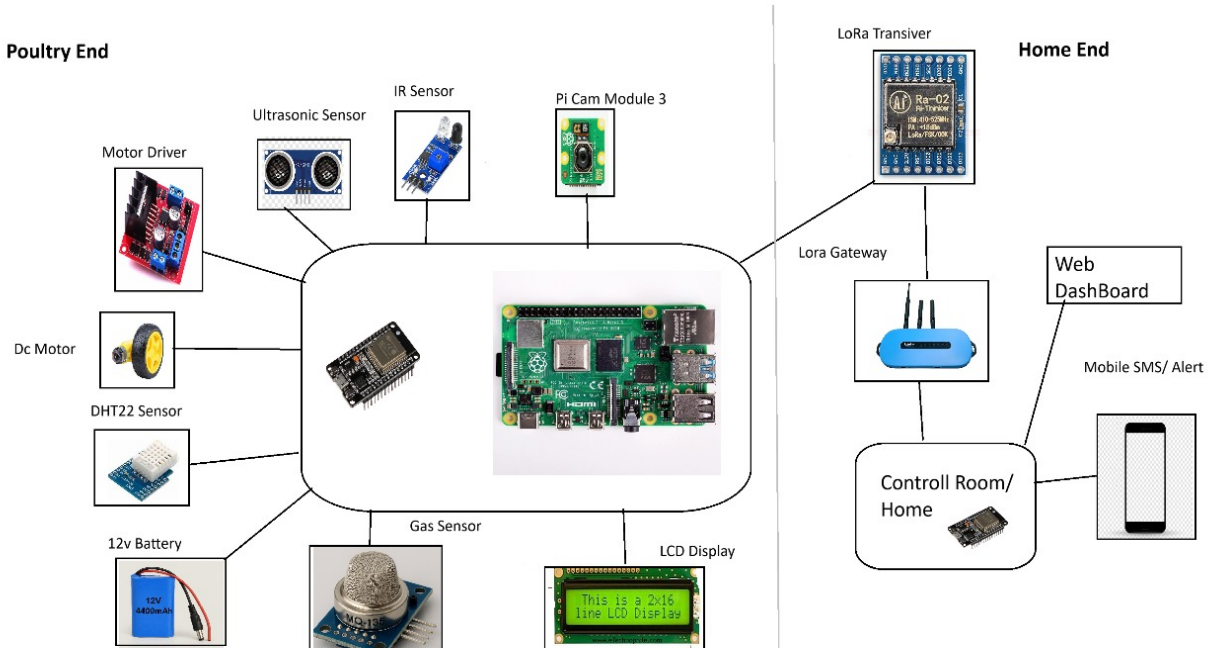


Fig. 3. Visual Block Diagram of System

VI. WORKING

The system will work in below phases:

1) Phase 1: Autonomous Navigation and Obstacle Detection The mobile robotic unit navigates beneath the poultry sheds using DC motors controlled by an ESP32 microcontroller. It utilizes IR sensors for line following and ultrasonic sensors (HC-SR04) to detect and avoid obstacles like birds, feeders, and walls, ensuring safe movement within the farm.

2) Phase 2: Environmental Data Acquisition As the robot moves, it continuously collects environmental data using integrated sensors. This includes measuring temperature and humidity with a DHT22 sensor and detecting hazardous gases like ammonia (NH3), carbon dioxide (CO2), and methane (CH4) using MQ-135/MQ-137 gas sensors.

3) Phase 3: Visual Surveillance and Video Capture a Raspberry Pi camera module mounted on the robot captures real-time video and high-quality images of the birds and their environment. This allows for close-range inspection of flock behavior and physical symptoms without disturbing the birds.

4) Phase 4: Local Processing and Display the ESP32 microcontroller process the raw sensor data locally. Critical real-time information, including gas concentrations and robot status, is displayed on a 16x2 LCD screen attached to the robot for immediate on-site monitoring by farm workers.

5) Phase 5: Long-Range (LoRa) Data Transmission Collected sensor data and status updates are transmitted wirelessly from the robotic unit to a central control room using LoRa (Long Range) communication technology. This ensures reliable data transfer over several kilometres, even in rural areas with limited Wi-Fi or cellular connectivity.

6) Phase 6: Central Processing and AI Analysis The Raspberry Pi, acting as the central server, receives the LoRa data and processes the live video feed. It uses Python and OpenCV to analyse visual patterns and behavior to identify early signs of diseased, inactive, or injured birds

7) Phase 7: Real-Time Alert Triggering The system continuously compares sensor readings against safe environmental thresholds. If harmful gas levels exceed safe limits or signs of disease are detected, the system automatically triggers alerts to notify farm managers for immediate action.

8) Phase 8: Web-Based Dashboard Monitoring All data, including live video feeds, gas level graphs, and historical logs, is hosted on a web-based dashboard developed using Flask. This allows farm owners to remotely monitor the poultry environment 24/7 from any internet-connected device.

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VII. FUTURE SCOPE

The IoT-Based Poultry Farm Monitoring and Disease Detection System has a wide potential for advancement due to rapid growth in IoT, AI, and sensor technologies. As poultry farming becomes more data-driven, future systems can automate decision-making, 41 reduce disease outbreaks, and improve production efficiency. These advancements will make poultry farming smarter, safer, and more sustainable.

1) AI and machine learning models can be added to predict diseases before symptoms appear. Real-time anomaly detection will help farmers take immediate action and reduce bird mortality.
2) Future versions can include gas sensors like ammonia and carbon dioxide, thermal imaging cameras, and sound-based monitoring. Wearable or RFID sensors can also be used to track bird movement, stress levels, and general health continuously.
3) The system can be integrated with poultry disease databases to automatically identify diseases based on sensor data. It can also provide treatment suggestions and send alerts to veterinarians instantly.
4) Environmental control systems such as ventilation, feeding, lighting, and water supply can be fully automated. This helps maintain ideal conditions for bird growth without manual intervention.

VIII. CONCLUSION

The IoT Based Poultry Management and Disease Detection System successfully bring together sensing, automation, LoRa communication, and AI-based analysis to create a reliable and continuous monitoring solution for poultry farms. By integrating temperature, humidity, ammonia, and moisture sensors with a mobile robotic platform and a Raspberry Pi camera, the system is capable of observing both environmental conditions and poultry behaviour in real time.

The use of lightweight AI techniques helps detect abnormal patterns such as inactivity, clustering, or signs of stress, enabling early identification of potential disease conditions that often go unnoticed during manual inspection.

The inclusion of LoRa communication ensures long-range, low-power, and uninterrupted data transmission from within the shed to the control room, making the system suitable even for large poultry houses where Wi-Fi networks are unreliable. The decision-making and alert module provides timely notifications to farmers, allowing immediate corrective action to be taken in critical situations. All events, sensor readings, and snapshots are logged for future reference, improving farm management and supporting data-driven health analysis.

Overall, the developed system reduces manual workload, improves accuracy, and enhances the safety and wellbeing of the flock. By combining IoT, robotics, and edge-level intelligence, the project demonstrates a practical, scalable, and cost-effective approach for modernizing poultry farm operations. The outcomes align closely with recent advancements in smart farming research and show strong potential for future expansion through more advanced AI models, multi-shed integration, and enhanced automation features.

IX. PROJECT SNAPSHOT



Fig. 4. Actual Development of System

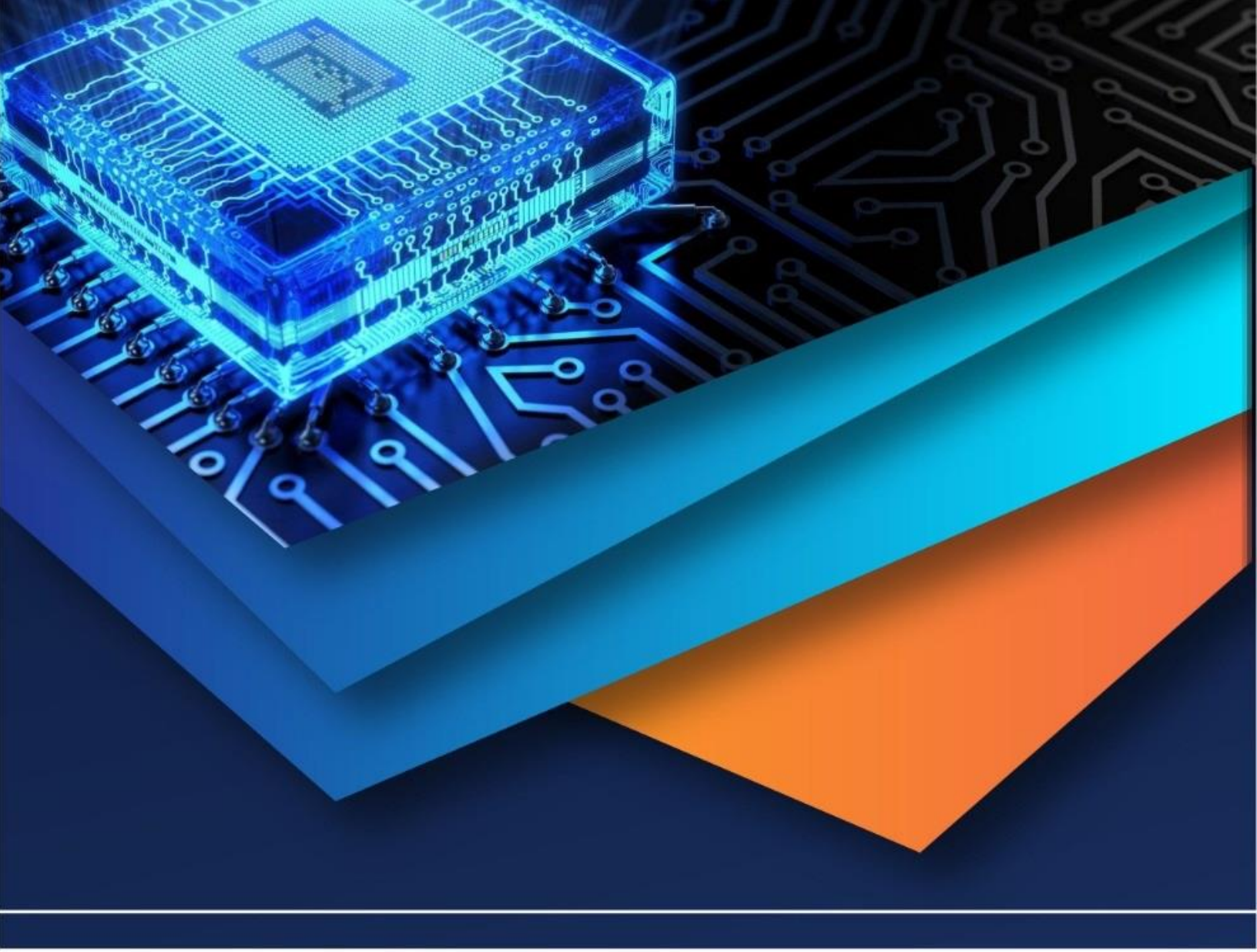
X. ACKNOWLEDGEMENT

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