IOT Enabled Hazardous Gas Detection and Removal System in Poultry Farm

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Abstract: Poultry farming is a critical sector for food production, but it faces challenges related to the management of gases like ammonia and methane, which can be harmful to both the birds and the environment. Traditional methods of gas detection and removal often fall short in efficiency and sustainability. This paper proposes an innovative approach using IoT technology and a cryptogamic biofilter for gas management in poultry farms. The proposed system consists of IoT sensors strategically placed throughout the farm to continuously monitor gas levels. These sensors communicate wirelessly with a central hub, which processes the data and triggers actions based on predefined thresholds. When gas levels exceed safe limits, the system activates the cryptogamic biofilter. The cryptogamic biofilter is a natural and sustainable solution that uses a mixture of fungi, algae, and bacteria to break down gases. It is housed in a specially designed chamber where contaminated air is passed through. The biofilter's microorganisms metabolize the gases, converting them into harmless byproducts like water and carbon dioxide. By combining IoT technology for real-time monitoring and the cryptogamic biofilter for efficient gas removal, this system offers a sustainable and effective solution for gas management in poultry farms. It not only improves the health and well-being of the birds but also reduces the environmental impact of poultry farming.

Keywords: IoT, gas detection, gas removal, cryptogamic biofilter, poultry farming, sustainability.

I. Introduction

Poultry farming is a vital sector for food production, providing a significant portion of the world's meat and eggs. However, it faces many challenges related to the management of gases such as ammonia (NH3) and methane (CH4), which are byproducts of bird metabolism and manure decomposition. These gases can accumulate to harmful levels, leading to the respiratory issues, reduced egg production, and even mortality in poultry. Traditional methods of gas management in poultry farms often involve ventilation systems and chemical treatments. While these methods can be effective to some extent, they are not always sustainable or efficient. Ventilation systems can be energy-intensive, while chemical treatments may have environmental impacts and require frequent replenishment. To address these challenges, there is a need for innovative and sustainable solutions that can effectively monitor and remove gases from poultry farms. This paper proposes an IoT-enabled gas detection and removal system using a cryptogamic biofilter, which offers a natural and environmentally friendly approach to gas management. The proposed system aims to improve the health and well-being of poultry by maintaining optimal air quality in the farm environment. By continuously monitoring gas levels and efficiently removing harmful gases, the system can help reduce the incidence of respiratory issues and improve overall production efficiency. In the following sections, we will discuss the components of the proposed system in detail, including the IoT sensors for gas detection, the cryptogamic biofilter for gas removal, and the overall system architecture. We will also discuss the potential benefits of the system in terms of sustainability, efficiency, and environmental impact.

II. Literature Survey

*Gas Emissions in Poultry Farms***:** Several studies have highlighted the significant levels of ammonia and methane emissions from poultry farms and their negative impacts on the environment and bird health (*Zhao et al., 2016; Sistani et al., 2011*). These studies emphasize the need for effective gas management strategies in poultry farming.

Traditional Gas Management Methods: Ventilation systems are commonly used in poultry farms to remove excess heat and moisture, as well as to dilute and remove gases. However, studies have shown that traditional ventilation systems may not always effectively remove gases, especially in cold weather conditions *(Ni et al., 2019*). Chemical treatments, such as acidifiers and litter amendments, are also used to reduce ammonia levels but may have limited effectiveness and environmental concerns (*Jiang et al., 2018).*

IoT Applications in Agriculture: IoT technology has been increasingly applied in agriculture for various purposes, including environmental monitoring, precision farming, and livestock management *(Al-Fuqaha et al., 2015)*. IoT sensors can provide real-time data on environmental conditions, helping farmers make informed decisions and optimize farm operations.

Biofiltration for Gas Removal: Biofiltration is a sustainable and environmentally friendly method for gas removal, using microorganisms to biologically convert gases into harmless byproducts *(Van Groenestijn et al., 2002)*. Cryptogamic biofilters, which utilize a mixture of fungi, algae, and bacteria, have shown promise in efficiently removing gases from various sources, including livestock facilities *(Lebrero et al., 2012).*

Integrated Gas Management Systems: Some studies have proposed integrated gas management systems for livestock facilities, combining IoT technology for gas monitoring and control with biofiltration for gas removal (*Chen et al., 2017*). These integrated systems offer a holistic approach to gas management, aiming to improve air quality and reduce environmental impact.

Manasi Chochea, Amuthavalli Yadavb, Manjusha Shelkec, Dr. Shobha Tyagid(2020) Internet of Things based Hazardous Gas Leakage Detection System using Arduino UNO- This paper presents an Internet of Things (IoT) based system for detecting hazardous gas leaks using Arduino UNO microcontroller. The system utilizes gas sensors to detect the presence of gases such as methane, ammonia, and carbon monoxide, which are commonly found in industrial environments and pose serious health and safety risks. The Arduino UNO is used as the central processing unit, collecting data from the gas sensors and transmitting it to a remote server using Wi-Fi or GSM/GPRS module. The system is designed to provide real-time monitoring of gas levels, allowing for timely detection and response to gas leaks.

Namrata S. Chougale, Suraj K. Haragapure, Shubhangi B. Patil, Amarsinh B. Farakte(2014) Internet of Things (IoT) based smart poultry farming- This paper presents an IoT-based smart system for monitoring and managing poultry farms efficiently. The system integrates various sensors and actuators to collect real-time data on environmental conditions, health status, and production metrics of the poultry.The key components of the system include temperature and humidity sensors, water level sensors, feed level sensors, and surveillance cameras. These sensors are connected to a central IoT gateway, which collects, processes, and transmits the data to a cloud-based server. The cloud-based server stores the data and provides a user interface for farmers to remotely monitor and control the poultry farm operations. The system also includes algorithms for automated control of ventilation, lighting, and feeding systems based on the data collected from sensors.

III. PROPOSED MODEL

This project aims to enhance poultry farm safety by implementing a gas detection using MQ series sensor (MQ-135) and notification system using an ESP32 microcontroller. This system monitor the hazardous gas like ammonia, methane,H2S and CO2,and when abnormal levels are detected, it trigger a notification to a ground station via Wi-Fi and store data in cloud storage. Additionally electronic filter and exhaust fan is activated to mitigate the impact by extracting harmful gases from the poultry farm to the external environment.

a) IMPLEMENTATION OF THE PROPOSED SYSTEM

Planning: **-** Agile methodology principles for proposed gas detection sensors are applied in a way that available hardware resources are utilized in an optimum manner to enhance the system performance with minimum power consumption.

Analysis: **-** Extensively studied existing gas sensor systems and focussed to overcome their limitations and selectively filtering their advantages like making data available and hardware available in the market, which can cope up our requirements to sense the gas leakage and integrate it with our data dissemination module to timely inform the people to revoke the mishappenings.

Coding: **-** Finally paved the way towards writing the whole code on ESP32microcontroller, to integrate the harbored data, from various hardware modules, to analyze it and display appropriate messages indicating the surrounding status as safe or in the state of danger.

Testing: **-** To check the applicability and performance of the proposed system, the fire detection model has undergone rigorous testing trials, under limited and different prevailing conditions of temperature, pressure and space. To analyze ESP32 performance and its robustness, sample data captured through MQ135 gas Sensor and Infrared Sensors are used iteratively.

Deployment: - After the successful trials of the developed fire detection system, it is deployed for end users for the public places wherever there is any danger of gas leakage or outburst of fire break outs.

b) BLOCK DIAGRAM AND FLOWCHART OF THE PROPOSED SYSTEM

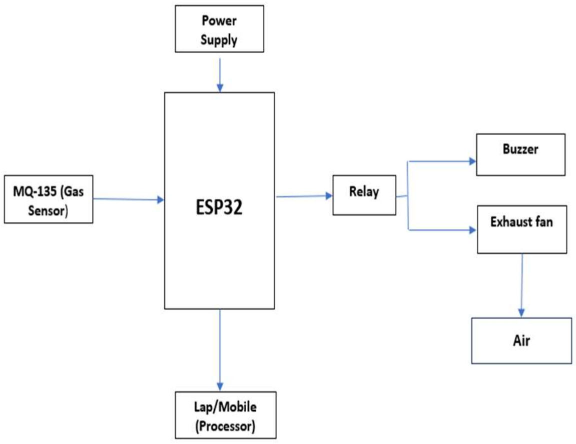

Figure 1: Block Diagram

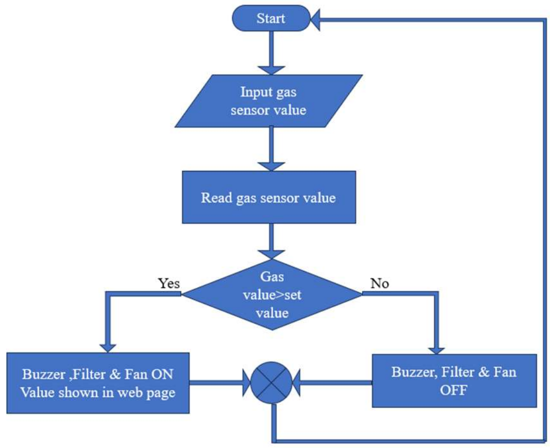

Figure 2: Flow chart

The hardware involved in the proposed model is illustrated as follows:

i. ***MQ-135 Gas sensor***: This sensor is a versatile gas sensor used for detecting various gases, including ammonia, methane, hydrogen sulphide, nitrogen oxides, benzene, smoke, and CO2, based on changes in its resistance.

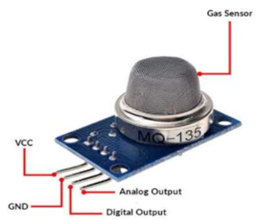

Figure 3:MQ135 sensor

ii. ***Buzzer:*** A buzzer is an electronic device that produces sound when an electrical current is passed through it. It is commonly used in alarms, timers, and notification systems to alert users of specific events or conditions.

Figure 4: Buzzer

iii. ***Exhaust Fan:*** An exhaust fan is a mechanical ventilation device that helps to remove stale air, odors, moisture, and other airborne particles from an enclosed space. It works by drawing air out of the space and expelling it outside, improving air quality and preventing the buildup of humidity and contaminants.

Figure 5: Exhaust Fan

iv. ***Relay:*** A relay is an electrically operated switch that uses an electromagnet to mechanically control the switching of a circuit. It is commonly used to control high-power devices or circuits using a low-power signal, providing isolation between the control circuit and the load circuit. Relays are often used in automation, automotive applications, and industrial control systems.

Figure 6: Relay

v. ***ESP32 Microcontroller:*** The ESP32 is a dual-core microcontroller with built-in Wi-Fi and Bluetooth capabilities, ideal for IoT applications requiring wireless connectivity and low power consumption. It features a wide range of peripherals, including GPIO pins, analog-to-digital converters, and communication interfaces, making it highly versatile for diverse projects.

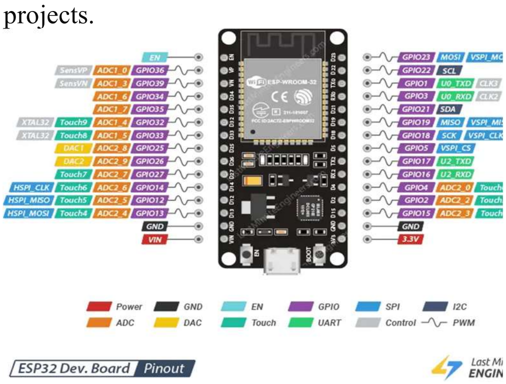

Figure 7: ESP32Microcontroller

vi. ***Cryptogamic Biofilter:*** A cryptogamic biofilter is a type of biofiltration system that uses a mixture of fungi, algae, and bacteria to remove contaminants from air or water. These microorganisms metabolize pollutants, converting them into harmless byproducts, making cryptogamic biofilters an environmentally friendly solution for air and water treatment. It is a non-electronic filter, combination of moss plant, four type of soil with different nutrient content and charcoal.

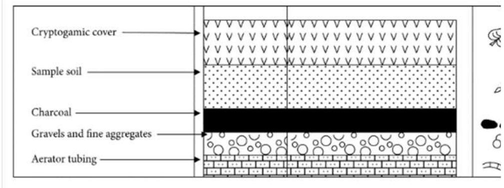

Figure 8: Cryptogamic Biofilter

vii. ***Cloud:*** Processed data will get stored in the cloud. If value exceeds threshold value, then notification as "Gas Leakage" will be sent to the registered user.

viii. ***Alert System on mobile:*** Create an alert system on a mobile device through a browser, you can use a combination of C, C++, Python and JavaScript.

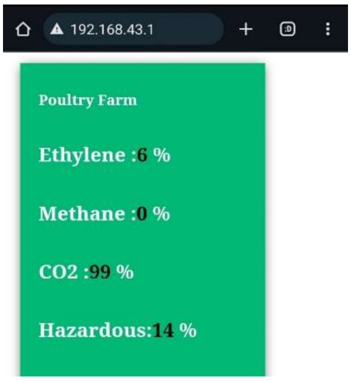

Figure 9: Alert System on mobile

IV. FUTURE SCOPE

The future scope for an alert system on mobile through a browser includes enhancing real-time updates using WebSockets or server-sent events for instant alerts, allowing customizable notifications, integrating geolocation services for location-specific alerts, enabling IoT device integration for sensor-triggered alerts, developing a dedicated mobile app for a seamless experience, ensuring secure authentication, optimizing for scalability, integrating with other services for comprehensive alerting, and incorporating data analytics for insightful alert pattern analysis. These improvements would make the system more functional, user-friendly, and valuable, opening up opportunities for growth and expansion.

VI. CONCLUTION

The integration of an alert system on mobile through a browser presents a valuable tool for instant communication and notification. By leveraging technologies like WebSockets and server-sent events, developers can create real-time alert systems that offer customizable notifications and location-specific alerts. Additionally, integrating with IoT devices and other services enhances the system's functionality and utility. Ensuring security, scalability, and user-friendliness are key factors for the success of such systems. Overall, the future scope for alert systems on mobile through a browser is promising, with ample opportunities for innovation and improvement.

ACKNOWLEDGMENT

An IoT-enabled system for detecting and removing hazardous gases in poultry farms, utilizing a non-electronic cryptogamic biofilter, offers a sustainable and efficient solution. This innovative approach combines advanced sensing technology with natural biofiltration, enhancing poultry health and environmental sustainability.

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