Enhancing Poultry Farming Practices: A Sensor-Driven Approach to Gas Emission Monitoring and Control

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ABSTRACT–In this paper, we propose a sensor-driven approach to address ammonia (NH3) and hydrogen sulphide (H2S) gas emissions from bird litter in the poultry sector. The goal is to enhance poultry farming practices by effectively managing odour and harmful gas issues through real-time monitoring and control. We present a system design that integrates MQ2 and MQ135 gas sensors for NH3 and H2S detection, respectively, along with ESP32 microcontrollers and battery backup for sensing nodes. The proposed system aims to improve gas emission monitoring and control in poultry farming, leading to enhanced environmental sustainability and productivity.
Keywords: Poultry farming, Gas emission monitoring, NH3 detection, H2S detection, MQ2 sensor, MQ135 sensor, ESP32 microcontroller, Battery backup, ESP-NOW communication, GSM module, Remote monitoring.

I. INTRODUCTION

Poultry farming plays a crucial role in meeting the global demand for animal protein. However, the release of ammonia and hydrogen sulphide gases from bird litter poses challenges in terms of environmental impact and animal welfare. Effective monitoring and control of gas emissions are essential for maintaining a healthy and sustainable poultry farming environment. In this paper, we present a sensor-driven approach to address these challenges through real-time gas emission monitoring and control.

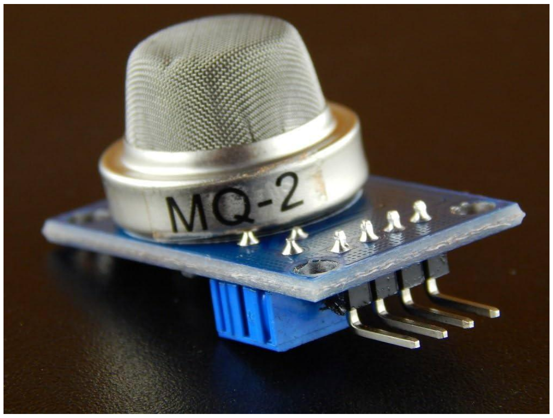
II. METHODOLOGY AND COMPONENTS:

2.1 GAS SENSORS:

Gas sensors play a critical role in our poultry monitoring system, as they are responsible for detecting and measuring the levels of ammonia (NH3) and hydrogen sulfide (H2S) emissions from bird litter. We have chosen to integrate two types of gas sensors into our system: the MQ2 sensor for NH3 detection and the MQ135 sensor for H2S detection.

2.1.1 MQ2 GAS SENSOR:

- The MQ2 gas sensor is widely used for detecting multiple gases, including NH3, methane, propane, and smoke. Its versatility makes it suitable for our application, where we need to monitor NH3 emissions from bird litter. The sensor operates based on the principle of resistance change in response to the presence of target gases. When NH3 molecules come into contact with the sensor's surface, it causes a change in resistance, which can be measured and quantified.
- The detection range of the MQ2 sensor for NH3 typically falls within the range of 300-10000ppm, making it suitable for detecting NH3 emissions in poultry farming environments.
- The MQ2 sensor offers high sensitivity and a fast response time, allowing us to accurately measure NH3 concentrations in real-time.



Detection range:	300-10000ppm(Flammable gas)	
Detection principle:	Semiconductor	
Characteristics:	Has high sensitivity to C3H8 and smoke	
Size:	φ19×24.2	
Working conditions:	Loop Voltage	
	Heater Voltage	
	Heater consumption W ≤950m	

2.1.2 MQ135 GAS SENSOR:

- The MQ135 gas sensor is specifically designed for detecting gases such as H2S, ammonia, benzene, and alcohol vapor. We utilize it to monitor H2S emissions from bird litter, as H2S poses significant health risks to both poultry and farm workers.
- Similar to the MQ2 sensor, the MQ135 operates on the principle of resistance change in the presence of target gases. When H2S molecules interact with the sensor's surface, it induces a change in resistance, which can be measured and analyzed.
- The detection range of the MQ135 sensor for H2S typically falls within the range of 10-1000ppm, providing us with accurate measurements of H2S concentrations in the poultry farming environment.
- The MQ135 sensor offers high sensitivity and accuracy, allowing us to effectively monitor H2S levels and take appropriate measures to mitigate gas emissions.

Detection range:	NH3 ~ C7H8 1000ppm)
Detection principle:	Semiconductor
Characteristics:	Good sensitivity to toxic gas
Size:	φ19×24.2
Working conditions:	Loop Voltage
	Heater Voltage
	Heater consumption

2.2 ESP32 MICROCONTROLLER:

The ESP32 microcontroller serves as the brain of our sensing nodes, providing processing power and communication capabilities for data collection and transmission.

We have chosen the ESP32 due to its versatility, low power consumption, and built-in Wi-Fi and Bluetooth connectivity, which are essential for our wireless monitoring system.

- The ESP32 microcontroller offers sufficient processing power to handle data acquisition from the gas sensors, data analysis, and communication with other nodes in the wireless mesh network.

Specification	Value
Working Voltage	3.3V
Input Voltage Range	5V
Digital I/O Pins	36
Analog Input Pins	18
DC Current per I/O Pin	12mA
DC Current for 3.3V Pin	40mA
Flash Memory	4MB
SRAM	520KB
Clock Speed	80MHz

- Its dual-core architecture ensures efficient multitasking and real-time processing, allowing us to perform complex tasks such as gas concentration calculations and threshold monitoring.
- The ESP32 supports various communication protocols, including Wi-Fi, Bluetooth, and ESP-NOW, making it ideal for wireless sensor network applications.
- We leverage the ESP32's Wi-Fi capabilities for seamless integration with the wireless mesh network, enabling reliable data transmission between sensing nodes and the main gateway Node.
- Additionally, the ESP32's Bluetooth functionality allows for easy configuration and control of the sensing nodes via mobile devices, facilitating setup and maintenance of the monitoring system.

2.3 BATTERY BACKUP:

To ensure uninterrupted operation and data collection, we have equipped our sensing nodes with battery backup systems. These backup systems provide power redundancy, allowing the nodes to operate independently of external power sources for extended periods.

- By incorporating battery backup systems, we extend the operating lifespan of the sensing nodes, enabling them to collect data over prolonged periods without the need for frequent battery replacements.
- This extended operation enhances the reliability and effectiveness of our gas emission monitoring system, ensuring continuous surveillance of NH3 and H2S levels in the poultry farming environment.

Overall, the integration of MQ2 and MQ135 gas sensors, ESP32 microcontrollers, and battery backup systems forms the core components of our poultry monitoring system. These components work together to enable real-time gas emission monitoring, data transmission, and analysis, ultimately enhancing environmental sustainability and productivity in poultry farming practices.

III. PROPOSED SYSTEM

The proposed system consists of ESP32 nodes equipped with MQ2 and MQ135 gas sensors deployed across the poultry farm. These nodes form a wireless mesh network, with data transmitted to the main gateway node for analysis and reporting. Battery backup systems ensure continuous operation of sensing nodes, enabling real-time monitoring of NH3 and H2S gas emissions.

3.1 INTEGRATION OF ESP-NOW COMMUNICATION:

ESP-NOW is a communication protocol developed by Espressif Systems for ESP8266 and ESP32 microcontrollers. It enables peer-to-peer communication between ESP devices without the need for a Wi-Fi network or access point. In the proposed poultry farming system, ESP-NOW communication enhances the reliability and scalability of the network.

3.1.1 EFFICIENT DATA TRANSMISSION

ESP-NOW facilitates efficient data transmission between sensing nodes and the main gateway node. By eliminating the need for a Wi-Fi network, ESP-NOW reduces communication overhead and latency, enabling real-time exchange of gas emission data.

3.1.2 MANY-TO-ONE COMMUNICATION

In a Many-to-One communication setup, multiple sensing nodes deployed across the poultry farm can communicate with a single main gateway node. This architecture simplifies network management and reduces power consumption, as the gateway node can aggregate data from multiple sources.

3.2.3 MESH NETWORK FORMATION

ESP-NOW allows for the formation of a wireless mesh network, where each sensing node acts as a relay to extend the network's coverage. This mesh topology improves network reliability and robustness, ensuring seamless communication even in challenging environments.

3.3 INTEGRATION OF GSM MODULE

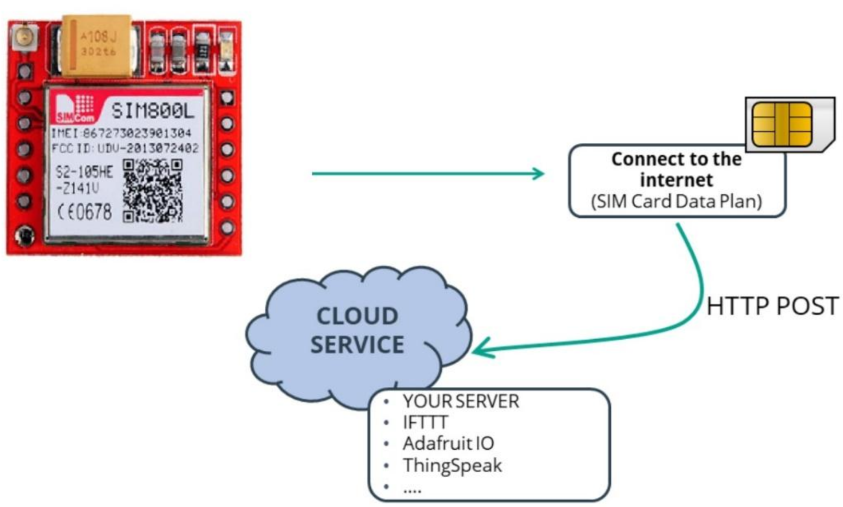
3.3.1 REMOTE DATA TRANSFER

In addition to local communication between sensing nodes and the main gateway node, remote data transfer is essential for accessing gas emission data from anywhere. A GSM module, such as the SIM800L, enables

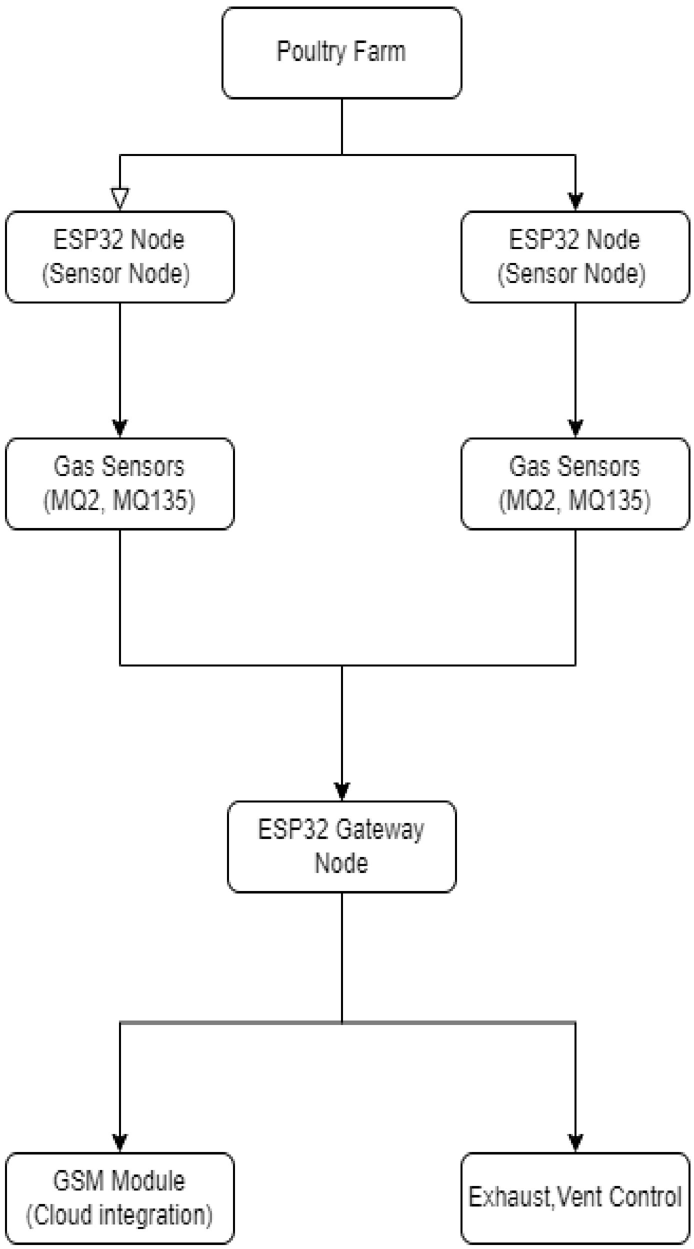
Specifications	
Supply voltage:	3.8V - 4.2V
Recommended supply voltage:	4V
Power consumption:	
sleep mode	< 2.0mA
idle mode	< 7.0mA
GSM transmission (avg):	350 mA
GSM transmission (peek):	2000mA
Module size:	25 x 23 mm
Interface:	UART (max. 2.8V) and AT commands
SIM card socket:	microSIM (bottom side)
Supported frequencies:	Quad Band (850 / 950 / 1800 /1900 MHz)
Antenna connector:	IPX
Status signaling:	LED
Working temperature range:	-40 do + 85 ° C

cellular communication, allowing the gateway node to connect to the internet via cellular networks.

3.3.2 HTTP COMMUNICATIONThe GSM module facilitates communication with cloud platforms using HTTP protocols. Gas emission data collected by the main gateway node can be transmitted to cloud servers for storage, analysis, and visualization.This remote access to data enables poultry farmers to monitor gas emissions and make informed decisions in real-time



IV. PROCESS FLOW CHART



Start

Initialize System

Initialize ESP32 Nodes

Initialize Gas Sensors (MQ2 and MQ135)

Initialize Wireless Mesh Network (ESP-NOW)

Initialize GSM Module

Monitor Gas Emissions

Read Gas Levels from Sensors

Check NH3 and H2S Levels

If Exceeded, Trigger Alert

Data Transmission

Transmit Data to Main Gateway Node

Send Data to Cloud via GSM Module

Control Mechanism

V. CONCLUSION

In conclusion, the sensor-driven approach presented in this paper offers a practical solution for monitoring and controlling NH3 and H2S gas emissions in poultry farming. By deploying MQ2 and MQ135 gas sensors, along with ESP32 microcontrollers and battery backup systems, poultry farmers can effectively manage gas issues and promote environmental sustainability and animal welfare. The proposed system, augmented with ESP-NOW communication and GSM connectivity, represents a significant advancement in poultry farming practices, enabling real-time monitoring, remote access, and proactive management of gas emissions.

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