TEXAS A&M UNIVERSITY Engineering

Booth Number: 336

Livestock Gas Monitor

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Problem Definition

Animal farms often experience a buildup of harmful gases that can threaten the health of both workers and animals. We were tasked with designing and implementing a durable, real-time gas monitoring system that can track harmful gases in animal farms. The gases monitored are Ammonia, Hydrogen Sulfide, Carbon Dioxide, and Methane.

Methodology

Our project is broken into 4 different subsystems, power, sensors, microcontroller & wireless communication, and UI

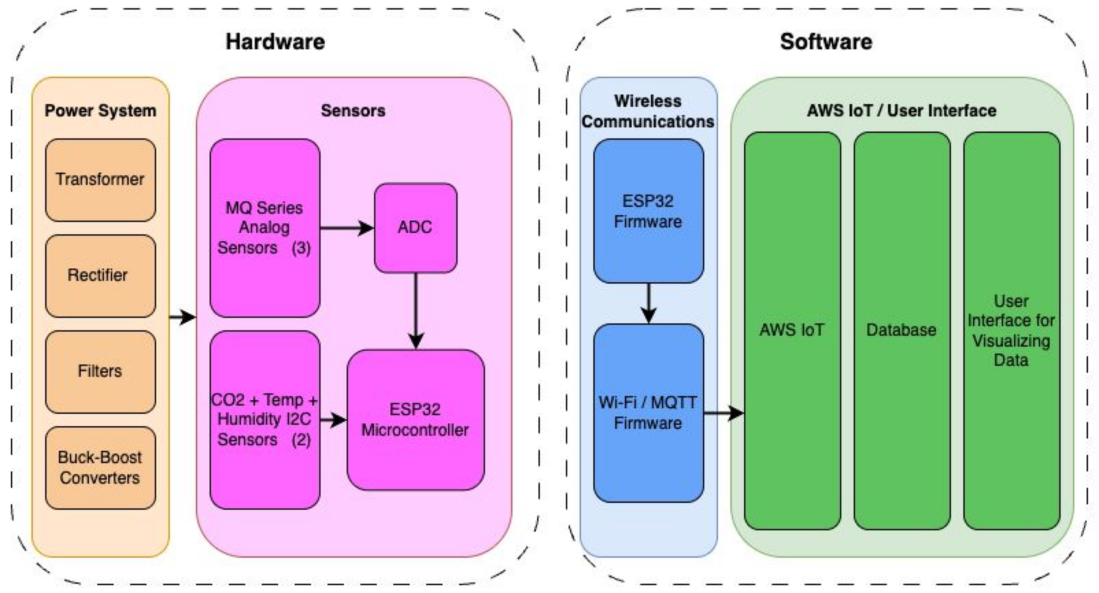

Figure 1. Subsystem breakdown block diagram.

Power

- 120V AC sent to a transformer that outputs 12V AC.
- Printed circuit board (PCB) rectifies AC to DC
- Buck-boost regulators and filter capacitors convert voltage to 3.3V, 5V, and -8V with current up to 1A

Sensors

- Designed PCB with 3 analog sensors, 2 I2C sensors, ADC, and microcontroller
- Determined gas concentrations from voltage detected

Microcontroller + Wireless Communication

- Programmed microcontroller to interface with gas sensors
- Transmitted real-time sensor data to AWS IoT over Wi-Fi using MQTT protocol

UI + Database

- Implemented a MySQL Database to store all data
- Connected database through Amazon Web Services -> Deployed website using AWS Elastic Beanstalk

Engineering Analysis

The complexity of our project stems from the integration between hardware and software components. Engineering analysis has been done using Altium, AWS, MySQL, and ESP-IDF.

A. The figure below shows the hydrogen sulfide concentration vs. input voltage. Gas concentration is derived from Rs using a logarithmic regression model based on the MQ-series sensor datasheet.

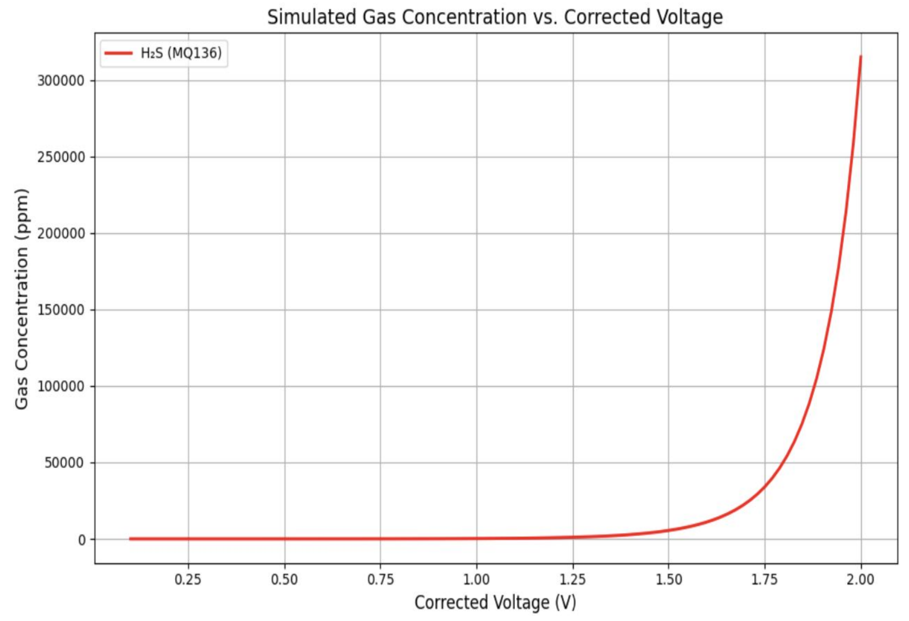

Figure 2. H2S Concentration vs Input Voltage

B. Below are screenshots of the data collection process and flow of data from the ESP32 terminal to the final web application. This data was collected on April 17, 2025 at 12:06 PM, and showcases the integration that was accomplished from the microcontroller to the AWS database, and finally to the web application.

```
I (359770) gasmonitor: Publishing: {"temperature":81.53, "humidity":48.59,
 "co2":636.00, "NH3":4.431723, "H2S":0.636742, "CH4":1.900668}
I (364980) AD7718: AIN1 Voltage: 0.515357 V
I (365180) AD7718: AIN2 Voltage: 0.481850 V
I (365380) AD7718: AIN3 Voltage: 0.331905 V
I (366380) gasmonitor: Publishing: {"temperature":81.25, "humidity":49.01,
 "co2":572.00, "NH3":4.391113, "H2S":0.668618, "CH4":1.914688}
I (370580) AD7718: AIN1 Voltage: 0.517552 V
I (370780) AD7718: AIN2 Voltage: 0.482742 V
I (370980) AD7718: AIN3 Voltage: 0.331237 V
I (370980) gasmonitor: Publishing: {"temperature":80.85, "humidity":49.54,
 "co2":575.00, "NH3":4.432902, "H2S":0.662237, "CH4":1.932789}
```

Figure 3. ESP32 Terminal showing data collection

ID	Temperature (°F)	Humidity (%)	CO2 (ppm)	NH3 (ppm)	H2S (ppm)	CH4 (ppm)	Timestamp
17135	80.85	49.54	575	4.4329	0.662237	1.93279	2025-04-17 12:06:39
17134	81.25	49.01	572	4.39111	0.668618	1.91469	2025-04-17 12:06:36
17133	81.53	48.59	636	4.43172	0.636742	1.90067	2025-04-17 12:06:28

Figure 4. Web application displaying data

C. The housing unit was designed to securely mount all printed circuit board with special attention made to orient sensors in the optimal positions.

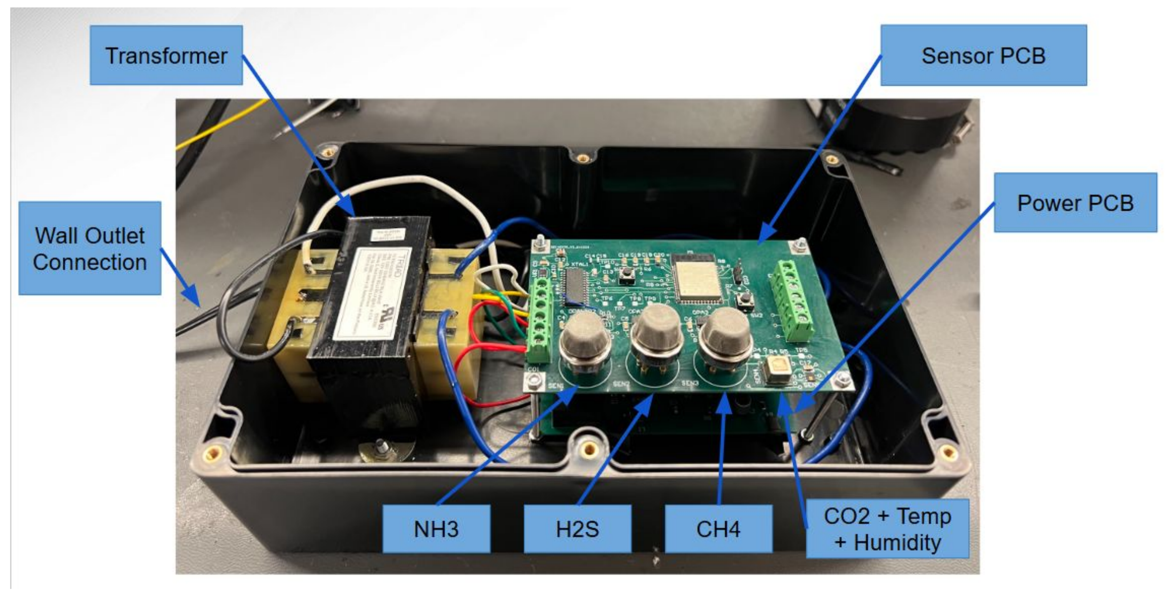

Figure 5. Gas monitor image with labeled parts

Outcomes

Our gas monitoring system was able to successfully detect all intended gases along with temperature and humidity. During our final test, we were able to achieve continuous operation for 3 hours, collecting 2160 gas concentration data points.

Farm Test

The base state for the test was sitting in the room with no elements placed next to it. When damp cow bedding was introduced, there was a spike in ammonia and a smaller spike in methane and hydrogen sulfide. This is consistent as ammonia is produced from damp cow bedding at 10x the magnitude of the other gases.

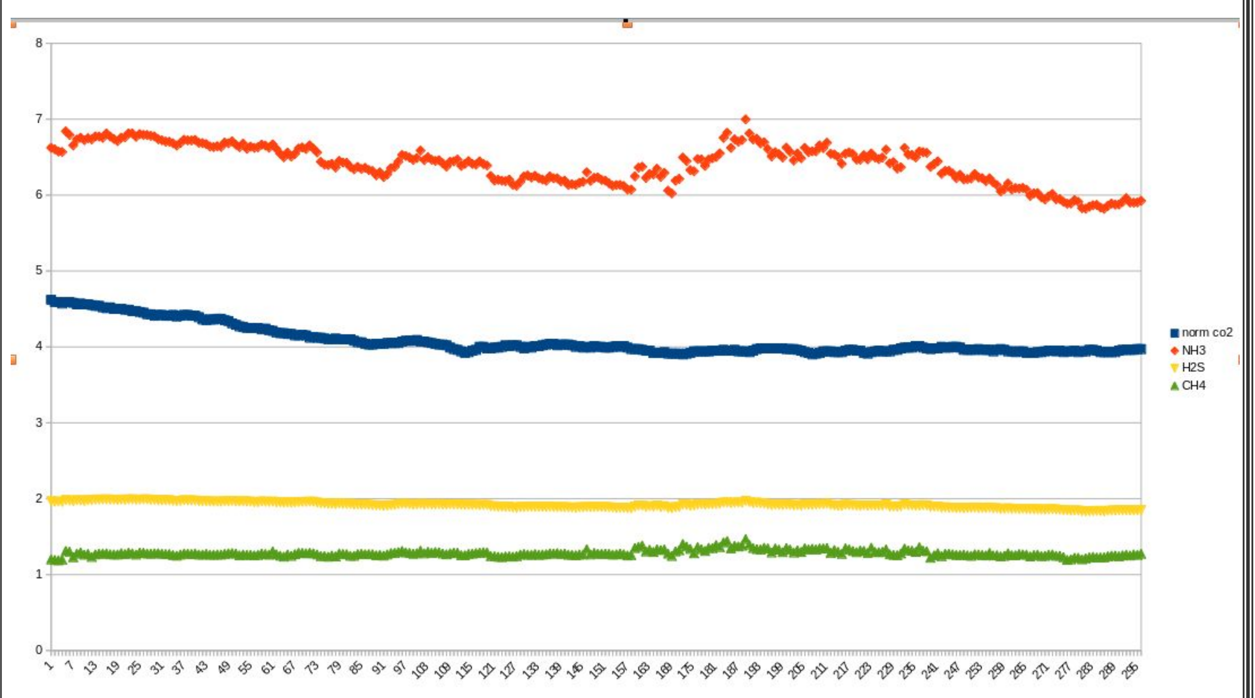

Figure 6. Red NH3, Blue CO2, Yellow H2S, Green CH4

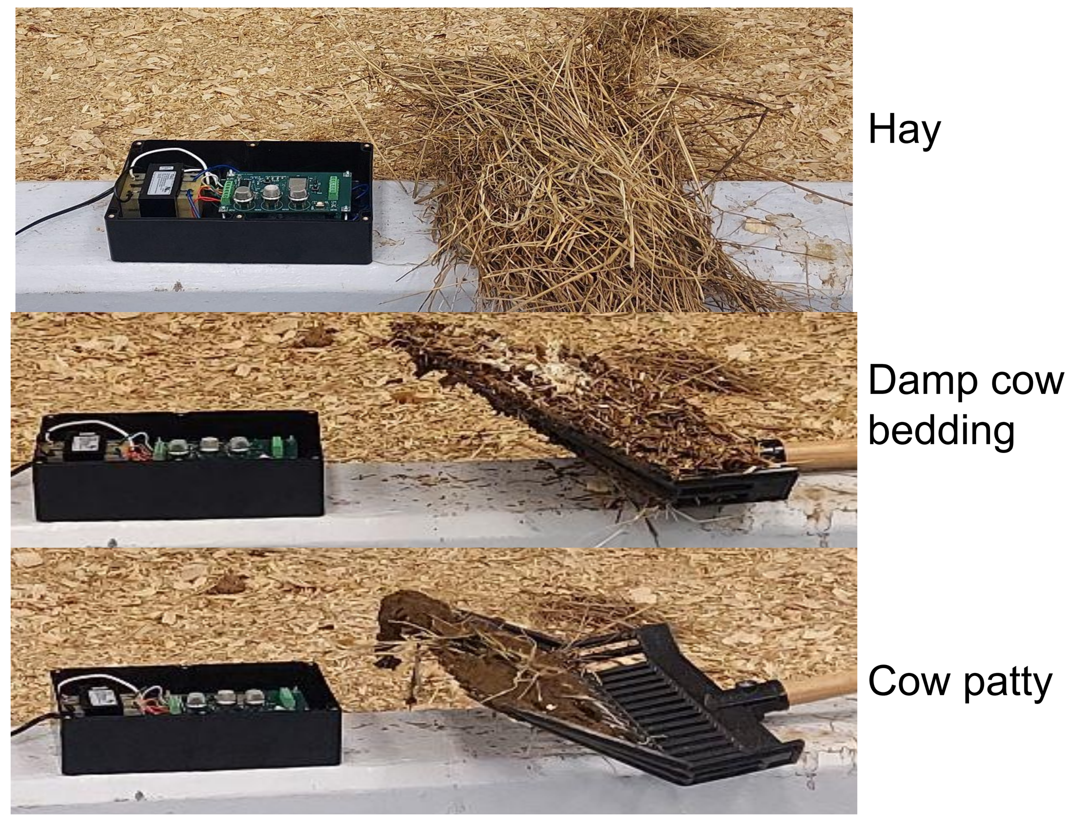

Figure 7. Testing system next to various stimuli

Impact

This system improves animal health monitoring by collecting gas concentration data via real-time, remote-access dashboard.

- **Early Detection:** We can be alerted very early if there are hazardous gas levels present.
- **Manual Inspection:** We can use this to minimize the manual labor required in inspecting the overall health of the animal and its environment
- **Data-Driven Decision Making:** Keeping track of the logs of data long-term would help us make decisions based on the statistics.

References

1. AWS IoT Core Documentation
2. AD7718 ADC Datasheet - Analog Devices
3. AWS RDS (Relational Database Services) - MySQL
4. Flask Web Framework Documentation
5. AWS Elastic Beanstalk Documentation
6. Altium - A complete design walkthrough of Altium Designer

Acknowledgements

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