TEAM 021

Smart Industrial Leak Detection and Hazard Assessment Vehicle (SILDHAV)

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Introduction

SILDHAV is an autonomous mobile vehicle designed for real-time gas leak detection in industrial environments. It helps safety engineers and operators detect hazardous hydrogen leaks early, improving safety, minimizing risks, and reducing downtime.

Problem Statement

Hydrogen leaks in industrial plants often occur in areas that are difficult to monitor. Stationary detectors cannot move or cover blind spots, which limits their effectiveness. **SILDHAV** solves this by autonomously navigating facilities and detecting hidden leaks in real time.

Constraints

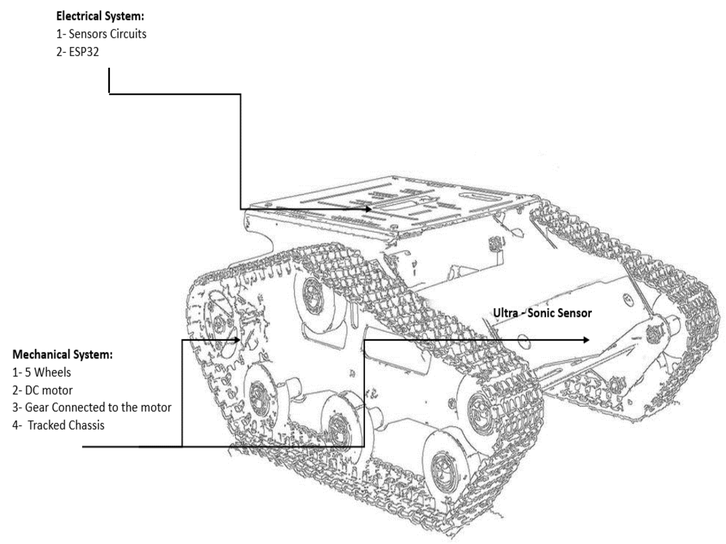
Constraints	Met
Weight of the Vehicle must not exceed 5 kilograms	✓
Sensor delay of no more than 5 seconds	✓
Hydrogen gas with concentration below 4000 ppm	✓

Target Specifications

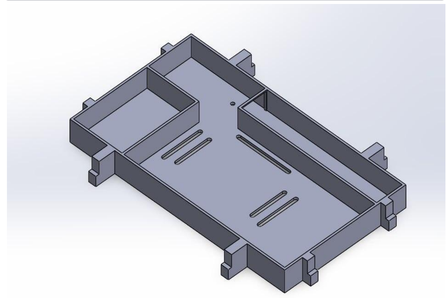
Target Specifications	Met
Maintain a mobile vehicle with maximum width of 30 cm	✓
Detect hydrogen leaks at flowrates as low as 0.5 L/min	✓
Operate continuously for at least two hours on a single battery charge	✓
Inspect a 2 m × 2 m area and detect leaks within 3 minutes	✓

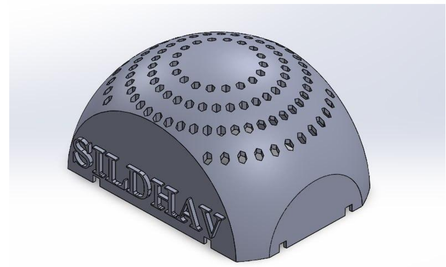
Prototype Design

Vehicle Design



Base and Frame





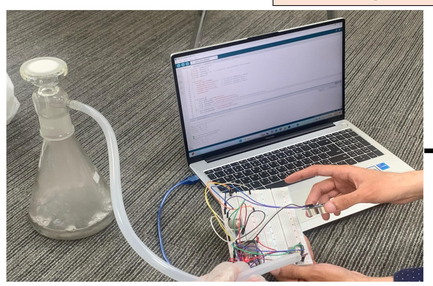
Testing and Validation

Testing Apparatus

$$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$$

Hydrogen Detection Results

1. During the Reaction



MQ-8 Sensor Result

```
Hydrogen PPM: 2.54
Distance: 7.93 cm
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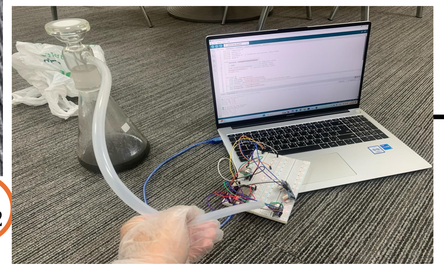
```

2. After the Reaction



MQ-8 Sensor Result

```
Hydrogen PPM: 0.00
Distance: 4.88 cm
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Project Impact

- Detects Hazardous Leaks
- Protects workers
- Safeguards the plant

Key Calculations

➢ **Motor Linear Velocity:**

$$v = r \times \omega = (radius\ of\ the\ gear) \times (angular\ speed)$$

- $r = 0.0325$ m
- $\omega = \frac{(RPM\ of\ motor) \times 2\pi}{60} = \frac{100 \times 2\pi}{60} =$ **10.47 rad/s**

$$v = r \times \omega = 0.0325 \times 10.47 = 0.34 \text{ m/s} \pm 10\%$$

$v =$ **0.34 m/s ±10%**

➢ **Total Consumption Power:**

$$P = V \times I$$

Component	Voltage (V)	Current (A)	Power (W)
ESP32 Microcontroller	3.3	0.24	0.8
MQ Sensors	5	0.6	3.0
Temperature Sensor	5	0.00006	0.0003
Ultrasonic Sensor	5	0.015	0.075
Motors	9	2.4	21.6

Total Consumption Power = Sum of each component power consumption
(from previous slide table)

Total Consumption Power =0.8+3.0+0.0003+0.075+21.6 = 25.4753 W

Total Consumption Power = 25.5 W

Conclusion

Our **SILDHAV** project proves to be a reliable solution for hydrogen leak detection. It is an innovative system that will impact the future in safety, efficiency, emissions control, environmental protection, automation, and sustainability.