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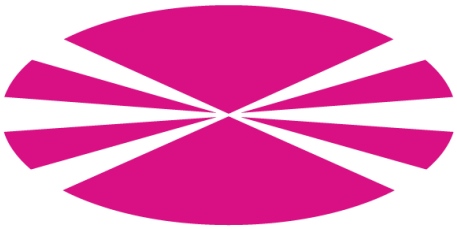

UNIVERSIDADE DA CORUÑA

INDUSTRY 4.0 ENABLING TECHNOLOGIES

Group Project Report

Fire Detection System for the Engine Room

LECTURERS

- Paula Fraga Lamas
- Tiago M. Fernández Caramés

GROUP MEMBERS

- Mehmet Furkan SAPMAZ
- Ibrahim Hamid Saray ABDALLA
- Bruno OMLENYI

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1. Abstract:

This report details the design, implementation, and evaluation of an IoT-enabled Ship Engine Room Monitoring System. The system aims to enhance safety and operational efficiency by continuously monitoring critical parameters such as temperature, smoke, flame, and light intensity. It provides real-time alerts through a cloud-based platform, enabling remote monitoring and timely intervention to prevent hazards.

2. Motivation:

The maritime industry relies heavily on the safe and efficient operation of vessels, particularly within the confined and critical environment of the engine room. The motivation behind this project stems from the need to enhance safety measures and mitigate potential risks associated with fire outbreaks, equipment malfunction, and inadequate environmental conditions within the engine room.

3. Problem Identification:

A ship's engine room presents numerous challenges, including the risk of fire hazards, temperature fluctuations, and insufficient lighting. Without a robust monitoring system, detecting and responding to these issues promptly becomes challenging, posing significant risks to personnel and assets aboard the vessel.

4. Objectives:

The primary objective of this project is to design and implement a Ship Engine Room Monitoring System capable of:

- Continuous monitoring of temperature, smoke, flame, and light intensity within the engine room and from any place through the IOT cloud
- Providing real-time alerts in the event of abnormal conditions or potential hazards.
- ensuring the safety of personnel and assets by facilitating prompt response and corrective actions.

5. Implementation:

- ## System Architecture:

  The Ship Engine Room Monitoring System comprises several components, including sensors, actuators, and a microcontroller unit (MCU) for data processing and control. The system architecture facilitates the seamless integration of sensor data update it in the IOT cloud and activation of alarms when predefined thresholds are exceeded.

- ## Required Sensors and Actuators:

  - Temperature Sensor (DS18B20): Monitors temperature levels within the engine room.

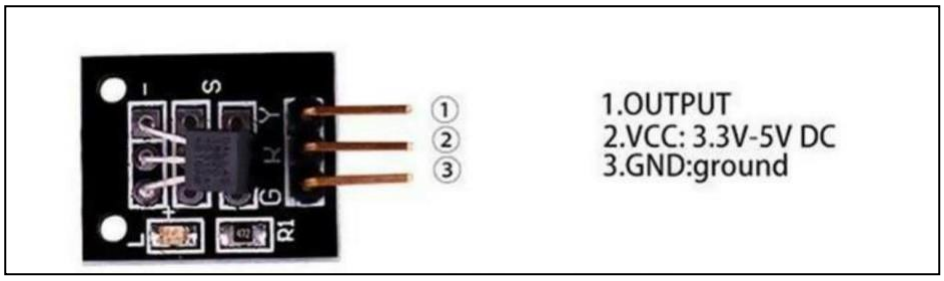

Figure 1Temperature Sensor (DS18B20):

- Smoke Sensor: Detects the presence of smoke particles, indicating potential fire hazards.

Figure 2 Smoke Sensor

- Flame Sensor: Identifies the presence of flames, providing early warning in case of fire outbreaks.

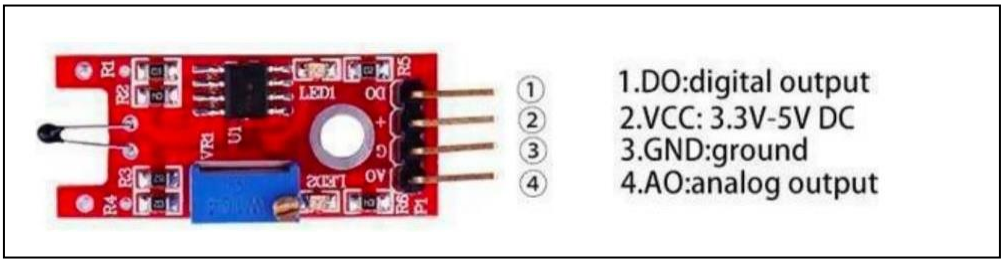

Figure 3 Flame Sensor

- Light Dependent Resistor (LDR): Measures ambient light intensity to ensure adequate illumination.

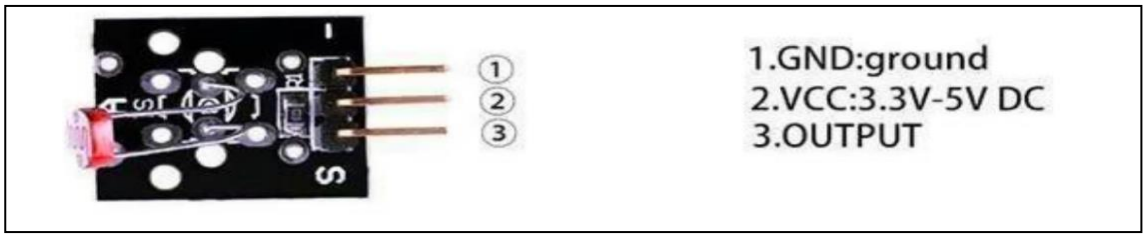

Figure 4 Light Dependent Resistor (LDR

- Passive Buzzer and LED Indicator: Activated to alert personnel in response to abnormal readings detected by the sensors.

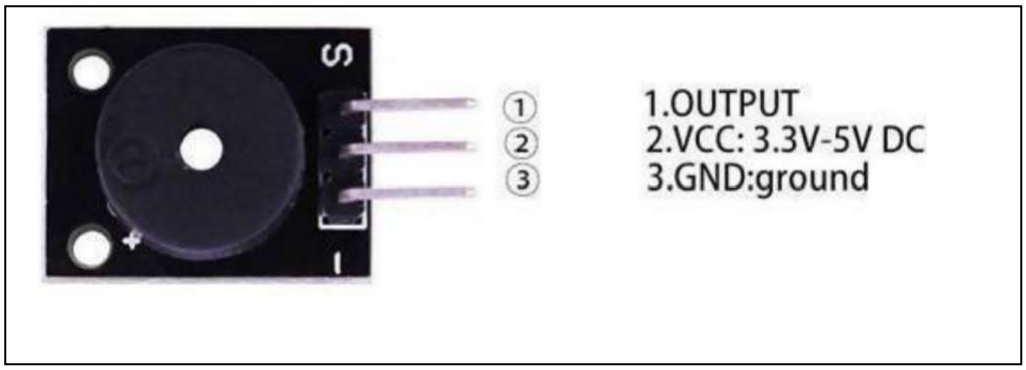

Figure 5 Passive Buzzer

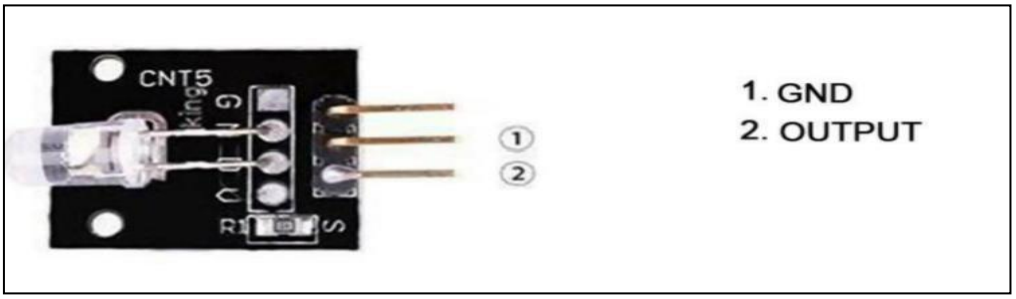

Figure 6 LED Indicator

- Two EPS8266 Arduino board

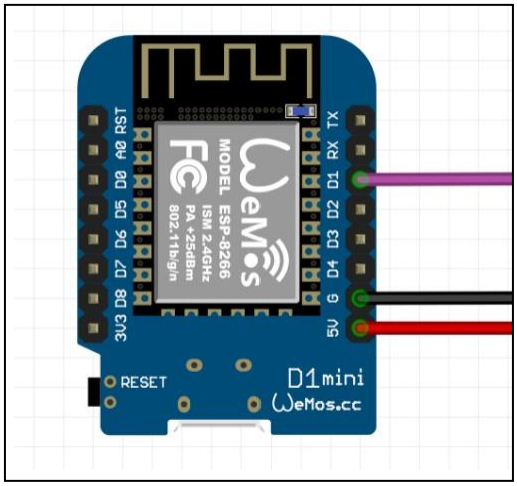

Figure 7 EPS8266 Arduino board

- ## Flow chart

The flowchart outlines a smoke detector's decision process for fire detection. It employs three thresholds: light below 150 lux, smoke above 200 ppm, and temperature exceeding 50°C.

If all conditions are met, the detector triggers a blinking LED and an alarm. A 30-second delay follows before restarting the monitoring cycle. This flowchart depicts a smoke detector's core algorithm for fire identification and alarm activation.

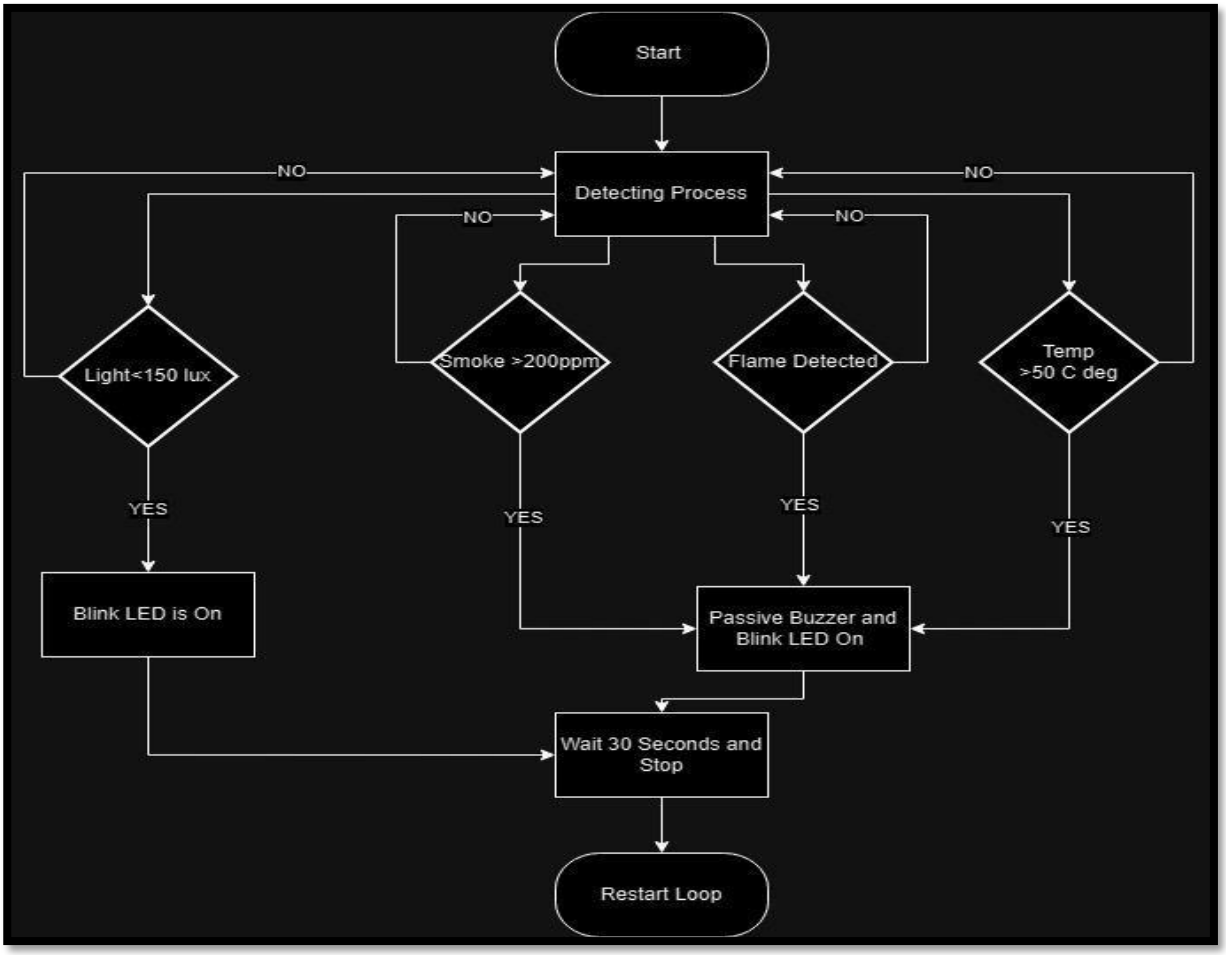

Figure 8 System Flow chart

- ## Codes used in this system

The first code snippet is for a Ship Engine Room Monitoring System (SERMS) that monitors temperature, smoke levels, and flame presence in the engine room. It activates an alarm (buzzer and LED) if any parameter exceeds predefined thresholds, ensuring quick response to potential fire hazards.

Code for the system working in local Arduino environment
https://github.com/mfurkansapmaz/IoT-Project/blob/main/Group%20Project/%22Ship%20Engine%20Room%20Monitoring%20System%20(SERMS)%20with%20Temperature%2C%20Smoke%2C%20and%20Flame%20Detection%22

Code for the system with IOT Arduino cloud
https://github.com/mfurkansapmaz/IoT-Project/blob/main/Group%20Project/%22Ship%20Engine%20Room%20Monitoring%20System%20(SERMS)%20with%20Temperature%2C%20Smoke%2C%20and%20Flame%20Detection%22%20in%20cloud

The second code snippet monitors ambient light intensity using a light-dependent resistor (LDR) and toggles an LED based on predefined thresholds. This provides visual feedback on lighting conditions, enhancing safety and operational efficiency onboard ships.

Code for the system working in local Arduino environment
https://github.com/mfurkansapmaz/IoT-Project/blob/main/Group%20Project/Ambient%20Light%20Monitoring%20System%20with%20LED%20Feedback

Code for the system with IOT Arduino cloud
https://github.com/mfurkansapmaz/IoT-Project/blob/main/Group%20Project/Ambient%20Light%20Monitoring%20System%20with%20LED%20Feedback%20in%20cloud

6. Results and Discussion:

- ## System Performance:
  The implemented Ship Engine Room Monitoring System demonstrates robust performance in continuously monitoring critical parameters and providing timely alerts. Real-world testing and simulations confirm the system's effectiveness in detecting and mitigating potential hazards, thereby enhancing safety measures within the engine room.

- ## Challenges and Limitations:
  Despite its efficacy, the system may encounter challenges such as sensor calibration, environmental interference, and false alarms. Addressing these issues requires ongoing optimization and fine-tuning of the system parameters to ensure reliable operation in diverse maritime environments.

- ## Opportunities and Advantages:
  Despite these challenges, the system presents significant opportunities for improvement and innovation. Integrating the system with Internet of Things (IoT) technology offers a transformative opportunity to enhance monitoring capabilities. By leveraging IoT platforms tailored for maritime applications, such as Arduino Cloud, the system achieve remote connectivity and real-time data transmission. This enables ship operators to access sensor data and receive alerts on their mobile devices, empowering them to monitor the engine room conditions from anywhere on the vessel or even ashore.

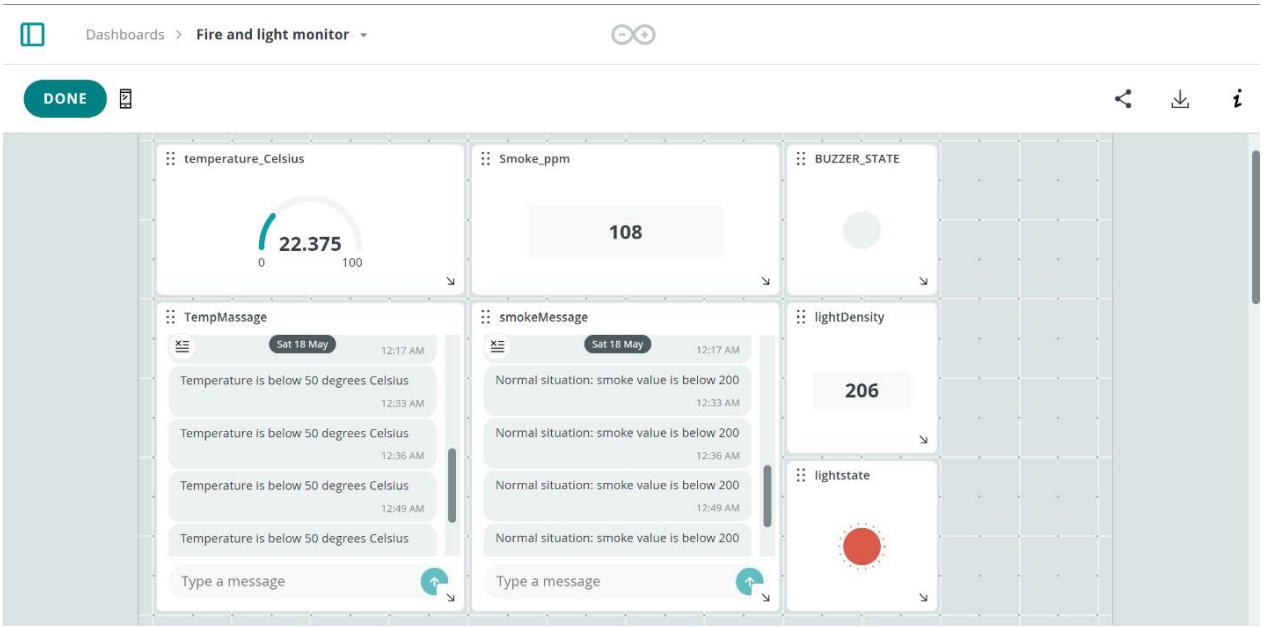

Figure 9 Arduino Dashboard

Description of the Fire and Light Monitoring Dashboard

The provided screenshot depicts an Arduino IoT Cloud dashboard titled "Fire and Light Monitor." This dashboard visualizes data from sensors connected to two ESP8266 devices, responsible for monitoring environmental parameters including temperature, smoke levels, and light intensity. Below is a detailed description of each widget and its corresponding functionality:

1. Temperature Sensor (temperature_Celsius):

- Widget: A gauge displaying the current temperature in degrees Celsius.
- Reading: 22.375°C.
- Functionality: This gauge dynamically updates to reflect real-time temperature readings from a DS18B20 temperature sensor.

2. Smoke Sensor (Smoke_ppm):

- Widget: A simple numerical display showing the concentration of smoke in parts per million (ppm).
- Reading: 108 ppm.
- Functionality: This widget updates in real-time, indicating the current smoke level detected by an analog smoke sensor.

3. Buzzer State (BUZZER_STATE):

- Widget: An indicator showing the status of the buzzer.
- Reading: Inactive (as indicated by the empty circle).
- Functionality: The buzzer activates if temperature exceeds 50°C or smoke levels surpass 200 ppm.

4. Temperature Messages (TempMassage):

- Widget: A text box displaying messages related to the temperature status.
- Messages: Repeated alerts indicating that the temperature is below 50°C.
- Functionality: This widget provides context-specific messages based on the temperature readings.

5. Smoke Messages (smokeMessage):

- Widget: A text box displaying messages related to the smoke sensor status.
- Messages: Repeated notifications stating that the smoke value is below 200 ppm, indicating a normal situation.
- Functionality: This widget updates with alerts based on the smoke level readings, providing important status updates.

6. Light Intensity (lightDensity):

- Widget: A numerical display showing the current light intensity.
- Reading: 206 (unit-less value from the LDR sensor).
- Functionality: This value indicates the amount of light detected, with higher values representing lower light levels.

7. LED State (lightstate):

- Widget: An indicator showing the status of the LED.
- Reading: Active (as indicated by the red dot).
- Functionality: The LED lights up if the temperature exceeds 50°C or smoke levels surpass 200 ppm.

7. Conclusion:

The Ship Engine Room Monitoring System represents a significant advancement in maritime safety technology, offering proactive monitoring and early warning capabilities to safeguard personnel and assets onboard vessels. By addressing the identified challenges and limitations, future iterations of the system hold promise for further enhancing safety measures and operational efficiency within the maritime industry.