

CARBON EMISSION MONITORING SYSTEM IN AVIATION

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Abstract - The aviation sector continues to face environmental challenges with aircraft emission. This project aims to provide viable and economical solutions that include various sensors and a microcontroller to monitor the aviation ecosystem continuously. The system utilizes a gas sensor to monitor the quantity and concentration of noxious gases in the air and continually monitor carbon emissions. An ultrasonic distance sensor is included in the design to assist in his measurement and estimate of the fuel level. Also, the system accounts for the fuel level and the rate of fuel that is being consumed of combustion and the carbon emissions that are being produced. The DS18B20 sensor accounts for the combustion temperature because the combustion temperature affects the efficiency of fuel consumption. The central control unit for the sensor system is an ESP32 microcontroller. The sensors are interfaced and provide inputs that the ESP32 will process to provide outputs of gas concentration, distance, and temperature. The ESP32 microcontroller engineer is designed to provide wireless connectivity for remote mobile and cloud monitoring of the system. In the design, a range for emissions is designed that, when the emissions monitored are greater than this, the system will provide an alarm to notify personnel.

Key Words: HC-SR04(ultrasonic distance sensor), ESP32(microcontroller), DS 18B20(temperature sensor)

1.INTRODUCTION

The aviation industry's global reach and connectivity are invaluable for commerce and logistics. Unfortunately, as air travel increases, so does pollution as aircrafts burn >1.5 billion gallons of fossil fuels annually, and produce tons of CO₂, CO, and other pollutants. The aviation industry's focus on environmental concerns and sustainability is driving the need to monitor, measure, and reduce emissions and pollutants. To provide a safe and sustainable environment for air travel, the aviation industry needs to monitor emissions and pollution as fuels are stored, aircraft's are maintained, and at the gate areas of the airport. The goal of the Carbon Emission Monitoring System for Aviation is to provide a cost-effective and smart environmental monitoring solution. Using gas and distance ultrasonics sensors, a DS18B20 temperature sensor, and an ESP32, the system measures gas concentration, fuel levels, and temperature to provide real-time monitoring of significant parameters. Using the provided data, the system's LCD display provides users

an analysis, and demonstrates emissions, fuel usage, and temperature's effect on combustion, combustion efficiency, and fuel usage. This user-friendly system and supporting sensor technologies provide the industry a cost affordable solution to reduce the environmental impacts of air travel.

2. Body of Paper

The Carbon Emission Monitoring System continuously senses environmental parameters, processes them in a microcontroller, and displays them in real time. The system inputs data, including environmental parameters, sensor data, et cetera, and processes them into informative outputs which are shown to the end user, typically through a display unit. The data processing is a division of labor in which every component plays an important role in the overall efficiency of the system.

ESP32 (Microcontroller)

The microcontroller is the most important component because it is literally the control unit of the system, and in overall, the system hinges, functionally speaking, on its performance. The ESP32 microcontroller is responsible for the system control. It accepts the input signal from all the sensors, processes the signals retrieved, and takes control of what is shown on the output display. This means the ESP32 processes all input data and decides electronically what output data should be shown to the end user through the display unit. The ESP32 handles the input signal from the MQ2 gas sensor in the analog domain and the HC-SR04 ultrasonic sensor and the DS18B20 temperature sensor in the digital domain. The controller converts the signals into gas concentrations, temperature, and distance, respectively. Then ESP32 is programmed using embedded C through the Arduino IDE (Integrated Development Environment) which enables it perform finite computations including filtering and threshold comparison. Further, the ESP32 microcontroller being a modern microcontroller, has a feature which enables Bluetooth and Wi-Fi communications hence supporting the remote monitoring capability of the system. In real. It means the module supports real time data transmission and remote monitoring. Its processing speed is quite satisfactory which ensures a real time, effective and efficient system operation.



emission of gasses are directly related to temperature and fuel consumption. By monitoring temperature of the system, the abnormal conditions such as system overheating and poor combustion can be detected and these problems can be addressed to improve system efficiency and reduce emissions.



MQ2 (Gas Sensor Module)

It detects harmful gases like Carbon monoxide, Methane, and smoke. It functions due to a change in electrical resistance of the sensing material when there are gas molecules. This change switches the analog voltage and is read by the ESP32. The microcontroller then processes the signal and converts the information to gas concentrations. The MQ2 sensor helps track air quality by continuously monitoring the changes and updating in real time the levels of the emissions. It also have a gas concentration alerting feature when the concentration is above the predefined threshold which helps ensure safety and environmental compliance.



LCD1602 (16x2 Display)

The LCD1602 display presents the processed data in a legible and also nice looking form. It has 2 lines and 16 characters which also allows it display gas concentration, temp and distance at the same time. The interfacing is done to the ESP32 which sends controls and display data to the LCD. It helps the users to track the system outputs directly and it also remove the need for auxiliary devices. The users will appreciate it because it is quite handy, simple and also efficient. The LCD increases the user experience.

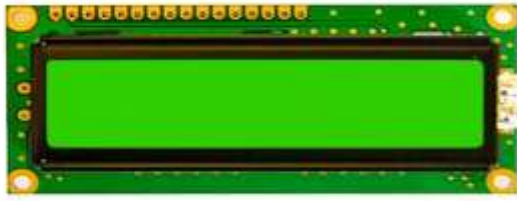
HC-SR04 (Ultrasonic Distance Sensor)

The HC-SR04 ultrasonic distance sensor calculates distance and estimates fuel levels using the reflection of ultrasonic waves. The sensor emits ultrasonic sound waves and reflects them back from the target of measurement. Depending on the time the waves take to travel to the target and reflect back to the sensor, the distance is calculated using the speed of sound. The distance measurement can also be used to estimate the fuel levels or to detect the proximity of objects. The non-contact measurements of the HC-SR04 is advantageous in aviation environments and the impact of fuel level monitoring on fuel consumption and carbon footprint is well established.



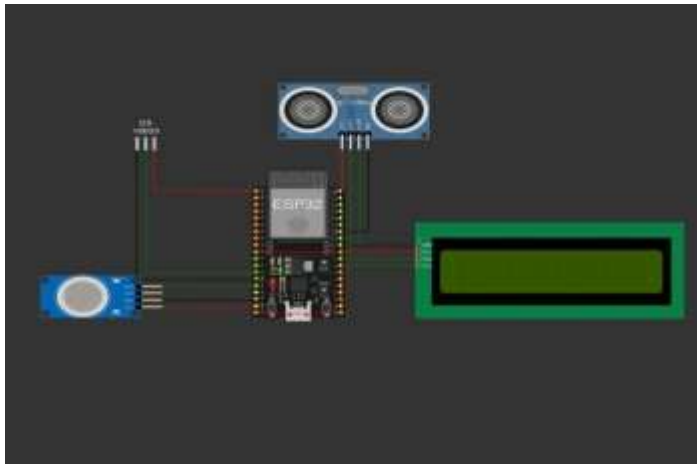
DS18B20 (Temperature Sensor)

The DS18B20 is a digital temperature sensor, and is used in this application to measure the ambient temperature. The temperature sensor uses the one wire communication making the connecting to ESP32 easier. The temperature readings from the DS18B20 are more accurate and by digital reporting the temperature sensor measurement reduces environmental noise and increases reliability of the measurement. The combustion of fuel and the



Overall System Operation

In their overall operations, the sensors collect data from the environment continuously and send it to the ESP32. The ESP32 processes the data, performs the required calculations and translates it to meaningful values. The results are shown on the LCD1602 screen and can be sent wirelessly if the need arises. The system works in real time and includes a threshold-based warning system to alert users when the unsafe level of emissions are exceeded. This integrated system offers precise monitoring, processing of data and management of the environment in aviation.



3. CONCLUSION

The aviation sector continues to face environmental challenges with aircraft emissions. The emissions of aviation activities are made of several pollutants that affect air quality and climate change. The system of emissions monitoring that is being developed is to aid the management of emissions and operational safety and efficiency. This project aims to provide viable and economical solutions that include various sensors and a microcontroller to monitor the aviation ecosystem continuously. The system utilizes a gas sensor to monitor the quantity and concentration of noxious gases in the air and continually monitor carbon emissions. An ultrasonic distance sensor is included in the design to assist in his measurement and estimate of the fuel level. Also, the system accounts for the fuel level and the rate of fuel that is being consumed of combustion and the carbon emissions that are being produced. The DS18B20 sensor accounts for the combustion temperature because the combustion temperature affects the efficiency of fuel

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ACKNOWLEDGEMENT

We're really grateful to everyone who stood by us while we worked on this "Carbon Emission Monitoring System in Aviation" research. First off, a huge thank you to our project guide. Their advice and encouragement made a real difference, and their suggestions helped us tackle both the tricky technical bits and the practical side of things. We want to thank the faculty members in our department, too. They gave us the knowledge and support we needed, and honestly, we couldn't have finished this without their help. The institution deserves a shoutout as well — thanks for providing the resources and creating an environment where we could get this research done right. We're also thankful for our teammates. Their commitment and teamwork kept us on track and played a big part in pulling this project together. And finally, we couldn't have done this without the constant support of our family and friends. Their encouragement meant a lot to us throughout the whole journey.

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