IOT based air quality detection in truck cabins

Archana Chaudhari
Dept. of Instrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
archana.chaudhari@vit.edu

Sharvit Shewade
Dept. of Intrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
sharvit.shewade20@vit.edu

Tinish Uge
Dept. of Instrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
tinish.uge20@vit.edu

Awanti Thigale
Dept. of Intrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
awanti.thigale20@vit.edu

Prathmesh Talekar
Dept. of Intrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
prathmesh.talekar20@vit.edu

Sidhhesh Shirsath
Dept. of Instrumentation Engineering
Vishwakarma Institute of Technology
Pune, India
sidhhesh.shirsath20@vit.edu

***Abstract*-- Air quality monitoring is an important tool for improving air quality, protecting public health, and ensuring compliance with regulations. It can also be used to identify pollution sources, monitor climate change, or support research and development. The goal is to identify the most significant sources and amounts of air pollution in truck compartments, with a focus on particles. Along with investigating how the design of the truck's ventilation system and air purification equipment affects air quality, and developing a robust and effective methodology for measurement in traffic environments. Levels of air pollution were measured both inside and outside the truck cabin, as well as comfort parameters while driving in real traffic, during five extensive full-scale and a number of smaller, scaled-down measurement campaigns. The majority of the experiment was conducted in a truck cabin, which included a dusty environment, city driving, and a stationary road. LPG or butane concentrations of size resolved particles are measured using physical components. Simultaneously, the driver is alerted by calculating vital health characteristics such as heart rate, oxygen level, and so on. After experimentation with a real truck the project was able monitor the air quality and altering the driver by delivering the message.**

***Index Terms*—Air quality, ppm, temperature, humidity, particle measurement, Arduino, nodemcu, mq135, gas sensors, oximeter max30100, cabin air quality, air pollution, truck cabin, ventilation and conditioning. Air temperature, ppm, heating rate, moisture, particle quantification, Microcontrollers, communication module, chemical sensors, oxygen concentrator, truck center console, and temperature control.**

I. INTRODUCTION

Truck drivers frequently work long hours and may travel to heavily polluted areas such as mines. To avoid accidents on the job, drivers must always be alert and in good health. Driver fatigue may occur when the air quality in the cabin deteriorates on occasion. We developed strategies to improve the air quality within the truck cabin while also alerting fleet management and the driver to important health indicators such as heart rate and oxygen saturation, among others. According to previous research, the air filters and air quality outside the vehicle are the most important parameters influencing air quality in vehicles. The experiments revealed repeatable differences in the reduction efficiency of various filters used in ventilation systems. Truck drivers typically work long hours and in polluted environments such as mines. Driver health and alertness while driving is critical for avoiding workplace accidents. Inside the cabin, air quality can deteriorate, which can lead to driver fatigue. The project's goal is to understand the most important sources of air pollution in truck compartments, detect hazardous gases inside the cabin, and investigate how the design of the truck's ventilation system air purification equipment affects air quality in the truck, as well as develop a robust and effective methodology for measurement in traffic environments.

II. LITERATURE REVIEW

Several actions can be taken to correct and improve air quality when a continuous gas system is integrated into a vehicle's vehicle and engine management system. The exhaust source, the engine, would eventually be turned off in an attempt to commit suicide. Audible and visual warnings could be set for poor cabin air quality at moderate hazardous gas concentrations. To reduce the possibility of "false alarms," the integration of a gas system for fatigue and suicide prevention must be able to determine both absolute and change in gas concentrations with reliability. Several actions can be taken to correct and improve air quality when a continuous gas system is integrated into a vehicle's vehicle and engine management system. The exhaust source, the engine, would eventually be turned off in an attempt to commit suicide. Audible and visual warnings could be set for poor cabin air quality at moderate hazardous gas concentrations. To reduce the possibility of "false alarms," the integration of a gas system for fatigue and suicide prevention must be able to determine both absolute and change in gas concentrations with reliability. False alarms are common in commercially available home CO detectors. Similar issues may arise in a cabin environment due to the dynamic nature of the conditions and the harshness of the environment [1].

The fresh air (FA) and RC ventilation modes are selected to observe the gas compositions inside the vehicle cabin. The eight gas parameters chosen to be sampled inside the cabin are O3, CO, VOC, NO2, SO2, CO2, PM2.5, and PM10. The raw data from the sensor is collected without any filtering. The filtering process is implemented in the cloud rather than on the embedded device to reduce the complexity of the embedded system. The development of a cloud-based in-vehicle air quality monitoring system that can forecast current and future cabin air quality [2].

Low-power MEMS metal-oxide gas sensors have sufficient selectivity to classify the AQL inside the car cabin using a multivariate approach similar to how human panellists perceive the AQL. Because the background fluctuates so much, it was necessary to strike a balance between adequate sensitivity and suppression of "false" events. By combining two different event-detection algorithms and finally merging them into an overall AQL, a feasible methodology for accomplishing this was established. Pattern recognition was also used successfully to scale the intensity (concentration) based on human perception. Real-world events that can be distinguished include cigarette smoke, fast-food odour and manure, and biofilaments (flatulence) [3].

The project's goal was to identify the most significant sources and amounts of particle pollution in vehicle compartments. In addition to researching how the design of the vehicle's ventilation system and air purification equipment affects air quality in vehicles, and developing a robust and effective methodology for measuring in traffic environments [4].

This review summarises major findings on air quality inside passenger vehicle cabins reported in the literature, including chemical species, related sources, measurement methodologies, and control measures. The literature shows that air pollutants commonly found inside cabins have high exposure levels and can harm passengers' health. The air pollutants of greatest concern in terms of negative health effects from chronic exposure are PM2.5, PM10, ozone, NO2, B(a)P, and 1,3 butadiene (WHO, 2006; WHO 2018). There is mounting scientific evidence that nanoparticles, rather than mass concentrations, and some PM compounds are more dangerous than general PM2.5. The most commonly discussed compound is elemental or black carbon, which corresponds to soot particles (WHO 2006, WHO 1013, WHO 2018 and references there in) [5].

Air filter with and without an active carbon coating, for measuring efficiency, five separate air filters are considered, three of which are (old) carbon-coated filters and one new air filter with and without an active carbon coating. Examine the performance of the current CEVT Air-Purification System for Multiple Air Pollutants, primarily particles but also gases. Air pollutants include nitrogen oxides (NOx), particulate matter (PM1, PM2.5, PM10), carbon monoxide (CO), ozone (O3), and volatile organic compounds (VOC). The long-term air quality monitoring is not mentioned in the paper. There is no mention of the use of filters or their long-term impact on results [6].

III. PROPOSED METHODOLOGY

This section presents the proposed work For air quality monitoring the air quality monitoring equipment:

Consist of node Microcontrollers and sensors:

1. Arduino uno, ESP8266
2. MQ135, LED, Buzzer
3. Cayenne, open-source software

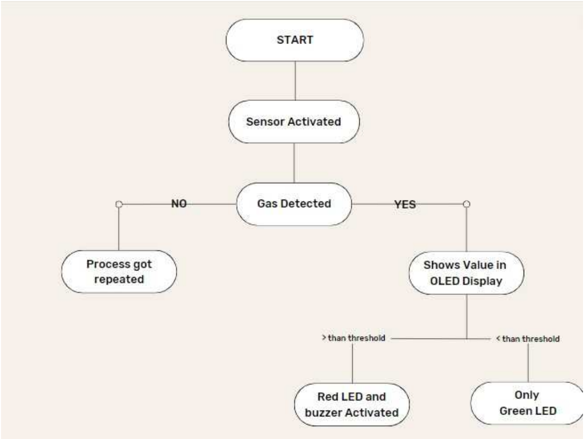

FIG.1: Flow Chart representing the working flow of real time air quality detection

figure-1 represents the flow of our project in which, when the sensor gets activated (gas sensor), it shows the value on OLED display. If the output value of gas sensor is greater than the threshold value given to the microcontroller then the Red LED glows and buzzer gets activated. and if the output value of gas sensor is less than the threshold value given to the microcontroller then Only Green Led glows. But, if the harmful gases aren't detected then the whole process gets repeated.

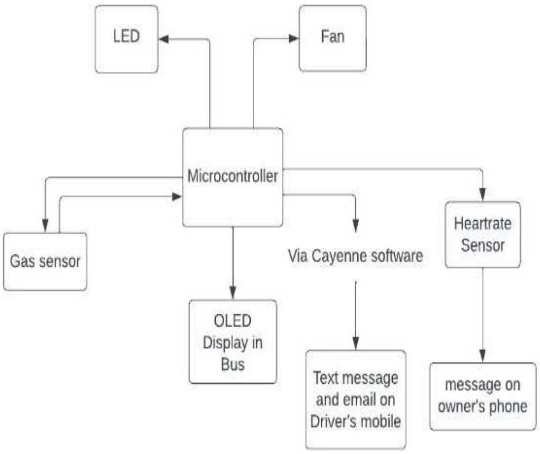

FIG.2: Block diagram representing the real time hardware working requirements

figure-2 represents the block diagram of our project in which the central block represents microcontroller which give commands to sensors, actuator(fan) and indicator. If the output value is greater than threshold value then messages as well as mail get forward to the users' phone using cayenne software.

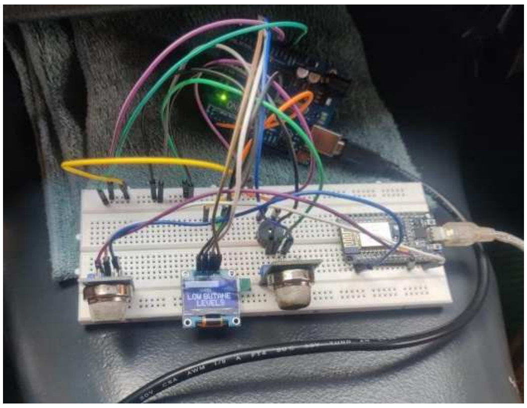

FIG.3: Real Time Hardware Integration

FIG.4: Real time working

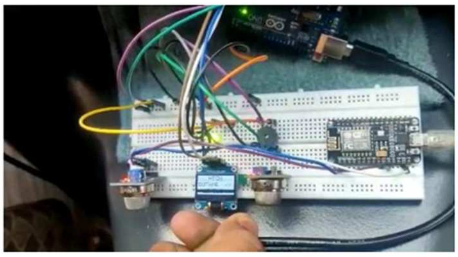

FIG.5: Real time display of Air Quality

figure-3,4,5 represents the real time hardware integration of our project. We implemented it in truck which gives us real time data of it.

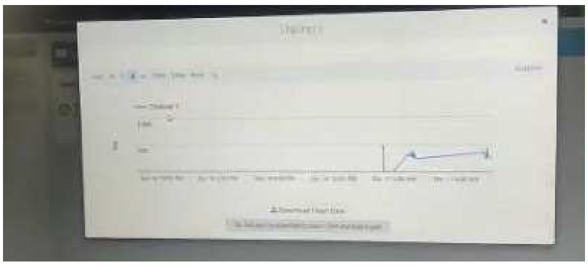

FIG.6: Graph Representing hourly air quality index

figure-6 represents the graph of variation in output of gas sensor.

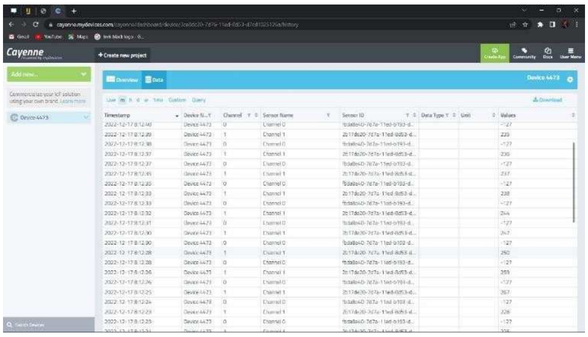

FIG.7: Dataset Recorded of Air Quality Index on Cayenne Software

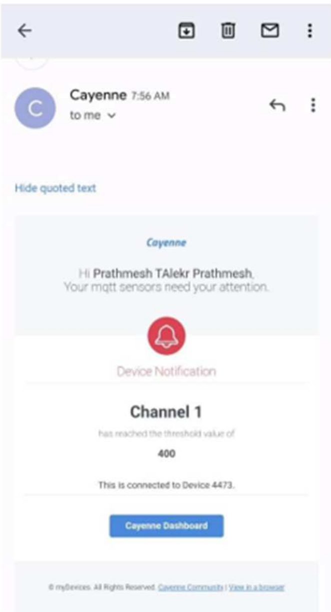

FIG.8: Email Configuration

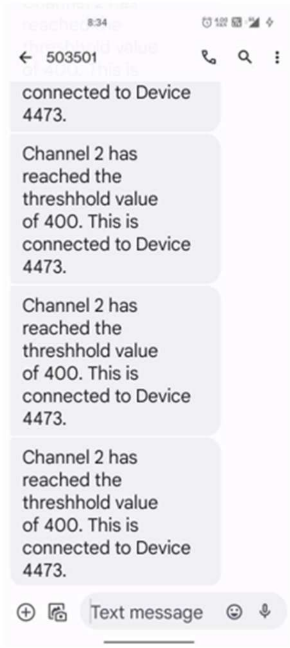

FIG.9: Text Configuration

figure-8,9 represents the forwarded mail as well as text massage of exceeding of gas to user's mobile.

IV. WORKING / EXPERIMENTATION

The working of this system starts with the release of LPG near the gas sensor. For experimentation we have used a lighter. As soon as the LPG is released mq9 gas sensor detects it and warning is given by displaying “High level butane” on OLED display with the buzzer and LED turned on. The components include Arduino nano board, mq9 gas sensor module, 0.96 OLED display, two pin buzzer, one led and wires.

The connections of the OLED with Arduino nano board include the VCC will connect to 5V, the GND will be connected to the GND, the SCK pin will be connected to the analog pin 5 and SDA pin will be connected to analog pin 4 of Arduino nano board. Further, the connection of MQ9 gas sensor with Arduino uno include, VCC connected to 5V Arduino, GND will be connected to the GND, Analog pin of gas sensor will be connected to analog pin 0 of Arduino. For connection of buzzer to Arduino, the positive end of buzzer will be connected to digital pin 2 whereas the negative end will be connected to GND. Similarly, for LED connections, positive end will be connected to the digital pin 3, and negative end will be connected to the GND.

The code is written in Arduino IDE software, the libraries include Adafruit GFX and Adafruit SSD306.

Then define analog values, buzzer and led for digital pins. Then we have analog values as input and buzzer as output and led as output as well. Then some conditions are mentioned in the code to detect the level of butane whether it is high or low.

In our project, for experimentation purpose we kept 400 as maximum limit but it can be changed and reset accordingly. Also, the sensitivity can be adjusted using the knob which is behind the mq9 gas sensor.

Addition to this, when the butane level will rise or will be high there will be a message or an alert given to the driver to stop the vehicle or take certain precautions. This message or alert will be given through a software application or website.

V. FUTURE SCOPE

The potential application is that device which we have can be done in a compact way by reducing the size of the device for further implementation or the modifications which can be that detecting the amount of pollution which can be determined inside the cabin. We can also add a GSM module so that the driver is alerted as soon as possible. In moreover, future work with air quality would then focus on development in relation to energy efficiency, as well as detecting endocrine disrupting chemicals and risk assessments.

VI. CONCLUSION

Ventilation system with and without an active carbon coating, for measuring efficiency, five separate air filters are considered, three of which are (old) carbon-coated filters and one new air filter with and without an active carbon coating. Examine the performance of the current CEVT Air-Purification System for Multiple Air Pollutants, primarily particles but also gases. Air pollutants include nitrogen oxides (NOx), particulate matter (PM1, PM2.5, PM10), carbon monoxide (CO), ozone (O3), and volatile organic compounds (VOC). The long-term air quality monitoring is not mentioned in the paper. There is no mention of the use of filters or their long-term impact on results. This review summarises major findings on air quality inside truck cabins reported in the literature, including chemical species, related sources, measurement methodologies, and control measures. The research has shown that air pollutants commonly found inside truck cabins are at high exposure levels and can harm truck drivers' health. Under different ventilation or driving conditions, different air pollutants emitted by different sources are at different levels. Ventilation mode and airflow rate, vehicle age and airtightness, interior materials, passenger count, and outside pollution level may all play a role in determining in-cabin pollutant concentrations. Some guidelines, national standards, or protocols have been developed to better protect drivers and passengers while in transit and travelling. The development of environmental health manufacturing standards would be a significant step towards more environmentally friendly vehicles that consider the well-being of humans inside truck cabins.

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