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Optimizing Transportation Safety with Realtime Air Quality Monitoring and Health Alert System

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Abstract: ***The proposed system is a smart air quality monitoring and health alert system designed specifically for truck drivers. The system aims to address the issue of poor air quality within truck cabins, which can lead to a range of health problems for drivers who spend extended periods on the road. The system utilizes advanced sensors to monitor the air quality within the truck cabin, measuring a range of parameters including carbon monoxide, carbon dioxide, and particulate matter. In addition to air quality monitoring, it also includes a health alert system that can notify drivers of potential health risks based on their personal health data and environmental conditions. This feature helps drivers take proactive measures to prevent health problems and maintain their well-being while on the road. Proposed system is a cost-effective and user-friendly solution that can improve the health and safety of truck drivers, ultimately benefiting both the drivers and the trucking industry. It can also be easily integrated into existing fleet management systems, making it a scalable solution for trucking companies of all sizes.***
Keywords: Arduino UNO, Transportation, Logistics & IOT

I. INTRODUCTION

Drivers of trucks spend a lot of time on the road, often in small spaces like truck cabins. Unfortunately, a variety of factors, including exhaust fumes, dust, and other pollutants, can contribute to poor air quality in these cabins. Unfortunate air quality can essentially affect the wellbeing and prosperity of transporters, prompting a scope of medical conditions like respiratory issues, weariness, and cerebral pains. We have created a smart air quality monitoring and health alert system for truck drivers, to address this issue. The system makes use of cutting-edge sensors to keep an eye on the cabin of the truck's air quality and send out alerts and reports in real time. In addition, the system includes a health alert system that, using information about drivers' personal health and the environment, can alert them to potential health risks. The system aims to improve truck drivers' health and safety by informing them of potential health risks and providing them with actionable information about the quality of the air they are breathing. Trucking companies of all sizes can use the system because it is designed to be affordable and easy to use. The system has the potential to improve the overall well-being of truck drivers and contribute to a safer and healthier trucking industry by addressing the issue of poor air quality in truck cabins.

II. LITERATURE REVIEW

Air quality and its impact on public health have collected significant attention in recent research. The authors of [1] discuss about the calculation of the air quality index (AQI), travel time, distance, and their implications on health. The AQI serves as a crucial tool for assessing air pollution levels and aiding decision-making. By studying the AQI, the study offers a medium for individual awareness about the polluted areas. Furthermore, the analysis of travel and transportation parameters contributes for awareness plans that minimizes health risks due to air pollution. Beyond this, the paper explores the broader perspectives of air pollution, particularly its association with respiratory and cardiovascular diseases.

Further, the next research [2] talks about focusing in automotive safety using integration of Internet of Things (IoT) technology in the automotive sector. This research introduces an innovative approach by incorporating IoT sensors into an automated vehicle braking system and driver health monitoring. By monitoring physiological parameters such as heart rate and blood pressure, the proposed system can detect driver health issues in real-time. In cases of health concerns like driver fatigue, the system can automatically engage the vehicle's braking system, thus mitigating potential accidents. This amalgamation of IoT technology with automotive safety systems underscores the potential for technology to enhance road safety with a focus on human well-being. Similar approach [3], mentions exploration of driver health monitoring, employing Raspberry Pi technology. The study proposes a comprehensive system that continuously tracks essential health parameters, including heart rate, blood pressure, body temperature, and alcohol levels.

This dynamic monitoring equips the system to detect potential hazards such as driver drowsiness and other health issues that could compromise driving ability. The integration of this analysis with the vehicle's ignition system ensures that only drivers in optimal health conditions can operate the vehicle, thereby enhancing road safety. Moreover, similar studies [4] have researched into driver health monitoring through IoT technology that introduces a solution to address the significant issue of drowsy driving, a leading cause of accidents. By leveraging techniques such as Video Stream Processing and deep learning, the proposed system analyzes driver behavior, particularly focusing on eye blink patterns. The system establishes a predictive model for detecting drowsiness and issues alerts to the driver and relevant authorities. The outcome of the research helped for ideation of alerting mechanism for the system.

Similar approaches are researched [5] emphasizing on the importance of robust measuring techniques for air pollution using Air Quality Index (AQI) as a tool for evaluating air pollution levels and their implications. The study provides a comprehensive overview of AQI methodologies, highlighting their strengths and weaknesses. It underscores the need for continuous refinement of AQI methodologies to account for the dynamic nature of air pollution and its multifaceted impact on public health. The study [6] proposes the incorporation of Dijkstra's algorithm to identify the safest travel routes based on air quality information. Next the sensor information is studied [10], using air quality monitoring through the utilization of IoT technology and machine learning. The study presents an integrated framework that employs IoT sensors, MQ135 and MQ7, to measure air quality parameters. Machine learning algorithms are utilized to derive insights from the collected data. This approach enables accurate and real-time monitoring of air pollutants, thus enhancing our understanding of environmental health. Within the field of gas sensing [11], introduces an innovative solution for detecting multiple gases using the MQ135 sensor. The study proposed a cost-effective modification to the sensor's response unit, allowing for the detection of different gases based on their distinct physical properties. This cost reduction facilitates the widespread utilization of the MQ135 sensor for gas sensing applications. The outcome of these researches provided sensory information through various approaches.

Further, more deep study research regarding air pollutant and pollutant measure oriented research were reviewed. The research [9] mentions the relationship between on-road transportation and fine particulate matter (PM2.5) concentration. The study quantifies the impact of transportation-related activities on PM2.5 levels using advanced statistical methods. This analysis provides the importance of the role of on-road transportation in contributing to air pollution and provides insights for researchers aiming to control pollution concerns. The similar research [12] which helped in gaining more clearer details which was titled as, "Laboratory evaluation of particle size-selectivity of optical low-cost particulate matter sensors" provided a detailed and precise evaluation of the Sharp GP2Y1010AU0F sensor for particulate matter sensing. The study assesses a variety of sensors finding out its suitability for measuring particulate matter, especially PM2.5 and PM10. Despite certain limitations in size-selectivity, the sensor proves to be an economical alternative for extending spatial coverage in air quality measurements. Therefore, the outcome research resulted in choosing the appropriate and suitable sensor.

III. METHODOLOGY/EXPERIMENTAL

A. Proposed System Architecture

To deal with the critical issue of poor air quality and ensuring health risks faced by high altitude truck drivers, our system is structured in a way that it combines of all the necessary components and sub-systems that help in safeguarding the environment of the drivers. Broadly, the system consists of three major parts that are – air quality measuring mechanism, health monitoring mechanism, and alerting mechanism. The overall aim of the proposed system is to deliver a combination of these sub-systems to achieve greater usability.

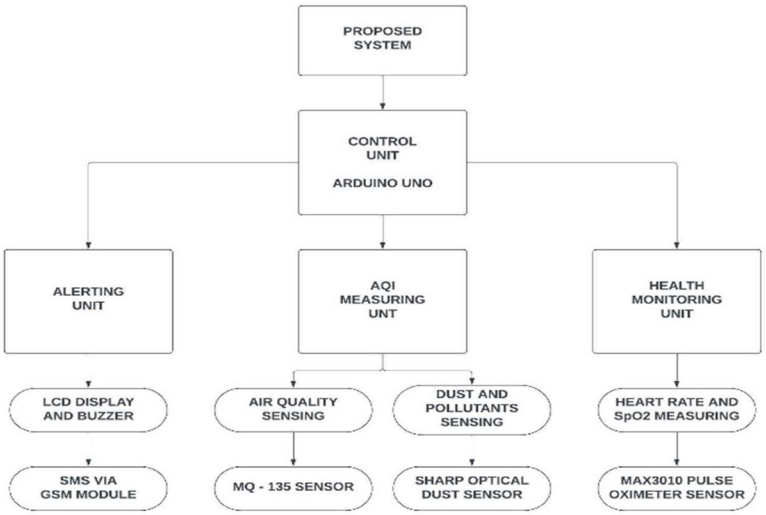
The proposed system includes a centralized unit which is the control unit. The control unit is a sub-system that is responsible for carrying out all the necessary tasks that need to be performed. The main objective of the control unit is to control all other sub-systems – the air quality measuring unit, health monitoring unit and alerting unit.

The components utilized in the proposed system provide the desired functionalities accordingly through their respective units. The control unit consists of an Arduino Uno microcontroller, that is programmed through an Arduino IDE. While the air quality measuring unit consists of extremely useful sensors that are – MQ135 and SHARP optical dust sensor (GP2Y1010AU0F). Whereas, other units like health monitoring unit and alerting unit include the electronic components like Pulse sensor module, and GSM with LCD display for alerting, respectively.

Further, the role of the overall sub-systems and their respective functionalities through their components is been discussed below in details:

1) *Air Quality Measuring Mechanism:* At the core of our system lies the Air Quality Measuring Mechanism, addressing the critical concern of poor air quality faced by high-altitude truck drivers. This pivotal unit ensures driver safety by continuously monitoring air quality parameters through the MQ135 sensor and the SHARP optical dust sensor (GP2Y1010AU0F) for measuring dust concentrations of pollutants, specifically PM2.5. Real-time data is fed into the Arduino Uno microcontroller, programmed via Arduino IDE, where predefined threshold values are analyzed against the live air quality and dust measurements. The mechanism's immediate feedback aids in informed decision-making, allowing drivers to adjust routes or breaks to mitigate health risks arising from air pollution.
2) *Health Monitoring Mechanism:* Prioritizing the well-being of high-altitude truck drivers, our Health Monitoring Mechanism integrates advanced technology to ensure their physical health during challenging journeys for emergency usage. By harnessing the pulse oximeter sensor MAX3010, it tracks real-time pulse/heart rates and blood oxygen saturation (SpO2) levels. These vital parameters are crucial indicators of cardiovascular performance and oxygen supply at high altitudes. The collected data is processed by the microcontroller, which continuously compares it to established health benchmarks. Any deviations trigger alerts, empowering drivers to take necessary actions and logistics companies to intervene promptly, preventing potential health complications in hazardous conditions.
3) *Alerting Mechanism:* Facilitating timely communication in critical scenarios, the Alerting Mechanism acts as a vital link between the system and drivers, ensuring immediate responses to potential risks. This mechanism seamlessly integrates an LCD display and a GSM module. In situations where air quality levels, or dust concentrations, or drivers' health parameters exceed safe thresholds, the microcontroller triggers the Alerting Mechanism to convey necessary alerts/messages to the driver as well as the logistics department. The LCD display provides visual alerts to drivers, while the GSM module communicates vital information to the logistics department for coordinated action. This preventative method improves driver security and emphasizes the mechanism's importance in preventing emergencies.

B. Block Diagram



IV. APPLICATION

This specific project, the smart air quality monitoring and health alert system for drivers, has numerous applications that can help improve air quality and protect the health of drivers and passengers. Here are some major applications of this innovative technology: Health and Safety of Drivers and Passengers: The system can be used to monitor the air quality inside a vehicle and alert the driver when the air quality reaches dangerous levels. This feature can help protect the health and safety of both the driver and passengers.
Improved Driving Experience: By providing real-time air quality data and suggestions for improving air quality, The system can help drivers create a more comfortable and healthy driving environment. This can lead to a more enjoyable and stress-free driving experience.

Environmental Monitoring: The system can be used to collect data on air quality levels in different regions and cities. This data can be used by local authorities and researchers to understand air pollution trends and develop effective strategies for reducing pollution.
Compliance with Air Quality Regulations: Many cities and countries have air quality regulations that drivers must comply with. The system can help drivers stay in compliance by providing real-time air quality data and alerts.
Health Monitoring: The wearable device component of The system can also be used to monitor the respiratory health of drivers in real-time. This can help identify potential health issues early on and allow drivers to take proactive measures to protect their health.
Overall, The system has the potential to revolutionize the way we think about air quality and health in the context of transportation. By providing real-time data and alerts, this innovative technology can help drivers and passengers breathe easier and stay healthier on the road.

V. RESULTS AND DISCUSSION

AQI Value	Health Concerns	PM2.5 Concentration (mg/m³)	Daily AQI Color	Level Number
0-50	Good	0-30	Green	1
51-100	Satisfactory	31-60	Yellow	2
101-200	Moderate	61-90	Orange	3
201-300	Poor	91-120	Red	4
301-400	Very Poor	121-250	Purple	5
401-500	Severe	251-500	Maroon	6

Fig [A]. Air Quality Index

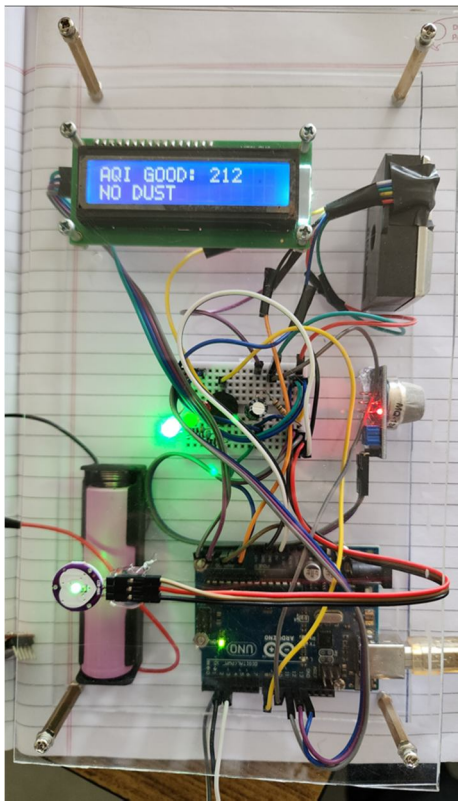


Fig [B]. Implemented System

VI. CONCLUSION

The Smart Air Quality Monitoring and Health Alert System for Transportation is an innovative project that has the potential to significantly improve the health and well-being of commuters and transportation workers. This is the conclusion for the Smart Air Quality Monitoring and Health Alert System for Transportation project. The system can assist users in avoiding exposure to harmful pollutants and making informed decisions regarding their travel routes and modes of transportation by continuously monitoring air quality levels in real time and providing alerts and recommendations. In addition, the incorporation of health tracking features like

heart rate and respiratory rate monitoring can supply individuals with useful data to assess the health effects of air pollution and take the necessary precautions. By providing data on air pollution levels in various locations, the project also has the potential to improve public health by assisting in the formulation of policies aimed at lowering pollution and enhancing air quality. Overall, the Smart Air Quality Monitoring and Health Alert System for Transportation is a promising initiative that can have a significant impact on commuters' and transportation workers' lives and address a significant public health issue.

VII. ACKNOWLEDGEMENT

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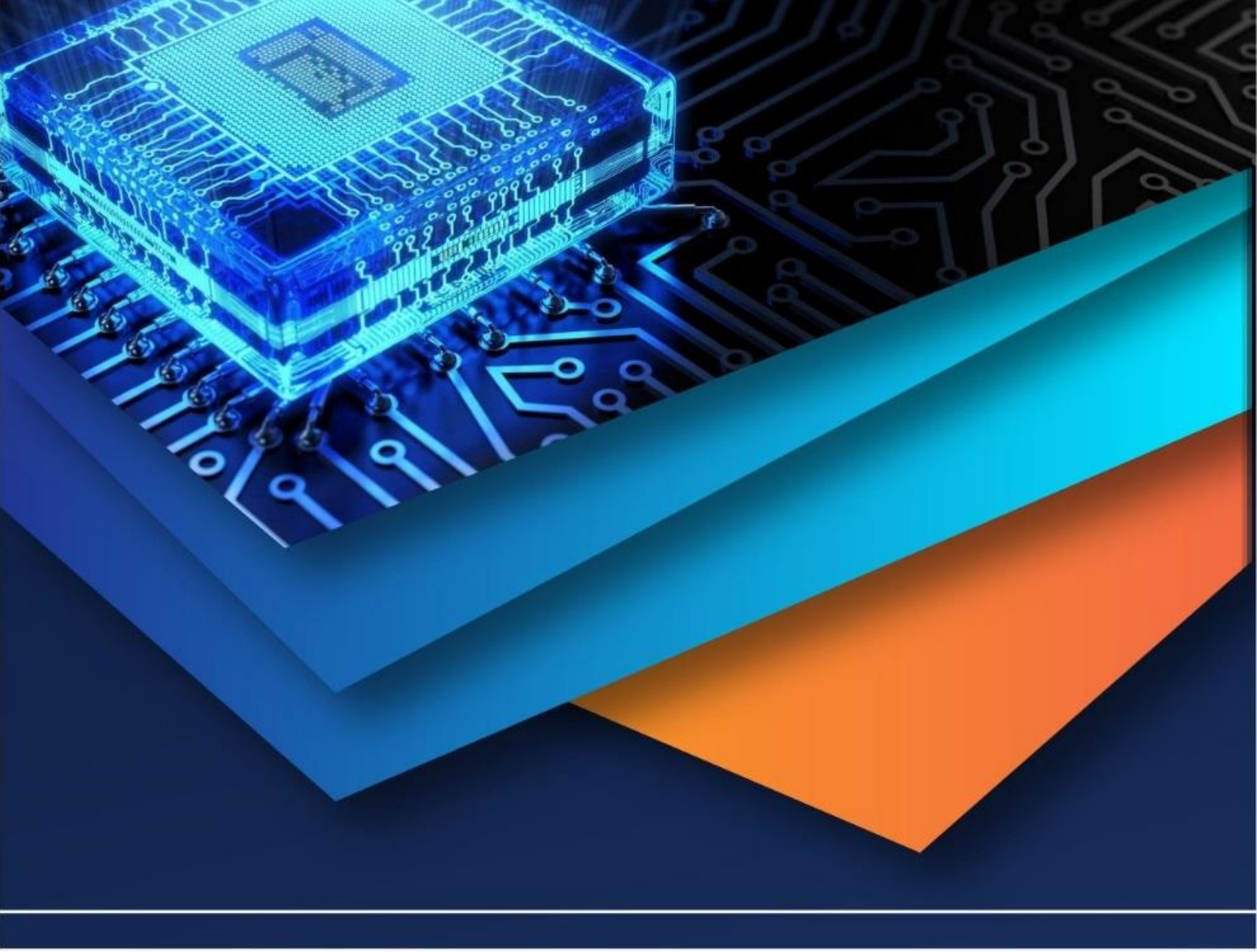

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