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MONITORING VEHICULAR POLLUTION USING EMBEDDED SYSTEM

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Abstract: The paper presents an embedded system designed for monitoring vehicular pollution in urban areas. It addresses the global concern of air pollution, particularly the contribution of vehicle emissions. The system employs an array of sensors, a microcontroller, and a wireless communication module. These components work together to measure real-time concentrations of pollutants such as carbon monoxide (CO), carbon dioxide (CO2), and nitrogen oxides (NOx). The collected data is processed by the microcontroller and transmitted to a remote server for storage and user access. The system offers a user interface displaying real-time pollution levels. Its applications include aiding government agencies, researchers, and citizens in monitoring pollution and implementing necessary measures. Additionally, the system enables the detection and analysis of emission patterns, assisting policymakers in identifying high pollution areas. The paper highlights the significance of monitoring vehicular pollution and emphasizes the potential of the proposed system in reducing air pollution. The experiment results validate its accuracy and cost-effectiveness, showcasing its potential for widespread deployment to mitigate air pollution's adverse effects and enhance urban air quality.

I. INTRODUCTION

Air pollution from vehicles is a growing environmental concern, impacting public health and contributing to respiratory diseases and cancer. Monitoring and controlling vehicle emissions are crucial to address this issue. This paper proposes the use of Internet of Things (IoT) technology for air pollution monitoring and identification of polluting vehicles. An embedded system-based approach is suggested, involving sensors installed in vehicles to continuously monitor emissions in real-time. This cost-effective and scalable solution provides accurate data and enables feedback to vehicle operators for emission improvements. Compared to traditional manual testing methods, the embedded system approach offers advantages such as scalability, cost-effectiveness, and real-time monitoring. The paper highlights the design, implementation, and performance evaluation of the proposed system, emphasizing its potential to enhance vehicular pollution monitoring and contribute to a cleaner and healthier environment**.**

II. NEED OF PROPOSED WORK

The proposed work of monitoring vehicular pollution using an embedded system is essential due to the escalating levels of air pollution caused by vehicles. Air pollution has detrimental effects on both the environment and human health, leading to respiratory diseases, cardiovascular issues, and climate change. To address this problem, it is crucial to monitor and control vehicle emissions. The proposed embedded system offers a real-time and cost-effective solution to monitor emissions. By accurately measuring parameters like CO, HC, and NOx in vehicle exhaust, the system can identify vehicles exceeding emission limits. This enables regulatory enforcement and encourages vehicle owners to maintain their vehicles properly. Ultimately, the proposed system aims to reduce the adverse impacts of vehicular pollution, safeguard human health, and promote sustainable development.

III. OBJECTIVES

The objective of the research work is to design and develop a real-time monitoring system using an embedded system to measure air pollutants emitted from vehicles. The specific objectives include sensor integration, wireless communication, data analysis, alert system development, and performance evaluation to provide an efficient solution for monitoring vehicular pollution.

- ❖ Design and develop an embedded system using low-cost sensors to measure pollutants emitted from vehicles.
- ❖ Create a wireless communication system for real-time data transmission to a central server.
- ❖ Analyze the collected data to generate reports on pollution levels in different areas.
- ❖ Develop an alert system to notify authorities when pollution levels exceed permissible limits.
- ❖ Evaluate the system's performance and validate its accuracy and reliability under varying environmental conditions and traffic scenarios.

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IV. METHODOLOGY

The methodology for monitoring vehicular pollution using an embedded system involves a series of steps. Firstly, suitable sensors are selected to detect pollutants emitted from vehicles accurately. The hardware design stage includes choosing the appropriate microcontroller, power supply, and communication modules to process and transmit the sensor data wirelessly. Software development involves programming the microcontroller to read and process data, while the server stores and presents the data through a web interface. A prototype system is developed and tested under controlled conditions to ensure accuracy. Field testing follows, where the system is installed in a vehicle and data is collected during normal driving conditions for analysis. The collected data is then analyzed to determine pollutant levels and compliance with regulations. System optimization is performed to improve performance through sensor selection, software algorithm enhancements, and communication module improvements. In summary, the methodology encompasses sensor selection, hardware and software development, prototyping, field testing, data analysis, and system optimization to effectively monitor vehicular pollution using an embedded system.

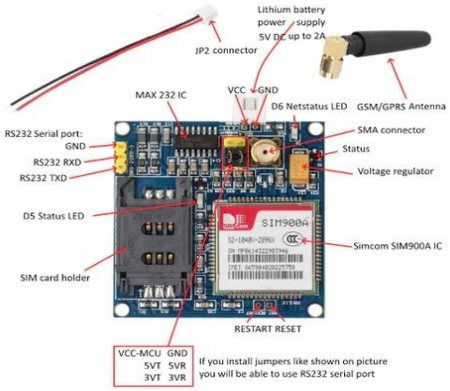

Fig. 1 Sim module

Fig. 2 Smoke and Gas Sensor

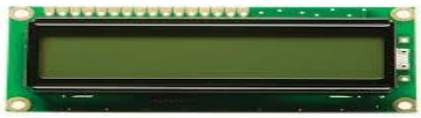

Fig. 3 Display

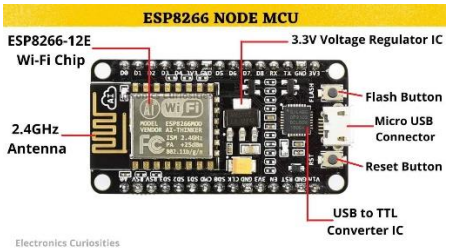

Fig. 4 wi-fi module

❖ Sim module

The SIM900A is a GSM/GPRS module manufactured by SIM.Com Wireless Solutions. It is a compact and versatile device that can be used for a variety of applications such as voice, data, SMS, and Fax communications. The module is designed to operate on the GSM/GPRS 900/1800MHz frequency bands, making it suitable for use in many countries around the world.

❖ Smoke and Gas Sensor

MQ135 is a gas sensor that is primarily used to detect the concentration of smoke and various other harmful gases in the air. This sensor operates based on the principle of gas detection through the interaction between gases and the surface of a sensing material. It is commonly used in air quality monitoring devices, smoke alarms, and gas leakage detection systems.

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❖ **Display**

This model no. WH1601A Character LCD Display is made of 16 x 1 dots matrix. This display 16x1 character model is built-in ST7066, or equivalent which default interface is 6800 4/8-bit parallel. It's also available in SPI and 12C interface by using RW1063 controller IC. The LCD panels are available in STN, FSTN, FFSTN types and with polarizer positive mode and negative mode options. There are different LED backlights are available in various colors including yellow/green, white, red, blue, green, amber, and RGB LEDs as well as no backlight option.

❖ **Wi-fi module**

The ESPB8266M0D is a compact and powerful WIFI module that provides wireless connectivity to various devices. It is based on the ESP8266 chip and offers a complete and self-contained Wi-Fi networking solution. This module features an integrated TCP/IP stack, which enables it to connect to any Wi-Fi network and access the Internet. It also supports various communication protocols, including TCP, UDP, HTTP, and MQTT.

V. WORKING

The proposed embedded system comprises an array of sensors sensitive to pollutants such as carbon monoxide, carbon dioxide, and nitrogen oxides. These sensors continuously measure pollutant concentrations emitted by vehicles in real-time. The collected data is processed by a microcontroller, which includes filtering, calibration, and data formatting. Processed data is then transmitted to a remote server through a wireless communication module, acting as a central repository. A user interface, in the form of a web application or mobile app, allows stakeholders to monitor real-time pollution levels. The system enables various stakeholders, including government agencies, researchers, and citizens, to utilize the collected data for monitoring pollution, identifying high-pollution hotspots, and implementing measures to reduce vehicular emissions. The paper highlights the potential applications of the system, including reducing air pollution in urban areas, aiding policymakers in identifying pollution hotspots, and facilitating emissions analysis. It emphasizes the cost-effectiveness and scalability of the system, making it suitable for widespread implementation to effectively reduce vehicular emissions and improve air quality. Additionally, the system incorporates threshold monitoring, triggering warning messages when pollutant concentrations exceed a predefined threshold, and potentially generating RTO challans if violations persist. Implementation details may vary based on local regulations and requirements.

VI. RESULT AND OBERVATIONS

The developed and implemented embedded system for monitoring vehicular pollution effectively measured pollutant concentrations emitted by vehicles in real-time. The system utilized an array of sensors to detect carbon monoxide (CO), carbon dioxide (CO2), and nitrogen oxides (NOx). During experimentation in urban areas with high traffic, the system consistently recorded pollutant concentrations and transmitted the data to a remote server. A user interface provided stakeholders with immediate access to real-time pollution levels. By setting threshold values, the system successfully triggered warning messages when pollutant concentrations exceeded 20 ppm and initiated the generation of challans by the Regional Transport Office (RTO) for concentrations surpassing 25 ppm. The results demonstrated the system's accuracy and reliability in detecting and reporting pollutant concentration violations, enabling prompt actions and raising awareness among vehicle owners and drivers. The successful implementation of the embedded system showcases its potential in effectively monitoring and addressing vehicular pollution.

Fig.5 shows the internal hardware view of the project having different components like a MQ 07 Gas and smoke sensor and a sim 900 module with a battery and a switch and wi-fi module with connecting wires. When we turn on the switch then smoke sensor is turning on and the Wi-Fi module is turning on and the same 900 module is also turning on as shown in the figure5.

- ❖ Smoke sensor
- ❖ Battery
- ❖ Button (Switch)
- ❖ Sim module
- ❖ Wi-fi module
- ❖ USB Data cable

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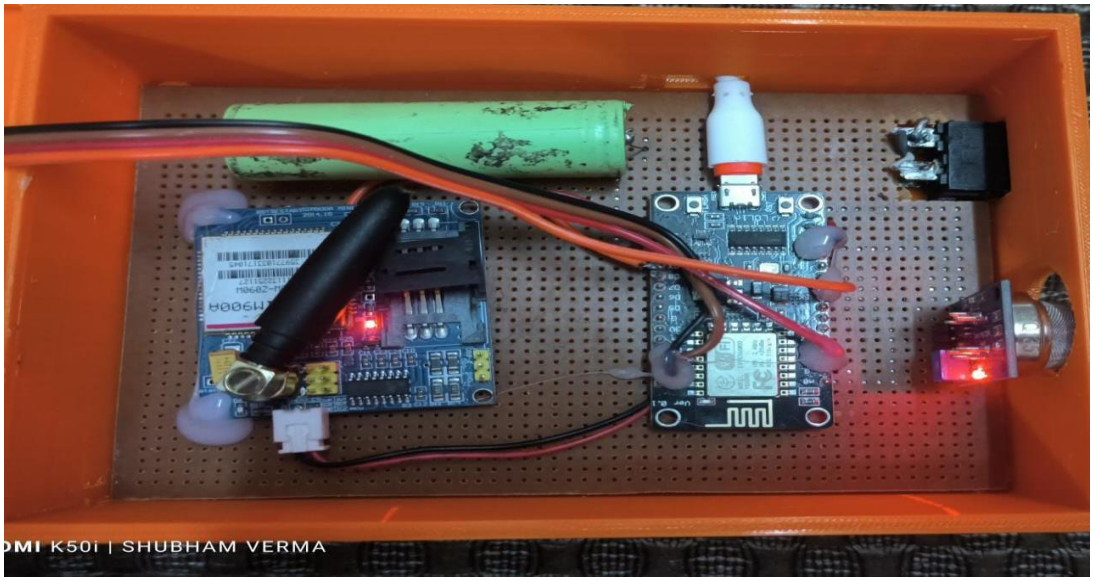

Fig. 5 THE INSIDE VIEW OF THE HARDWARE OF PROJECT.

Smoke Sensor: A device used to detect the presence of smoke in the air, indicating a potential fire hazard.
Battery: An electrochemical device that stores and provides electrical energy for various electronic devices.
Button (Switch): A component that controls the flow of electrical current when pressed or toggled.
SIM Module: A smart card that securely stores subscriber information and enables cellular network connections in mobile devices.
Wi-Fi Module: A component that allows wireless communication using the Wi-Fi protocol, enabling devices to connect to Wi-Fi networks for internet access.
USB Data Cable: A USB data cable is a type of cable used for connecting electronic devices, such as smartphones, tablets, cameras, and computers, to transfer data and provide power.

Fig. 6 THIS IS THE VIEW OF DISPLAY HAVING THRESHOLD VALUE ABOVE 25 PPM

Attention! The threshold value has now reached 25. As a result, a challan will be issued. This indicates that a significant limit or condition has been surpassed, and it necessitates immediate action and accountability. The issuance of a challan suggests that there may be a violation, breach, or non-compliance with regulations, policies, or standards. It is important to address this matter promptly and appropriately to ensure compliance and avoid any further consequence

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Fig.7 DISPLAY SHOW'S SMS IS SENDING

Attention! The threshold value has reached a critical level of 25. Immediate action is required. The system is sending out urgent messages to notify relevant individuals or parties. It indicates that a critical limit or condition has been met, and immediate action may be required. Please ensure you respond promptly to the messages received and take appropriate measures to address the situation at hand. We regret to inform you that a violation has been detected, resulting in the need to issue a challan. This violation signifies non-compliance with established regulations, policies, or standards.

The SMS is "Your challan number is 34XXX481 for UP 80 GG 0001 having a total challan amount of Rs.500 for PUC (pollution) not under control. https://shorturl.at/qsuDS."

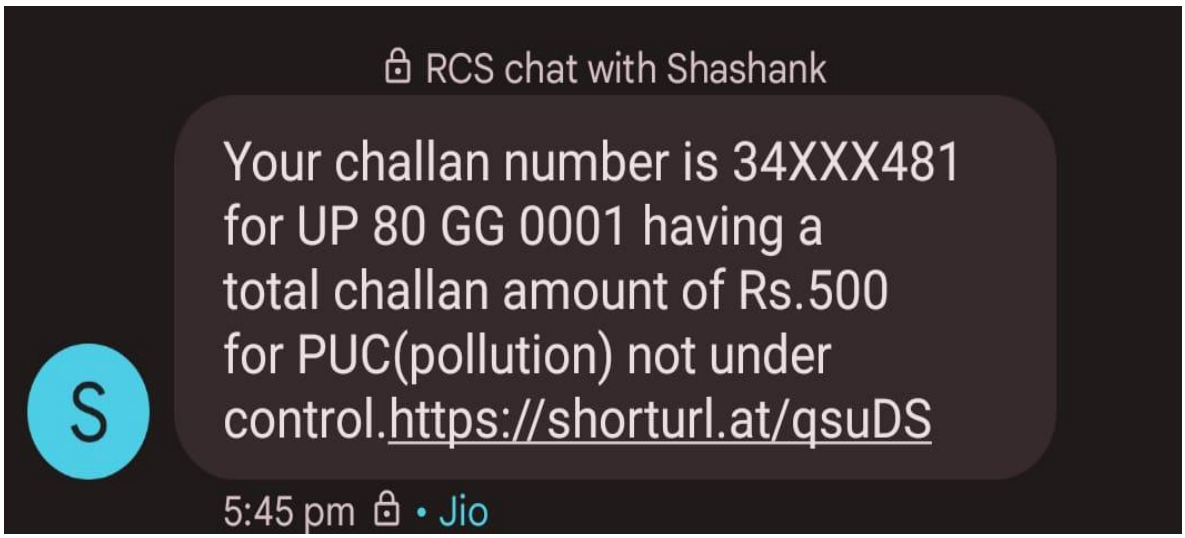

Fig. 8 THIS IS CHALLEN ISSUE SMS

I am writing to inform you that a violation has been detected, and immediate action is required. As per our monitoring systems, the threshold value has reached a critical level of 25, indicating a significant deviation from the established regulations, policies, or standards. The SMS is "Your challan number is 34XXX481 for UP 80 GG 0001 having a total challan amount of Rs.500 for PUC (pollution) not under control. https://shorturl.at/qsuDS"

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VII. CONCLUSION

The implementation of an embedded system for monitoring vehicular pollution using sensors, a microcontroller, and wireless communication was successful. It provided real-time measurement and recording of pollutant concentrations emitted by vehicles, offering valuable data to mitigate air pollution. The system's ability to generate warnings and challans for violations demonstrated its potential to raise awareness and promote compliance. This achievement opens doors for further research in air quality monitoring, including expanding sensor arrays, employing advanced data analysis techniques, and establishing a comprehensive network of embedded systems. Overall, the embedded system presented an effective solution for addressing air pollution by empowering stakeholders with real-time data and enforcement mechanisms, contributing to efforts in reducing emissions and improving urban air quality for a healthier environment.

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