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Emission Control System in Urban Environment Using IoT

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Abstract: Vehicles have become the main part of regular life. Situations and circumstances demand the usage of vehicles in this urban life. Transportation carbon emission is a significant contributor to the increase of greenhouse gases, which directly threatens the change of climate and human health. Under the pressure of the environment, it is very important to measure transportation carbon emissions on a real-time basis. We get the transportation carbon emission information by calculating the combustion of fossil fuel in the transportation sector. In this paper, we predict the vehicle's real-time carbon emission using an MQ2 Gas sensor based on the Support Vector Machine (SVM) algorithm to observe datasets in the city, and the GPS data helps to locate the vehicle's current location. An initial warning is given to the driver regarding the amount of CO^2 gas with the help of an LCD, buzzer, and later the same information is transferred to the Police Control Room in case of negligence. Here the hardware (carbon emission sensor) device which connected to the android application, and the application sends the data to the cloud server (RTO) through the Global System of Mobile Communication (GSM). When there is an excess amount of CO^2 release from the vehicle, an alert message is sent to the vehicle owner.

Keywords: CO^2, GSM, MQ2 Gas Sensor, GPS, Support Vector Machine (SVM).

1. INTRODUCTION

Vehicular ad hoc networks (VANETs) [1] are a special case of mobile ad hoc networks. The group of vehicles communicates with each other in VANETs. Efficient mechanisms [2] are necessary for VANETs to reduce road traffic. The pollutants from vehicles can impact the environment in an expansion of approaches. This mission suggests a treasured path for sensing engine emissions, especially CO^2 gasoline emissions. The carbon emission is mostly done by the vehicle like car, bike, trucks, etc. To detect the pollution and to control the emission by using the gas sensor with a hardware set. The high emission CO^2 is done by the old vehicle because the new vehicle comes with the catalytic converter, which catalytic converter reduces the 90% of the harmful gas and the pollution in the exhaust gas, even though it's hard to anticipate the specific effect of environmental change. The environment we are familiar with is not, at this point, a dependable guide for what's in store later on. These dangers from environmental change to humankind can be decreased generally. By settling on decisions that decrease ozone harming substance contamination and getting ready for the progressions that are now in progress, we can lessen chances by ceaseless observing CO^2 outflows. CO^2 sensors are available, but no system is available for real-time monitoring and thus controlling the CO^2 emission levels with the control centers' help. The amount of CO^2 emissions has to be reduced by having a check on the transport system or industries with governing bodies' help. The proposed model helps in real-time monitoring of CO^2 emissions. The decision-making can happen at the central server at the environment board or the Pollution control board. CO^2 can be controlled and thus helps in reducing global warming

We have developed a hardware set that includes a gas sensor, a Pic Controller, LCD Display, Transformer, Power Supply Board, Bluetooth, and Global System of Mobile Communication (GSM). Gas sensor to discover Motor Vehicle Pollution. The vehicle proprietor can discover the emission stage without problems in advance. We used cloud storage to save the facts and to study the facts at any time. This gadget intends to create a compact vehicle pollutant detection device installed at the vehicle itself and detect the CO^2 emission from the exhaust. The smoke ratio emitted from the car or bike is monitored by using sensors. The statistics can be displayed on the car proprietor's smartphone by the android application, which can be exhibited to officers while requested approximately the car's emissions document. These are the ways the emission occurs. This framework aims to make a conservative vehicle poison discovery device that could be mounted on the actual vehicle and diminish the CO^2 discharge in the air. Sensors check the smoke proportion radiated from the vehicle. The information can be shown on the vehicle proprietor's mobile, which can be shown to authorities when getting information about the vehicle's discharge report. The information (CO^2 level) is also stored in the cloud server here, which acts as an RTO server. Where the emission level increases, there will be an alert to the vehicle owner through the message, and the 2 nd alert will be held at the period of 15days where the user can service the vehicle within the period. If not, there will be a fine for the overdue service owner and more air pollution. With the device, air pollutions can be controlled in the main cities.

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2. RELATED WORK

Famesh et al. [3], Discusses a way to eliminate CO & CO^2 from Two-Wheeler Motorcycle Exhaust Gases by using adsorption technology. This paper's emphasis was on growing an environment-pleasant and fee-powerful adsorption model that could actively reduce the amount of pollution from vehicle exhaust gases. Here, adsorption is finished in an adsorber-like shape that includes a charcoal pad, thru which the exhaust gases bypass. Charcoal powder is used as an adsorbent that could substantially reduce the total price. The adsorption-based version can be, without difficulty, tailored to a two-wheeler emission portion. There's a large amount of CO^2 discount following adsorption from exhaust gases with outstanding output in this machine. Here, the CO^2 adsorption performance of charcoal is expected to be 20 %. It is beneficial to society to reduce the discharge of pollution into the environment from cars. Jung et al. [4], Proposed to include a geo sensor-based totally air fine tracking machine, which uses the contextual model to understand environmental pollutants popularity within the present and near future pollution vicinity. This offers the steerage for alert and protection in keeping with remote vicinity place. It also uses the flexible adjustment within the sampling duration relying on the nature of the circumstance being diagnosed. It can keep geo sensor batteries because it limits the amount of records switch. The output of the strength is advanced depending on the versatility of the exchange between sampling rates and battery lifestyles.

Abu Jayyab et al. [5] proposes an Air Pollution and Insurance Based Vehicle Locking System that is designed with a mega processor that controls the engine of car primarily based on the values of the sensors and present date at the controller. Every vehicle that crosses the pollutants threshold stage in an area, the car's engine could robotically become off through the engineered circuit. Similarly, security is one of the constraints to provide better communication in vehicles [6]. Locating the vehicle is important for efficient communication. The messaging with accurate position improves errors in communication [7]. Kadri et al. [8] describe a framework for tracking the ambient air excellent in actual time. The network consists of many allotted monitoring stations, which use device-to-device connectivity to speak wirelessly with a backend server. The backend server gathers information from the stations in actual time and interprets it via net portals and cellular apps into data transmitted to customers. Every facility is outfitted with gaseous and meteorological sensors. It also affords the potential for data logging and wi-fi communication. The gadget is deployed in the pilot phase and four sun power stations built over a 1 km 2 subject. Here, the records are accrued over four months, after which performance analyses and checks are executed. The cellular apps rely on communication protocols to provide communication between vehicles [9]. Lee et al. [10], An Environmental Air Pollution Monitoring System (EAPMS) for monitoring the concentrations of fundamental air pollutant gases has been advanced, complying with the IEEE 1451.2 general. This gadget measures concentrations of gases, including CO, NO 2, SO 2, and O 3, using semiconductor sensors. The intelligent transducer interface module (STIM) turned into implemented the usage of the analogy gadgets' ADuC812 micro converter. Network Capable Application Processor (NCAP) turned into evolved using a private pc and linked to the STIM through the independent transducer interface. Three fuel sensors have calibrated the use of the standard calibration techniques. Gas awareness ranges and information regarding the STIM may be visible on the NCAP's graphical user interface. Further, the EAPMS can caution when the pollutant degrees exceed predetermined maxima, and the gadget may be developed right into a low-cost model for developing countries.

Al-Ali et al. [11], Uses an online GPRS-Sensors Array for air pollution monitoring has been designed, implemented, and tested. The proposed system consists of a Mobile Data-Acquisition Unit (Mobile-DAQ) and a fixed Internet-Enabled Pollution Monitoring Server (Pollution-Server). The Mobile-DAQ unit integrates a single-chip microcontroller, air pollution sensors array, a General Packet Radio Service Modem (GPRS-Modem), and a Global Positioning System Module (GPS-Module). The Pollution-Server is a high-end personal computer application server with Internet connectivity. The Mobile-DAQ unit gathers air pollutants levels (CO, NO2, and SO2), and packs them in a frame with the GPS physical location, time, and date. The frame is subsequently uploaded to the GPRS-Modem and transmitted to the Pollution-Server via the public mobile network.

Wrong et al. [12], Discussed a fine particle with a diameter of less than 10 micrometers (PM10) in the air can cause adverse health effects on humans, such as heart disease, asthma, stroke, bronchitis, and the like. This is due to their ability to penetrate further into the lung and alveoli. This study aims to develop a state-of-art reliable technique to use a surveillance camera for monitoring the temporal patterns of PM10 concentration in the air. Once the air quality reaches the alert thresholds, it will provide a warning alarm to alert humans to prevent these fine particles' long exposure. This is important for human to avoid the above-mentioned adverse health effects. Establishing a secure communication between monitoring devices (mobile/vehicle) is necessary to avoid vulnerability in communication [13]. Gao et al. [14], Proposed to monitoring system based on a wireless mesh network with the core of embedded system ARM9 S3C2410 microprocessor is presented in the paper. The flexible and self-organizing wireless mesh network is used to achieve real-time acquisition and multi-hop wireless communication of the atmospheric monitoring environment parameters such as SO2, NO2, NO, temperature, humidity, and air pressure, etc. The system's network structure is established, the hardware architecture of the system is designed, and the working system procedures are given. The entire monitoring system can be quickly arranged and rapidly withdrew without the support of the base station and has a strong self-healing capability and network robustness, and can be used for a variety of occasional atmospheric environmental monitoring. Postolache

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et al. [15] proposes a network for indoor and outdoor air quality monitoring. Each node is installed in a different room and includes tin dioxide sensor arrays connected to an acquisition and control system. The nodes are hardwired or wirelessly connected to a central monitoring unit. Trust mechanisms are needed to provide communication between devices [16] and [17. To increase the gas concentration measurement accuracy and to prevent false alarms, two gas sensors influence quantities, i.e., temperature and humidity, are also measured. Advanced processing based on multiple-input-single-output neural networks is implemented at the network sensing nodes to obtain temperature and humidity compensated gas concentration values. Abnormal operation of the network sensing nodes and power consumption are also discussed.

3. PROPOSED WORK

The proposed design falls in the IoT. The IoT system serves as a transparent path between the physical world like objects and the social world together with itself to form an intelligent system. Transportation is one of the main reasons for climate change and air pollution. The most of the existing system uses WSN to detect their data, but that cast a high range of noise, more time consumption, and signal duplication. Hence, we process and gather the real-time data. This makes less time consumption and a high accurate value of data. While going for the development cost-wise, the existing methods involve more protocol hierarchy algorithm and signal duplication. To avoid this problem, this paper aims to reduce the data by its complex nature and low-cost sensing setup. The proposed system focuses on monitoring and identifying the emission level in the individual vehicle and alerts the owner and RTO if the vehicle releases CO^2 more than the standard limit. This method consists of a gas sensor that can detect CO^2, where the sensor is placed in the exhaust of the vehicle. To protect the hardware from the malfunction caused by the vehicle's heat is terminated by using an Isolated Thermal Clip. The GPS that presents in the device is used to locate the vehicle by using the android application and helps from the vehicle's theft. The hardware set consists of a Global System of Mobile Communication, LCD, GPS (Global Positioning System), gas sensor, Pic Controller, Transformer, Power Supply Board, Bluetooth to transmit the data between the hardware application. The real-time data is collected and stored in the pic controller. Any abnormality in the reading is communicated to the driver through the LCD and the GPS and GSM modules, the nearest control station. Figure 1 shows the system's working prototype, and figure 2 shows the architecture of the proposed system

The proposed system consists of modules such as,

3.1 Hardware Module: This module combines the hardware components, which all combine to process the data. The main part is PIC microcontroller which controls the whole activity in the hardware.MQ-2 gas sensor, GPS, LCD, and GSM also fixed along with the microcontroller. The LCD display is used to indicate the system's status in which the emission level is in the normal parameters or abnormal parameters if the CO^2 emission level is high. When the device is on, the gas sensor senses the value of CO^2 and transmits the data to the Bluetooth device. Bluetooth can transmit the data to the cloud database using the GSM.

3.2 Sense Emission Values: The detected data from the sensor, which is in the hardware module, is stored in the cloud database and efficiently analyzed. The emission from the vehicle is sensed as per the value given below in tables 1 and 2.

3.3 Process with Cloud Database: The collected data are to be stored in the cloud database, which the GSM retrieves from the hardware module. It manages many of the same functions and takes care of scalability and high efficiency. We can access the data both in the android application and webpage. Here it can compare the required level to the emission standards in India. If the collected data is more than the required level of CO^2 that is in abnormal parameters, then it alerts the user and the RTO, or it alerts only the owner of the vehicle.

3.4 Sending SMS: This module sends an alert message when the CO^2 level is abnormal. This sends a normal message to the vehicle owner by an alert notification. The message consists of the vehicle number and the due date of the service reminder.

PETROL EMISSION NORM (In g/Km)				
	CO^2	HC	NOx	PM
BS-III	2.30	0.20	0.15	-
BS-IV	1.00	0.10	0.08	-
BS-VI	1.00	0.10	0.06	0.00

Table 1 Emission (Petrol) Standards in India

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DIESEL EMISSION NORM (In g/Km)				
	CO^2	HC	NOx	PM
BS-III	0.64	0.50	0.56	0.05
BS-IV	0.50	0.25	0.30	0.025
BS-VI	0.50	0.06	0.17	0.005

Table 2 Emission (diesel) Standards in India

As per the government norm, the CO^2 sensor is designed, and the collected data is sent to the cloud.

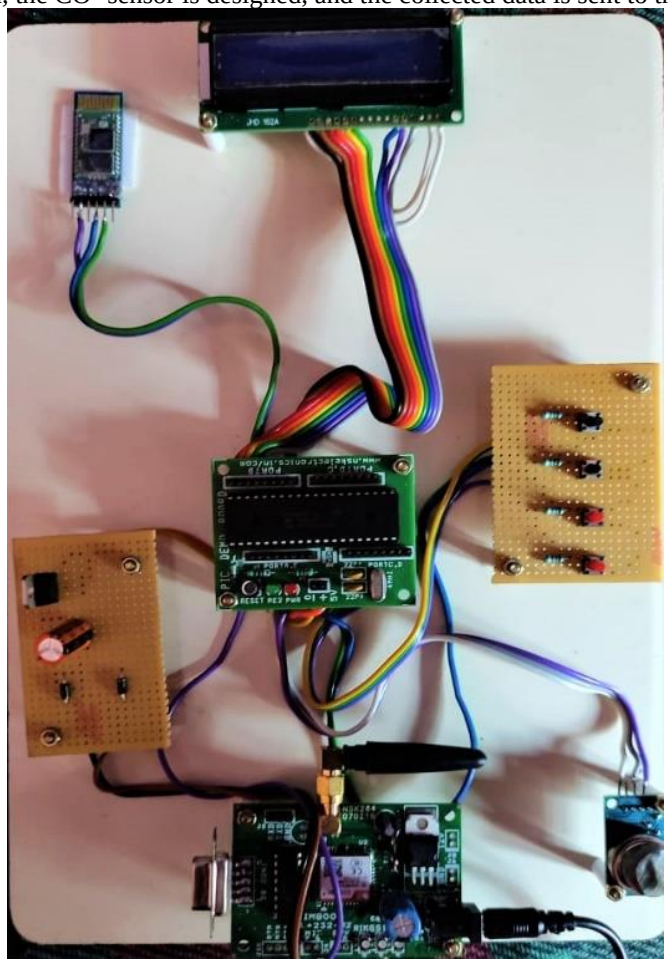

Fig.1: working prototype of the system

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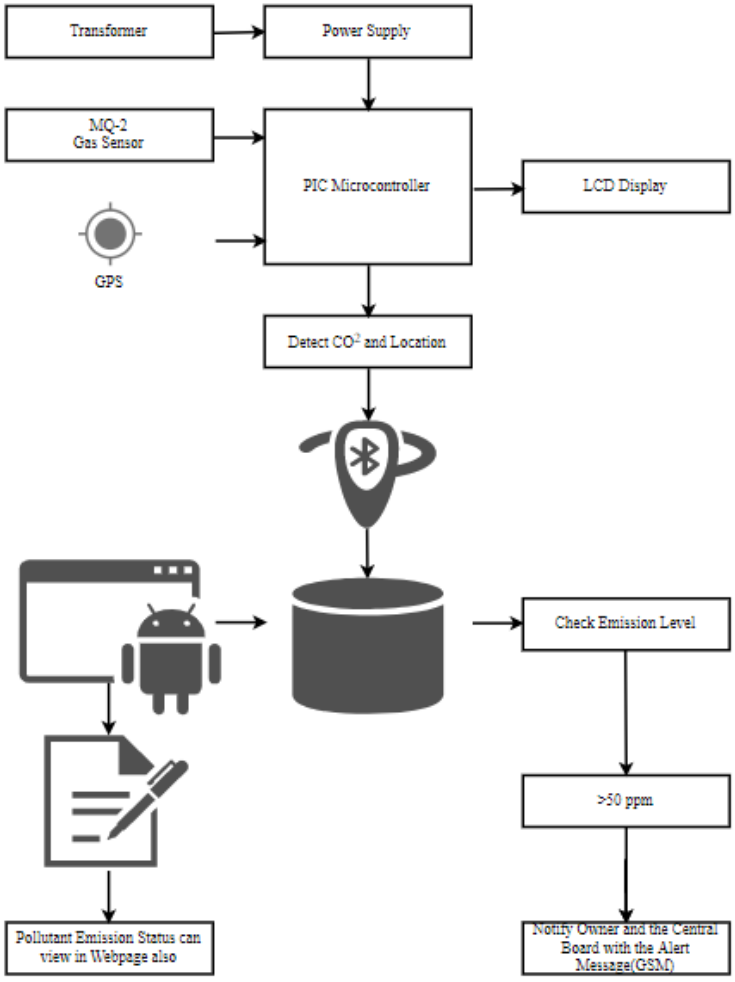

Fig.2: Architecture system

4. ALGORITHM

Table 3 Algorithm for monitoring CO^2 (Sensor)

Algorithm for monitoring CO^2 (Sensor)

Input: ɵ CO^2 emission get from the vehicle
Output: CO^2 emission level is in range or high from the vehicle
Variables Used: ɵ: - CO^2 level in the vehicle
μ: - The value of the emitted CO^2 is in normal parameter
Ψ: - The value above which the pollution is considered as high
α: - The time after which the user wants to re-read the value again from the sensor.
Step 1: Read the CO^2 value with a delay of α.
/*after getting CO^2 values, converting emission value dividing by 50*/
Step 2: ɵ/50
/* so, then that value is compared to emission value norms*/
Step 2: if (ɵ < Ψ)
Then the value is marked as a normal parameter.
Step 3: if (ɵ > Ψ)
Then send value to the Owner and Central Board with the value as high
Step 4: The sensor is not in working condition. Kindly re-Check it.

To keep the computational load reasonable, the mappings used by SVM schemes are designed to ensure that dot products of pairs of input data vectors may be computed easily in terms of the variables in the original space by defining them in

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terms of a kernel function selected to suit the problem. Table 3 shows the algorithm for monitoring $CO^{2.}$ According to the SVM(Support Vector Machine) algorithm is used to analyze the parameter is optimized by classification and regression method, existing methods need more time to classify when modeling on the quantitative gas analysis. Given a set of training data, each marked as belonging to one of two categories; an SVM training algorithm builds a method that assigns new data to one category or the other. SVM is used to improve the accuracy of the classification of the data. The algorithm is used to divide the value of carbon emission to the trained set of data. When the divided value is less than the train data, it is considered to be normal. The value of the quotient should be less than one. If its value is greater than one, it is checked and assumed to be abnormal. Then the abnormal value is taken and send to the owner with an alert of high emission. And it also sends the message to the RTO along with the emission value and the map location for the vehicle detection. It will analyze CO2 emissions using the SVM model, which considers various vehicles that impact the emergence of CO^2 emission. In this study, we consider vehicles emitting CO^2 that directly affect the increase of CO^2 emissions. The data were collected from the vehicles that must be converted into the values of CO^2 emission. The amount of CO^2 combustion of fuel in vehicles results depends on the value. The algorithm separates the value using hyper-plane. An SVM maps data to points in space so as to maximize the width of the gap between the two categories. New data are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.

5. RESULT

The data collected from the gas sensor is collected, monitored, and the irregular emission is detected, which is then registered to the RTO (cloud storage) for further action. The PIC controller is connected to the engine control unit, which is ECU, where it detects the unwanted excess CO^2 emission from the vehicle. As per the government norms, the sensor's value is fixed; the value of the normal and abnormal is shown in the below table. Table 4 represents the CO^2 standards. When the vehicle's emission is below 1, it is considered good, and it is in a normal state. When the CO^2 value is greater than >1, it is an abnormal condition; in this state, the following process is done.

Table 4- CO^2 Standard value

Condition	Required CO^2 value	Measured value from the sensor(g/km)
normal	≤1(0-1)	0.65
abnormal	>1(1.1-1.8)	1.34

5.1 SENSING OUTCOME

Emission from the vehicle is taken as the input for the hardware device. Where the device has the gas sensor which sense the level of CO^2 from the vehicle exhaust. The gas checks the value of the CO^2 with the help of a pic controller where the algorithm has been implemented in it. The GSM used helps transfer the data to the cloud in real-time, and the GSM is also used to send the SMS when the value is abnormal. Figure 3 and 4 represents the hardware module, to select the vehicle as well a s to sense the emission levels.

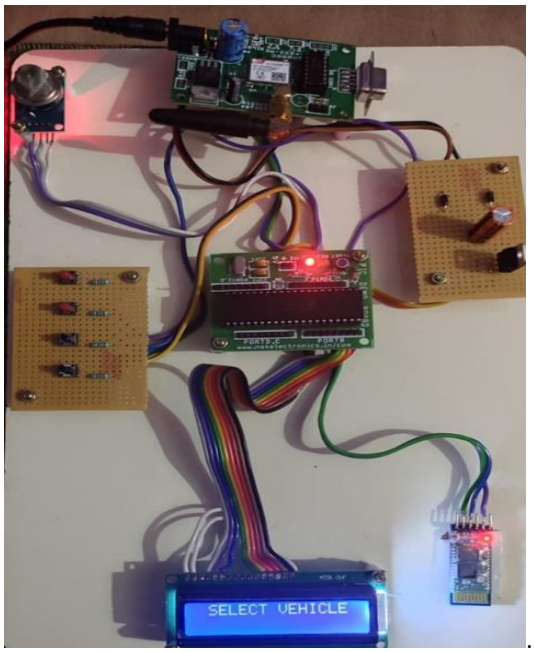

Fig.3: Vehicle selection

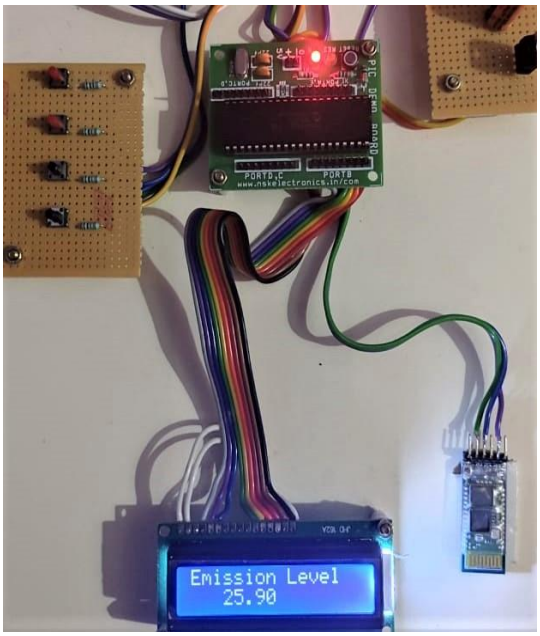

Fig.4: Sensing Emission Level

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5.2 USER INTERFACE AND DATABASE

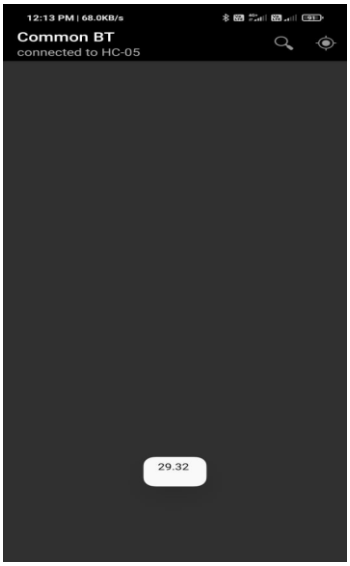

Fig.5: Application reading

Vehicle	Emission	EmissionDate
B	B	4/4/2021 8:19:35 PM
B	B	4/4/2021 8:19:36 PM
B	41.54	4/4/2021 8:19:36 PM
B	41.54	4/4/2021 8:19:39 PM
B	41.54	4/4/2021 8:19:41 PM
B	41.05	4/4/2021 8:19:42 PM
B	1	4/4/2021 8:19:43 PM
B	1.05	4/4/2021 8:19:44 PM
B	40.07	4/4/2021 8:19:44 PM
B	40.07	4/4/2021 8:19:46 PM
B	9	4/4/2021 8:19:47 PM
B	9.58	4/4/2021 8:19:49 PM
B	9	4/4/2021 8:19:53 PM
B	39.10	4/4/2021 8:20:06 PM
B	3	4/4/2021 8:20:07 PM
B	9.58	4/4/2021 8:20:07 PM
B	39.10	4/4/2021 8:20:08 PM
B	39.10	4/4/2021 8:20:09 PM
B	9	4/4/2021 8:20:11 PM
B	9.58	4/4/2021 8:20:12 PM
B	9	4/4/2021 8:20:13 PM
B	9.58	4/4/2021 8:20:14 PM
B	8	4/4/2021 8:20:15 PM
B	8.61	4/4/2021 8:20:16 PM
B	38.12	4/4/2021 8:20:17 PM
B	3	4/4/2021 8:20:18 PM
A	30.30	4/4/2021 8:21:20 PM
A	29.81	4/4/2021 8:21:21 PM
A	0	4/4/2021 8:21:23 PM
A	0.30	4/4/2021 8:21:23 PM

Fig.6: Emission Database

Figures 5 and 6 show the application reading part and emission database maintained. In this, we have the application that was connected to the hardware through Bluetooth and the user may also be able to see the Realtime emission value through the application. This shows the value in a popup notification inside the application. The database we use is the cloud that acts as an RTO to store the monitoring data along with their specified number. The data stored in the cloud can be used for later use when the vehicle is still in the same condition (abnormal emission). The application and the database show the same number value at the same time, but the cloud data shows the value as per the government norms.

5.3 ALERT NOTIFICATION

This sends a notification to the user and the RTO officer along with the location of the vehicle. The notification has the specified number of the vehicle and the emission level and the link of the location. This sends the message only when the vehicle's emission is higher than the specified value—figures 7 & 8 show alert messages sent to RTO and owner.

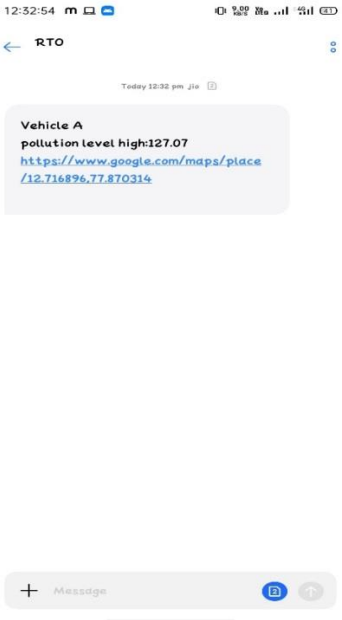

Fig.7: Alert Message to RTO

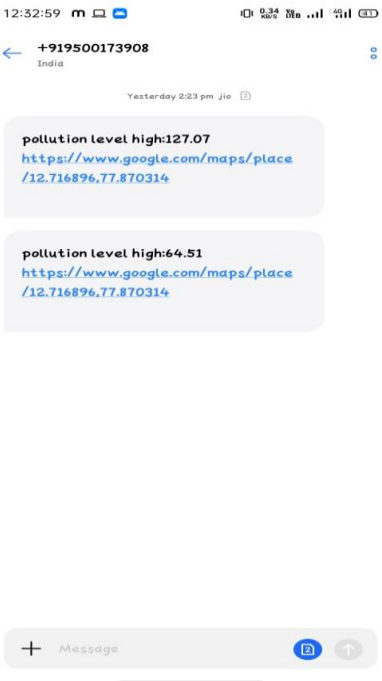

Fig.8: Alert Message to owner

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6. CONCLUSION

This specific gadget contains a sensor, which detects the parameter CO^2 that reasons vehicle pollutants. The proposed prototype in this paper is implemented in society which is very cost-effective and consumes much lesser space along based on the existing standard. It is easy to update the value of the carbon emission as per the standards. Whenever the Carbon monoxide stage increases, the sensor senses the state of affairs, and the vehicle proprietor is given an alert or signal. Thus, the project has been successfully designed and examined. This undertaking may be extended the usage of a high-performance GPS receiver and a GSM module. The system can also be implemented to show the nearby vehicle service station for quick service in the future. By adding the feature, there will very easy to maintain the vehicle for the owner, and it also helps the government to monitor the expired vehicle.

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