

Vehicular Emission Monitoring System Using Internet of Things

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Abstract

Vehicles have become an indispensable part of today's life. But the usage of vehicles contributes to air pollution by releasing a variety of toxic gases into the atmosphere by burning gasoline. The emission from vehicles contains nitrogen oxides (NOx), carbon monoxide (CO), and hydrocarbon (HC). Due to this, the quality of air is degrading and it also causes diseases like asthma attacks, cancer etc. Poor maintenance and ignition defect of the vehicle increases the emission by causing more fuel consumption. India is the fifth most polluted country in the world and a number of measures are being taken by the government authorities to control the air pollution. But it is a difficult task for the officials to constantly check all the vehicles on a regular basis and to keep a track of the emissions released. This work aims to use Wireless communication and IoT to control the pollution. The gas sensor is used to sense the emission from the vehicles and send it to the transport office database using Wi-Fi. A threshold value for the emission is initialized based on the BS-6 criteria. If the vehicle exceeds the threshold limit then an alert SMS is sent to the owner to Service the vehicle within 10 days. If the service is not done, then the report is sent to the police department to take necessary actions. Analysis is done to find out which engine emits more emission and it is displayed. A secured cloud database is used to prevent any eaves dropping or tampering. SMS gateway is used to send the alert messages.

Keywords: BS-6, Cloud, Gas Sensor, IoT, SMS Gateway, Wi-Fi, Wireless Communication.

1. Introduction

Environment pollution is caused by atmosphere, land and water which cause serious effects in human lives. A significant amount of air pollution is caused by the road transports in urban places. The emissions caused by such transports must be monitored and controlled continuously to lead a safe and healthy life. In India, transportation sector is the primary cause for emitting toxic gases. To prevent and control air pollution, the Indian nation has published the Air Prevention and Control of Pollution Act during 1981 which was amended in 1987. In order to minimize the pollution on the environment, new emission norms like BS-6 for monitoring the air pollution have been regulated by the

government. The Central Pollution Control Board (CPCB) issues Fitness Certificate to be renewed by all Heavy Vehicles once in a year and r Light Motor Vehicles once in five years. Pollution under Control certificate has to be obtained by all vehicles once in 3 months as per the regulations, but the renewal is ignored by most people. The proposed system contains a sensor to sense the vehicle emissions and update to the cloud server. It also contains a micro-controller. The problem occurs when the vehicle emission exceeds the standard limits as specified by CPCB. SMS gateway is used to alert the concerned person regarding the service of the vehicle by sending a warning message to the registered mobile number.

2. Literature Survey

In [1] Nocera and Cavallaro studied about the placement of RFID tags along with an embedded controller in parking locations, toll gates and traffic regions . In [2] the author presented architecture for measuring Carbon-dioxide and Carbon-monoxide. This measuring is done by using MQ135 analog sensors and certain variable sensors. The paper also states that inductive sensor is more accurate than the capacitive proximity sensor in measuring the emission of these gases. In [3] uses Internet of Things to find a solution to, this paper gives us, a novel solution is presented to monitor and control the pollution at the traffic sign monitor and control vehicle pollution. This is mainly implemented in traffic lights. A wireless chip is placed in the vehicles to manage the on and off of ignition at remote locations. The operator sends instructions to the traffic control mechanism; the traffic lights communicate with the chip and help to control the ignition. This is one of the best way to minimize the air pollution.

The study in paper [4-8], states that the advancement of technology has left to the tininess of electronics and communication technology. These in turn have led to the development of sensor networks which is mainly used to analyze air pollution. An alert is given if there is a change in air quality. Emergency actions are taken based on the analysis to save the life of the people in a specific area as indicated by the alert system. The author also used Air Quality Index to categorize the different levels of air pollution. In [9-14], narrates that Wireless sensor networks plays an important role in collecting data from a real time environment. The environmental factors that determine the air pollution is collected and this data is measured through these sensor networks and sent to the proprietor of the vehicle, traffic division and department of national environment. The urban population gets most of the advantages from these systems since they are of low cost and helps to manage air pollution.

3. Proposed Work

In this work, the emission from the vehicle is monitored by using IOT. The mq2, mq7, mq135 sensors are all connected to the microcontroller. As soon as the vehicle is started, the sensed emission values are sent to the transport office database using Wi-Fi. The standard threshold value can be chosen based on the BS-6 norms. The comparison is

done to check whether the emitted value is above the threshold limit. If so a warning message is sent to the registered mobile number of the owner indicating for a service to be done to the vehicle within 10 days. If not then the report will be sent to the police department for necessary actions to be taken. The engine model which emits large amount of emission more frequently can also be identified and displayed. The flowchart of the proposed system is depicted in Figure-1. The complete connection between the sensor and the server is done using the wireless medium with the internet connection. The warning message is sent directly from the office to the owner using SMS gateway.

The proposed system is divided is into 3 modules:

- A. Hardware
- B. DB Connections & Processing
- C. SMS Gateway

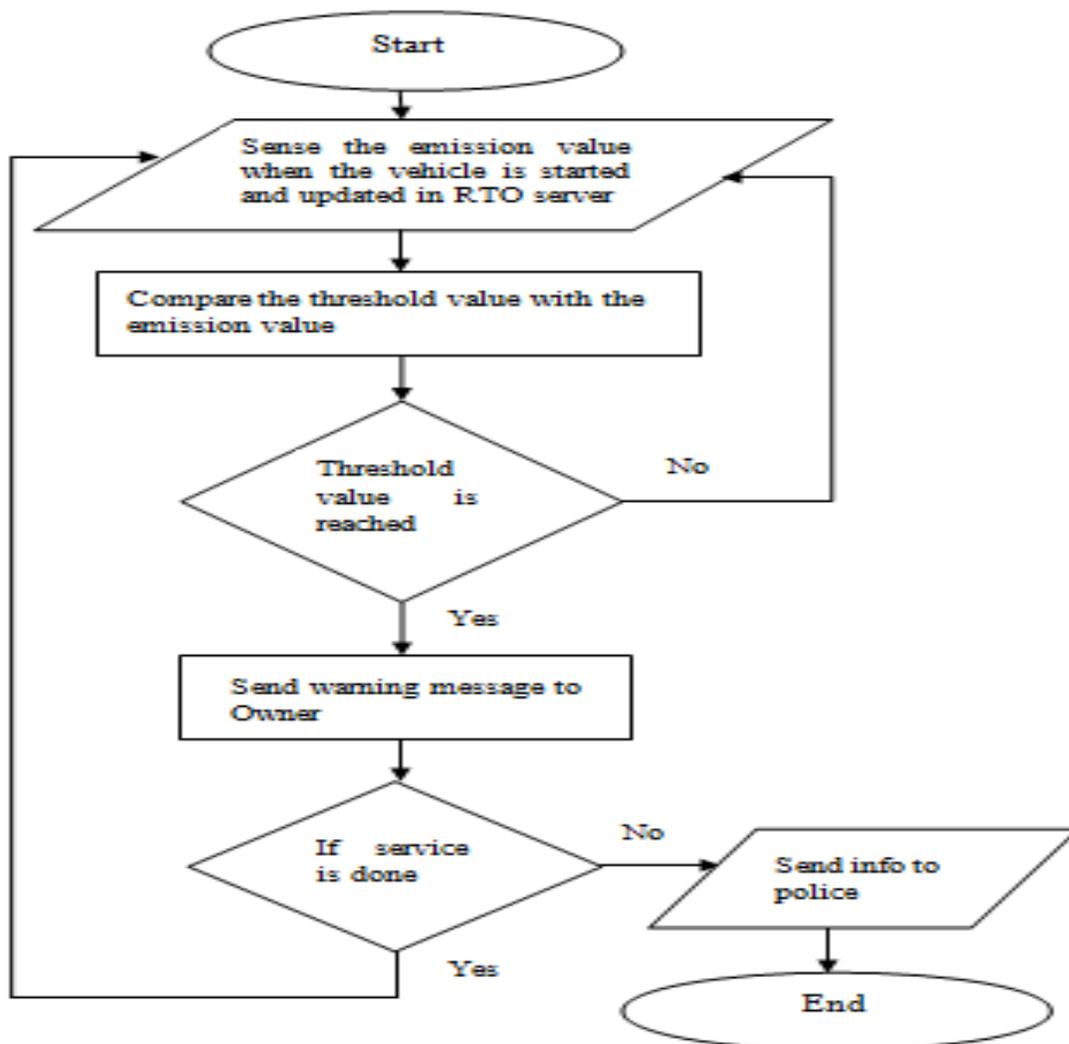


Figure-1. Flowchart of Vehicle CO2 Emission

A. Hardware

This method consists of a gas sensor interfacing with a pic microcontroller which is used to detect the presence of smoke. In case of harsh environments the sensor can be protected with the help of GALVI. The sensor is placed on the top of the exhaust in the vehicle. This sensor senses the temperature and the pressure. When an exhaust stroke occurs the exhaust gas leaves the engine cylinder. It then travels and connects with a smoke detector that is in the exhaust line. A server is placed at the Road Transport Office to record the emission value. The value is fetched from the server and displayed. Figure-2 shows the hardware setup of the work.

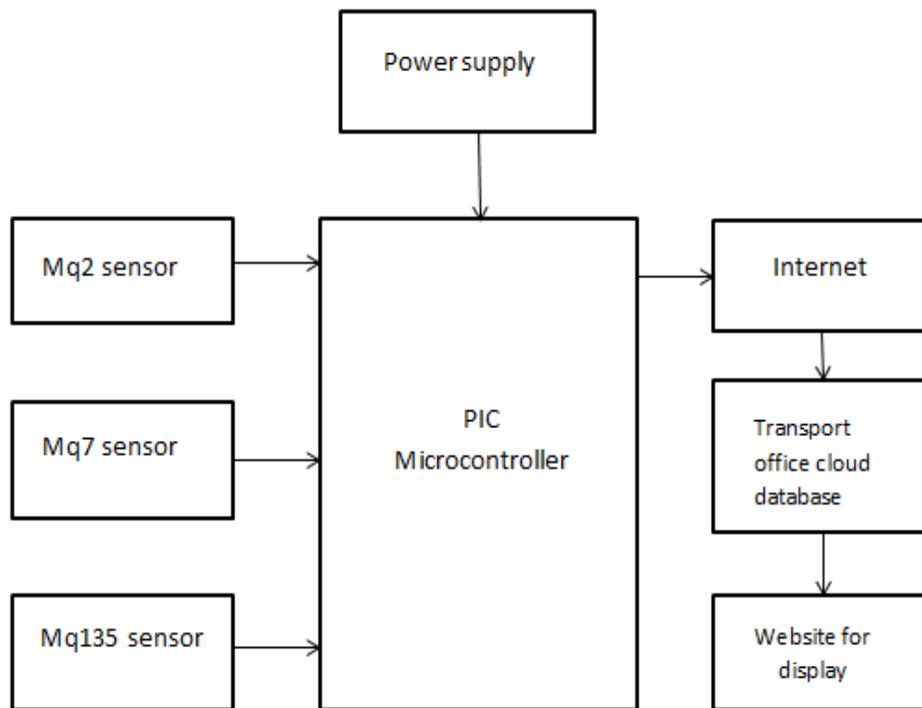


Figure-2 Hardware Connections

B. DB Connections and Processing

The Wi-Fi application is paired with the module to updates the server with all the emission values. The emission value received by the server is compared with the threshold value which is initialized based on the standard BS VI norms. According to BS VI the allowed limits of CO is 0.50 g/km, HC is 0.35g/km and NO_x is 0.15g/km .

Based on the above mentioned norms the threshold values are fixed. This is done in order to make sure that the pollution contributed by the transportational sector is reduced to a great extent. If the value shoots above the threshold level then the warning is sent to the registered mobile number stating that the vehicle needs a thorough service to be done. If the value is below the threshold level then no actions are taken. In the RTO database two

sections are displayed. The Home Section displays all the emission values along with the name of the owner, date & time of emission. In the Company Section, the emission values which have crossed the threshold level along with the company of that vehicle engine will be displayed. This in turn will help the officials to identify the engine company which has frequently emitted in large amounts. The notice can be sent to the concerned company regarding the large amount of emission in their vehicles and steps can be taken accordingly.

C. SMS Gateway

This module deals with the implementation of a software that can send and receive text messages. This is achieved via a GSM telephone network connected to a network or a PC. In the existing system, a modem is used to implement the GSM module. The work of the GSM is to digitize, and reduce the data. It then uses a channel consisting two different types of client data having its own time slot to send the data. GSM has its own disadvantage that multiple users can share the same bandwidth. To overcome the above issues, in this proposed system the SMS API is used send messages through a software interface. The architecture of the SMS Gateway is given in Figure.3. A HTTP request is send by the web applications to send and receive messages through a standard implementation within it. Then the web server sends the HTTP request via SMS Gateway into the network by using the SMS protocol. In the network, the mobile carrier SMS will carry the all text messages to the mobile switching center. Through the base station controller, it will automatically control the messages that have to be sent over the network which has to be received in the mobile device. The process of sending, receiving and controlling the messages can be done with the help of base station controller. In this process, if the vehicle emits CO₂ beyond the acceptable limit then a message will be sent to the person from the RTO office regarding the vehicle service which has to be done within 10 days to reduce emission.

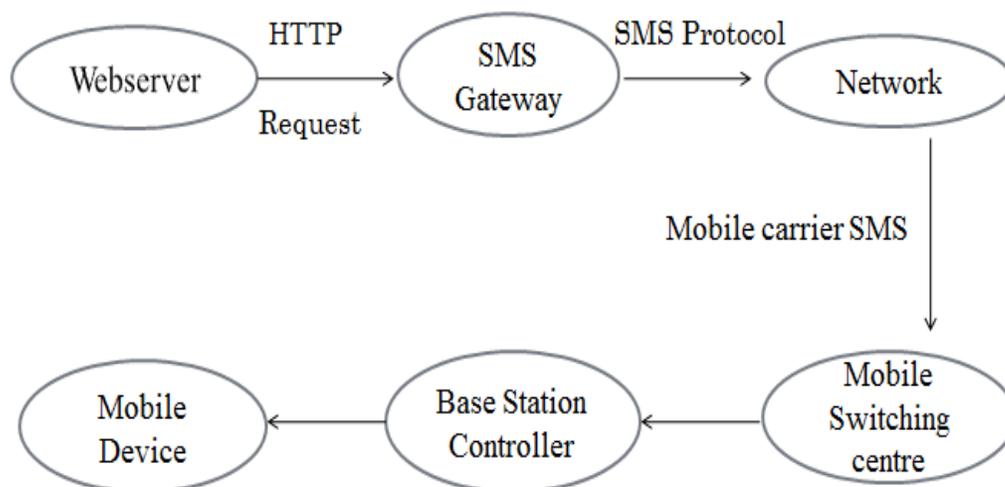


Figure-3 SMS Gateway Architecture

4. Implementation

The implementation of Vehicular Emission Monitoring System using IoT is given in Figure-4. The process involves a Transformer, PIC Controller, LCD Display, Smoke sensor, Bluetooth, Website for vehicle emission record. The 3 relay switches are assumed as vehicles. When the relay switch is pressed then the power supply from the transformer regulates with the help of capacitor, diode and regulator then supplies 12 volt to the PIC-microcontroller. The Gas Sensor PCB, Bluetooth module and LCD display are all connected with the micro controller. Then the gas sensor senses and detects the emission values and are updated to the transport office server. The software part of the work reads the emission value and gives caution to the owner of the vehicle through SMS.

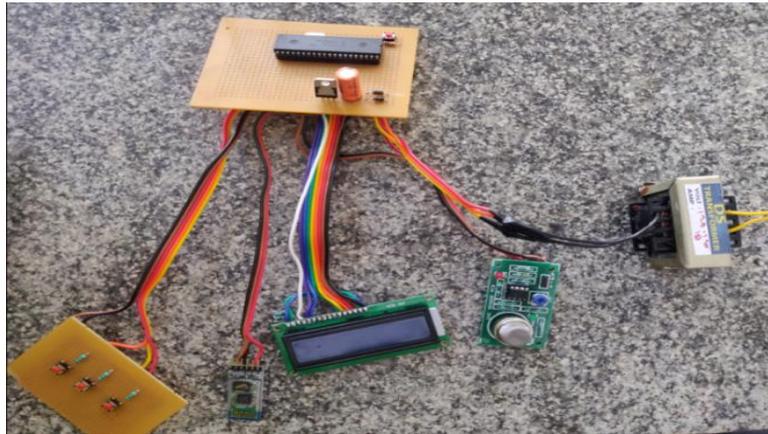


Figure-4 Hardware Connections of Vehicular Emission Monitoring System

5. Results and Discussions

The hardware implementation of the work is shown from Figures 5 through 7. They select the vehicle to be monitored and display the emission value which is then used by the software component of the system.



Figure-5 Display of Vehicle Emission Monitor



Figure-6 Selection of Vehicle



Figure-7 Vehicle Emission Value

The execution of the software component is shown from the figures 8 through 10. The home screen contains two tabs namely Home and Company respectively. All the emission values along with the name, date & time can be viewed easily by selecting the Home section. The Company Section in Figure-9 displays the engine company which crosses the threshold level along with the emission rate. By this the engine model which emits large amount of emission frequently can be identified. The warning message in Figure-10 is sent to the owner by using the SMS Gateway to service the vehicle within 10 days.



Figure-8 Display Of Emission Values



Figure-9 Display Of Company Name

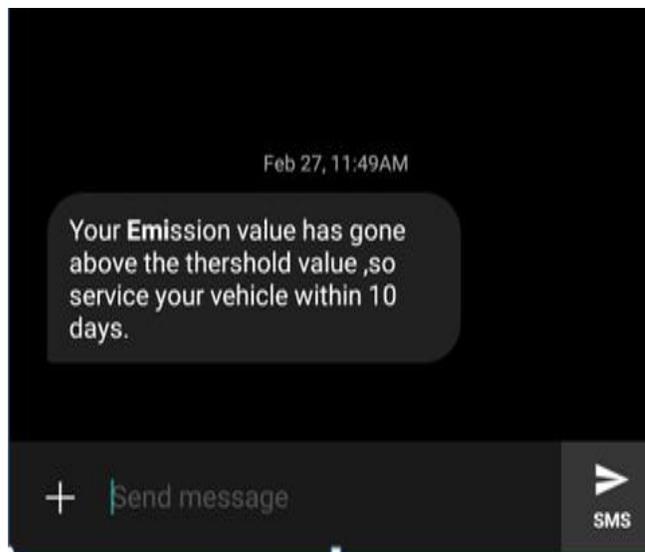


Figure-10 Pollution indication SMS

6. Conclusion

This work minimizes the pollution in the air by monitoring the emission values of the vehicles using the IoT technology. Vehicular Emission Monitoring System is used to sense the emission values from the sensor and update to the server. If the values crosses the threshold level then a warning is sent to the owner of the vehicle through message indicating that the vehicle must undergo a service immediately. Compared to traditional method, this work is more users friendly and reduces Global Warming. It helps to control

the respiratory problems and climate change. The high polluting engine model can also be detected.

7. Future Work

For establishing the connection between the sensor and the server instead of Wi-Fi, alternative technologies like SIM Cloud connections can also be used to publish data to the cloud. Along with the emission detection, accident detection, over speed detection can be integrated in order to make this system more efficient. Secured Hybrid Cloud can be used to prevent illegal actions. Using VLSI technology, the entire system should be designed compactly.

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