Inspection and Notification of Vehicle Emission in Smart Cities

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Abstract

The vehicular emission is a very important aspect these days in the cities of Internet of Things (IOT) or commonly known as the Smart Cities. Since years the vehicular emission is being checked with the help of PUC in the cities across the country. The vehicular emission is mostly caused due to the incomplete combustion of fuel which results in the production of Carbon Monoxide (CO). Thus this manual detection of the vehicular emission has to stop some day and the trend needs to be changed. With the help of Wireless Sensor Networks (WSNs) and RFID components this trend could be set up. This paper proposes such a system to inspect the vehicular emission by measuring the CO produced by the vehicle with additional features like detecting LPG leakage in vehicles running on gas and also a feature of measurement of engine temperature so as to prevent failure of the vehicle. All this information is gathered over a RFID tag present on a particular vehicle. This gathered information is sent to the RFID receiver present onto the traffic signal. The received data is analyzed and accordingly the owners of the vehicle are notified if any of the three cases of emission exceeding, gas leakage or engine temperature exceeding takes place. In all this is a nice system with the three features mentioned and that too at a comparatively low cost.

Keywords: Gas Leakage Detection System, Internet of Things, RFID Technology, Vehicle Emission Inspection System, Wireless Sensor Networks

1. Introduction

The main cause of air pollution is due to the vehicle emission caused in the cities. This emission turns out to be very hazardous for human health as well. This pollution tends to be increasing day-by-day due to the increase in the number of vehicles these days. It is almost impossible to control the pollution caused due to these vehicles. Although many cities now are implementing vehicle emission standards in order to arrest the excessive vehicle emission being caused in the Smart Cities. But in many cities these standards are difficult to implement in a real time. Although the government constantly keeps the vehicle owner bombarded with notifications and advertisements to check their vehicles periodically in order to avoid the excessive emission caused by them. This to some level helps to gain a control over the vehicular emission but in some way vehicle owners keep avoiding and keep delaying the manual checking needed for the vehicle to control its emission level. Moreover, in vehicles those are operating on LPG are sometimes unaware of the leakage of gas. This may result in hazardous accident. Also the exceeding of the temperature of the vehicle engine caused it to break down or shut down temporarily. Thus, a track of all these things also needs to be maintained in order to avoid accidents and vehicle failure. As a result, this system is proposed which includes all the three essential features mentioned above.

Due to the advancement and many updates in the wireless communication system and through the development and widespread of the concept of IOT it was possible to design this proposed system so as to detect the flaws in vehicles and notify them to the user.

In this proposed system the vehicle contains unique tag Identification (ID). The sensors will measure up the respective quantities and then this information would be sent to the server and stored into a database. At this end the administrator will examine the data sent by the transmitting end and will analyze whether the emission of the vehicle is in control or not, whether a vehicle is...
encountered with gas leakage or the temperature of the engine of the vehicle exceeds beyond a particular level. If the vehicle fails in any of these three cases then the server sends a message over the mobile phone of the user through the wireless network. Moreover, the user may also check its vehicle details on a special application designed for his Smartphone.

2. Design of the Proposed System

The whole system is divided into 3 subsystems namely:

- System for vehicle emission.
- System for gas leakage detection.
- System for engine temperature measurement.

These three systems measure the respective data and pass on to the server along with the unique Identification (ID) of the vehicle.

2.1 System for Vehicle Emission

The system for vehicle emission mainly focuses on measurement of Carbon Monoxide being emitted by the vehicle. According to the emission standards of the region this emission data of the vehicle is then compared to the standard value. If the emission exceeds above the standard value then the owner of the vehicle is notified with the help of a SMS or an email or it can also be notified through a message on a special application over the Smartphone.

Consider the diagrammatic representation as shown in below Figure. This Figure gives the block diagram of the proposed system. The temperature sensor measures the temperature of engine and the CO sensor measures the emission level of the vehicles engine.

All the measured data is then passed on to the Arduiono Uno the microprocessor which processes the data and passes on to the Zigbee. The microcontroller analyses the data sent by the sensors and if the value is beyond the threshold voltage then it notifies the vehicle user to get the vehicle serviced. Through Zigbee this data is passed on to the received side. At the receiving end the Raspberry Pi hands over the data to the server. The raspberry Pi is also responsible for notifying the user with the help of wireless networks like GSM and Wi-Fi. The server stores the data of the user into its database and keeps notifying the user regarding its emission and temperature of vehicle engine if it goes to a level beyond standard values. The user may also check its vehicular data through an android application over his Smartphone or may also check it over the website. Thus in all this proposed system makes it easy for the vehicle owner as well as the government authorities to keep track of the vehicular emission of each and every vehicle in the city. This in all helps the city to keep air pollution levels low.

3. Experimental Setup

The vehicle emission system works as shown in the Figure below:

![Figure 2. Real time data analysis of notification system.](image)

When the traffic vehicle comes into the vicinity of the traffic signal it automatically gets stopped when the traffic signal is red. During this time period the vehicle owner has to swap a smart card. This card contains every detail from the name of the vehicle owner to the vehicle details such as the vehicle number, license number, the emission data of the vehicle, temperature of the engine and the gas leakage if any which is all measured by the sensors placed inside the vehicle. These sensors measure the respective data and pass it on to the microcontroller.
which analyses the data and compares it to the reference value or the threshold value. If this value exceeds the threshold value then the user of the vehicle immediately gets a SMS regarding servicing of its vehicle. The emission, temperature and the gas is continuously sensed through the sensors and is constantly analyzed with the help of the controller device. When this data is sent to the server it is continuously saved into its database. A government administrator also keeps a track of the emission data of all the vehicles at this end. The users can also verify their data at the government websites or can keep a track on their smartphone application.

![Connection of Arduino Uno with gas and temperature sensors.](image)

**Figure 3.** Connection of Arduino Uno with gas and temperature sensors.

- Arduino Uno: It has a 8-bit RISC architecture with 32 kb flash memory, 1 kb SRAM, 23 programmable IO channels and six 10-bit ADC inputs. The sensors are all connected to the analog pins of the Arduino Uno board and the data is analyzed with the help of it. The Arduino Uno prompts a message if any of the sensed data exceeds the threshold value.
- LM35: This is a low cost temperature sensor used to record the engine temperature of the vehicle. It is highly suitable because of its low current drain less than 60 microamperes. Perfectly suitable as it has a low output impedance, linear output and precise inherent calibration.
- MQ6: This sensor is used to detect the CO₂ and any gas leakage from the vehicular system. This sensor is best suitable for the proposed system as it has a good sensitivity for combustible gases in wide range. Furthermore, this low cost sensor has a high sensitivity to gases like propane, butane and LPG. The simple drive circuit makes it easy to use.
- Raspberry Pi: This is an inexpensive and easy to use processor with SD storage in it. It has a Linux based OS to pass on the data towards the server and to the mobile applications of the vehicle owner.
- RFID: It is used for reading the data from the vehicular system and thus passing on this data to the receiver end. It also helps for storing all the sensors data which could be helpful for further analysis and future use.

4. Results and Discussion

The analyzed data is tracked using the active RFID. The vehicle owner's registration number and the vehicle number are inserted into the database once the owner swaps the smart card. Once this process has been done, the emission data and the temperature data sensed by the sensors are then recorded onto the database of the server. The date and time information is also tracked along with the mobile number of the vehicle owner.

The flow chart of the proposed system (Figure 5) works as below:

At the start the RFID reader waits for the tag to come in its vicinity. Once the reader comes into its vicinity the reader records the information in the tag. The sensed data consists of the vehicle emission data, the gas leakage data and the engine temperature data of the vehicle. The microcontroller analyses the data and sends it to the server. It also stores the data for future use and data manipulations and also displays this data on a PC along with the tag number and the sensor data. The server monitors the data which has been sent to it by the controller and it also saves it onto its own database for future use. Here the comparison of data is also done with the threshold values or the reference values. It is checked whether these values exceed the threshold values or not. If it has been exceeded by the reference values then an alert message is sent on the mobile application of the vehicle owner and also a message is sent via SMS service. If the sensor values have not been exceeded then the client simply analyses the data and all this procedure is repeated for multiple vehicles in the vicinity of the RFID reader.

The Arduino 1.6.5 software has been used to show the measurement of CO₂ and the engine temperature of the vehicle. The Figure 4 shows the software outcome of the proposed system.

This data is then sent to the server and analysed there. Normally, a fixed reference value is taken as per the city's emission standards. This reference value is fed to the
program and it will show the outcomes by analysing the sensor data every now and then. The outcome will alert if the vehicle exceeds the standard emission value. This goes same for the temperature value of the engine of the vehicle. The server will then analyse all this data and alert the owner.

The vehicle owner will also get a message on his mobile phone in the following format shown in Figure 6 below. This message contains the vehicle number, the name of vehicle owner, vehicle emission level as well as the engine temperature level and an alert whether the emission and the temperature are in control or not from the administrative authorities.

![Figure 5.](image_url1)  
**Figure 5.** Browser showing successfully running server.

![Figure 6.](image_url2)  
**Figure 6.** Message alert from the authorities regarding vehicle emission.

![Figure 7.](image_url3)  
**Figure 7.** Flowchart for notifying vehicle emission and temperature of engine.
5. Conclusions

The proposed system has used the concept of Internet of Things to keep a track of vehicular pollution in order to arrest the pollution levels of the environment. Thus, due to this concept the government authorities would be able to keep a track of the vehicle emission of every vehicle in the city. This will help reducing the hazardous effects of the air pollution caused due to vehicle emission. Moreover, this system is a low cost and effective system to measure the amount of vehicle pollution caused due to the vehicles. Once the vehicle comes into the vicinity of the RF components, it will send the sensed data to the server which would analyze the emission data and the temperature of the engine of the vehicle and will accordingly alert the vehicle owner. Thus, this developed system helps to provide an accurate outcome with low cost implementation.

6. References

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