

## Design and Development of Reliable High Speed Cost-Effective IoT Based Vehicle Pollution Administration System

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### Abstract

*In this century, the drastic growth of industries, automobiles, agricultural activities and home appliances leads to dangerous complications with the environment. The severe environmental pollution due to worsening of atmosphere, changing of climatic conditions, weakening of ozone layer, pollution of water resources, degradation of soil quantity, etc. finally ends up with global warming. Transportation is liable for more than 50 percent of carbon monoxide in the air. In present the vehicle pollution is inspected with the help of pollution checking stations installed in some places of cities only when getting Pollution Under Control (PUC) Certificate during the process of getting the Fitness Certificate (FC) from RTO Office. In case of Private (own) vehicles the FC is valid for 15 years and there after renewed at every 5 years. In case of Transport Vehicles the FC is issued for a new vehicle for 2 years and subsequently renewed every year. In this method we cannot identify pollution caused if the vehicle has been repaired before getting FC. The vehicle may produce more pollution in the between years. The real-time pollution emission cannot be monitored. To manage the air pollution, the quantity of air contamination needs to be observed and vehicles which are the source for the pollution should be identified.*

*This project gives solution for this problem, by automatic monitoring of gas emission from the vehicle frequently (once in a minute). The detected emission level is uploaded to the cloud once the emission level exceeds the threshold level, then the warning/alert message is sent to the vehicle owner. If she/he ignores the warning/alert message and also the emission level maintains the same dangerous level, then the message is sent to the respective authority. This project is the speed and cost effective collection of data, analysis of the collected data and the information transmission to the respective authority as well as the individual for the real-time environmental pollution monitoring purpose. Hence the reliable high speed cost-effective IoT based vehicle pollution administration system will greatly help the government to control the emission level as well protect the environment from pollution.*

**Keywords:** Pollution Under Control (PUC), Fitness Certificate (FC), pollution, monitoring, IoT, Arduino UNO, etc.

### 1. Introduction

In today's scenario people of all ages, in all the part of the world have pressurized about health effects due to environmental air pollution. The most severe concern is the hitch with children's healthiness. For the reason that, this may cause larger threat due to a grouping of behavioural, environmental and physiological aspects.

In the established part of the world, rules and regulations have already been implemented to the extent to maintain the level of pollution in the environment. Local authorities are essential to do the survey on the quality of air and the presence of pollutants like benzene, oxides of Nitrogen (NO<sub>x</sub>) and other toxics in the local environment due to industries and road transport vehicles. Accurate examination of

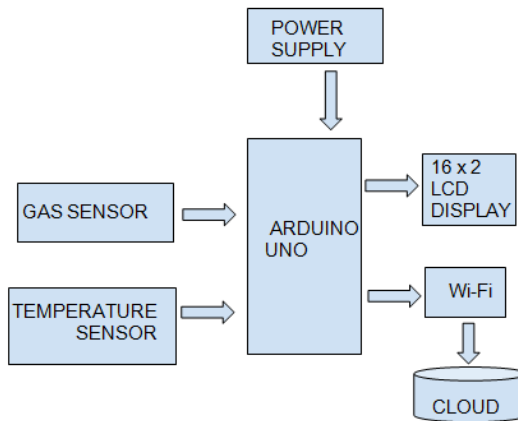
pollution concentrations, understanding of the atmospheric dynamic process and the quick identification of sources are necessary to accomplish this. The data base is necessary for decision making about the pollution levels promptly recognized that impart to real-time environmental conditions.

One of the foremost applications of the project is the speed and cost effective collection of data, analysis of the collected data and the information transmission to the respective authority as well as the individual for the real-time environmental pollution monitoring purpose. Among the many aspects of environmental pollution, air pollution is the most serious than water pollution and soil pollution. The increase in pollution level causes vast and severe damage to the environment and also to human health. Hence the environmental pollution monitoring and control system is the crucial process. The proposed reliable high speed cost-effective IoT based vehicle pollution administration system detects the toxic chemicals spreading in a minimum time period from the vehicles and transmits the stored information to the individual and also to the authorities who are responsible for the environmental pollution control.

There are many research papers published in this area of embedded systems and IoT[1]-[11] and especially in the area of pollution monitoring and control[1]-[10]. Tsow Knobbe and N. j. Tao developed a wearable system for real time monitoring system of toxic ecological unstable organic compounds using wireless sensor[10]. Al-Ali Imran Zualkernan carried out a work for monitoring air pollution using Mobile GPRS-sensors array[1]. The model exploits a microcontroller combines with Mobile-DAQ unit, array of air pollution sensors, a General Packet Radio Service Modem (GPRS-Modem), and a Global Positioning System Module (GPS-Module) and the Pollution-Server which is a high-end personal computer application server with Internet connectivity. Jung Lee Y. K et al. designed a geosensor network supported air pollution monitoring system[6]. Kularantna and B. H. Sudantha developed an IEEE 1451 standard based cost effective environmental air pollution monitoring system[8]. This work uses the smart transducer interface module which was implemented via the analog devices ADuC812 micro converter. Abu Jayyab and Aloul F. worked on Pollumap: Air Pollution mapper for cities[2]. PolluMap is a latest mechanized arrangement that supervises the air quality of urban cities and exhibits the information using a web service. The pollution data were collected by means of mobile hardware units and the collected data were transmitted using GPRS in regular fashion to a back-end server and integrates the available data to create a pollution map of the city by means of its geographical information system. Kwon and H. Kim designed a ZigBee supported air pollution monitoring system for ubiquitous-city[9]. From the wider analysis of the existing systems for pollution monitoring purpose, GPRS based designs are comparatively less speed and need cellular systems to connect and also they are costly. Hence a reliable high speed cost-effective IoT based vehicle pollution administration system is proposed.

## **2. Block Diagram of Reliable High speed cost-Effective IOT based Vehicle Pollution Administration System**

Figure 1 shows the block diagram of reliable high speed cost-effective IoT based vehicle pollution administration system.



**Figure 1. Block diagram of reliable high speed cost-effective IoT based vehicle pollution administration system.**

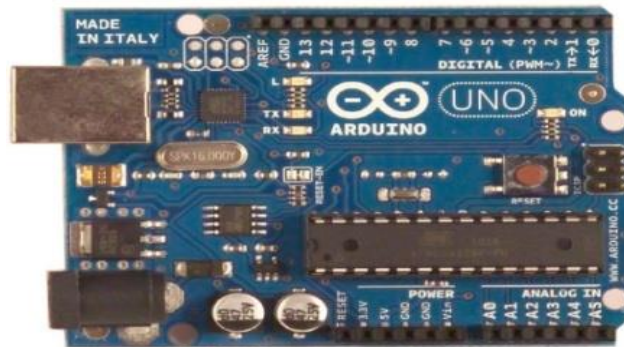
### 3. Hardware Requirement

For the development of the reliable speed-effective IoT based vehicle pollution administration system the following hardware components are required.

- Arduino UNO
- Power Supply
- LCD
- Temperature Sensor
- Gas Sensor

#### 3.1. Arduino UNO

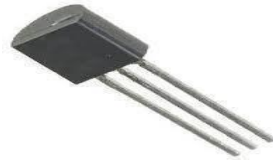
Arduino Uno is a microcontroller board industrialized by Arduino.cc which is an open-source electronics platform essentially based on AVR microcontroller Atmega328. Among the available versions of UNO boards, Arduino Nano V3 and Arduino Uno are the main official versions that move toward with Atmega328 8-bit AVR Atmel microcontroller.



**Figure 2. Arduino Uno**

The Arduino UNO shown in Figure 2 is a microcontroller board based on the ATmega328. It provides 14 pins for the digital type I/O, 6 pins for analog type input, one crystal oscillator of 16 MHz frequency, one USB connection, single power jack, an ICSP header, and one reset button. In the progression of USB Arduino boards, Uno is the most recent and the reference model. Using this open-source platform, the designers can direct and monitor the external electronic devices in the real world and allows easy usage of hardware and software.

### 3.2. Temperature Sensor LM35



**Figure.3. Temperature Sensor**

Figure 3 shows temperature sensor LM35 that measures a temperature range of -55 to 150 degrees Celsius with  $\pm 0.25$  degrees Celsius accuracy at room temperature and  $\pm 0.75$  degrees Celsius over the full temperature range. It generates a voltage signal in analog form which has a linear relationship to temperature, with a scale of 10.0 mV per degree Celsius. In general, the sensor needs a supply voltage of either 5 or 10 Volts, however it can admit a supply voltage ranging from 4 to 30 Volts.

### 3.3. Gas Sensor



**Figure.4. Gas Sensor**

Figure 4 represents MQ6 gas sensor. A gas detector is used to identify a gas leak and interface with a control system to shut down automatically for the purpose of safety. Sometimes alarm alerts operators in the leakage area to leave. Gas detectors can be required to find combustible, flammable and toxic gases, and oxygen depletion. These are widely used in industries like oil rigs.

## 4. Internet of Things (IoT)

Highly developed interaction among the linked devices and computerization arrangements and services are provided by IoT. Distribution and reception of information with applications and software with the support of various telecommunication protocols and tools are achievable with IoT. In order to formulate the human actions or public services more proficient, this incorporates software, hardware and telecommunications.

### 4.1 ThingSpeak Cloud

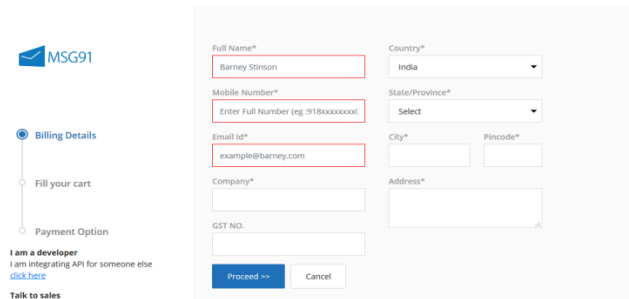
The Internet of Things (IoT) is the set of connections of hardware devices embedded with software and sensors and this enables the connectivity to accumulate and exchange data. This provides proficiency and economic benefits by means of combining group of devices into computer based system. In this work an open-source IoT application ThingSpeak is used. By means of HTTP protocol or through Local Area Network (LAN), API store and retrieve the data from things. When a new channel is created, API keys are automatically generated and enable the user to

write data / read data and the data uploading to the cloud is done by calling these keys.



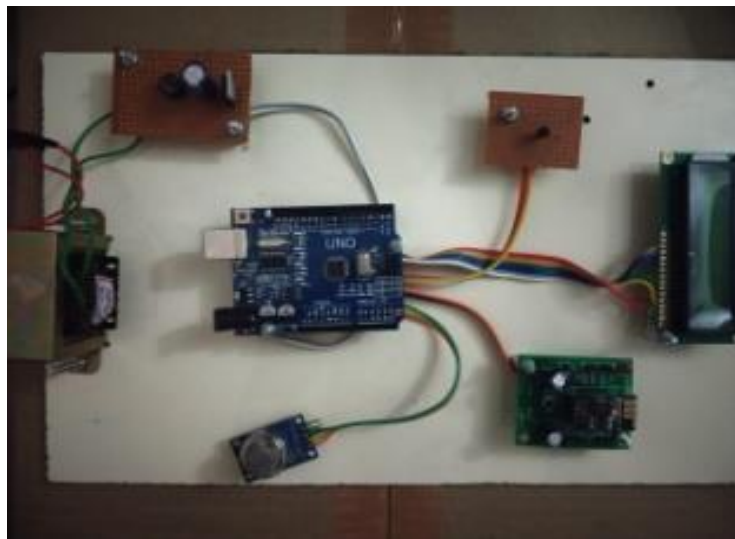
**Figure 5. API Requests**

An Indian massive SMS provider MSG91, has the objective to incorporate all means of communication. MSG91 is entirely regarding messaging using SMS, email or voice.



**Figure 6. MSG91 login page**

Figure 7 represents the experimental setup for the development of the reliable speed-effective IoT based vehicle pollution administration system. The Arduino UNO acts as the brain of this project to which the sensors and Wi-Fi module are connected and it acts as the controlling element.



**Figure 7. Experimental setup for the development of the reliable speed-effective IoT based vehicle pollution administration system**

In this system, the 5V DC supply is given to Arduino board. LM35 temperature sensor with three pins is employed to detect the vehicle temperature. The analog output of the sensor is given to A0 pin of Arduino Uno. MQ6 gas sensor with four pins is utilized to perceive the pollution level and the analog output is given to Arduino board. Four bit mode of LCD is needed for displaying the temperature and gas sensor values. Its D4-D7 pins are required for data which is specified to 5-8 pins of Arduino Uno. Also the register select (rs) and enable (en) pins are connected with third and fourth pins of Arduino board. For the purpose of accessing internet for uploading the data to the cloud Wi-Fi module ESP8266 is connected with Arduino. Ninth and tenth pins of Arduino are linked with receiver and transmitter of the Wi-Fi module. In this proposed system ThingSpeak cloud is used. When the pollution level exceeds the threshold limit initially for some time, then the alert message is propelled to the vehicle user. If it maintain for a long period, the alert message will be propelled to the authority.

## 5. Result and Discussion

We installed 2 sensors with various 10 types of vehicles to monitor temperature and gas. After installing sensors on the vehicles, the system can recognize the variation in temperature and gas emission from the vehicles. The system also connects the control system which operates with the threshold value, status check, and the communication control. Gas and temperature sensors send the measured data to Arduino. Then the Arduino exchanges the measured data to the LCD for displaying output which is in analog form as shown in the figure. These sensors are powered by 5V. LCD is also connected with Arduino Uno. Figure 8 displays the initial recorded value of gas and temperature sensor for a vehicle.



**Figure 8. LCD display at initial level**

Figure 9 LCD displays the newly recorded the gas emission level and temperature level at the threshold level.



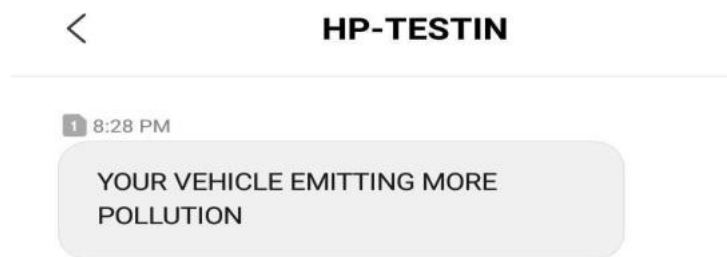
**Figure 9. LCD display at threshold level**

When the recorded value of gas sensor exceeds the threshold level and the level is maintained for a small duration of time, then the controller sends the alert message through SMS to the vehicle owner. Figure 10 shows the Display of Sending SMS Process to the vehicle owner in such a case.



**Figure 10. Display of Sending SMS Process to the vehicle owner**

In the monitoring system, while the recorded gas emission level from the vehicle exceeds the threshold level, the SMS is sent to the vehicle owner. Figure 11 shows the alert message “Your Vehicle Emitting More Pollution”, to the vehicle owner to indicate the pollution level.



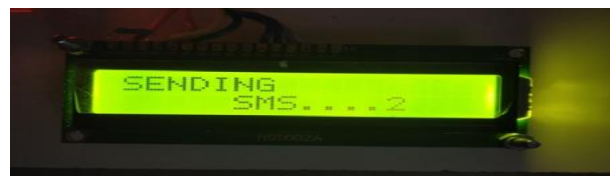
**Figure 11. SMS sent to the vehicle owner**

If the recorded gas emission level and the temperature are maintained at the threshold level, Figure 12 shows the LCD display of vehicle gas emission and temperature maintaining at the threshold level.



**Figure 12. LCD display of maintaining threshold level**

After message is sent to vehicle owner it wait for certain delay, if the vehicle owner ignores the alert message, then the message is sent to the respective authority to take actions.



**Figure 13. Display of Sending SMS to the authority**

Figure 13 shows the display of Sending process of SMS to the authority. After sending SMS to vehicles owner, if he ignores message then the pollution level maintains at the same threshold value, then SMS stated “Vehicle Number: \_\_\_ Emitting More Pollution” will sent to the relevant authority to take necessary action.



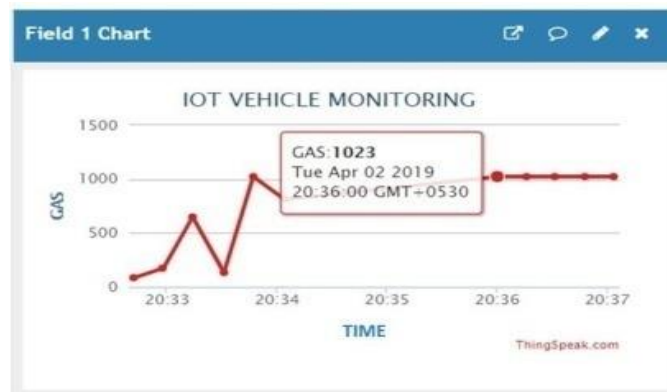
## HP-TESTIN

1 8:28 PM

VEHICLE NO: TN 99 A 2001 EMITTING MORE POLLUTION

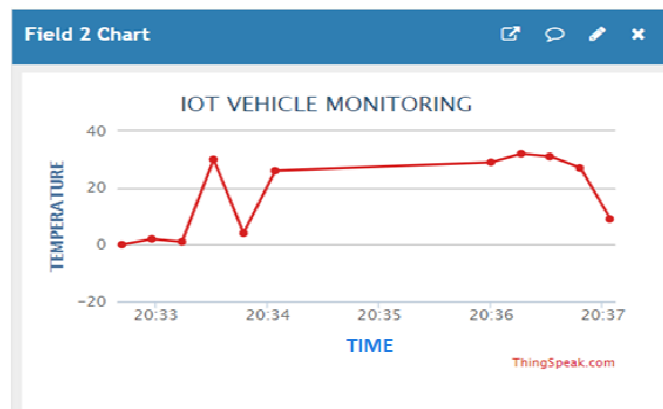
**Figure 14. SMS sent to the authority**

Figure 14 shows the SMS, “VEHICLE NO: TN 99 A 2001 EMITTING MORE POLLUTION” is sent to the relevant authority to take necessary actions, which includes the vehicle number.



**Figure 15. Chart for gas readings**

Gas sensor sends the observed readings to both LCD and Cloud for monitoring purpose. Figure 15 shows the graph for recorded emission level of gas from the vehicles. The amount of gas emitted by the vehicle is plotted with respect to time in field 1chart. Initially the pollution level is very low later it increases with time. When the pollution level crosses the threshold level, the alert message is sent to the vehicle owner and the relevant authority.



**Figure 16. Chart for temperature readings**

Figure 16 shows the readings of temperature, which is stored in the cloud for every 1000ms using Wi-Fi module. The temperature of the vehicle is plotted in the field 2 chart. It increases with time.



## 6. Conclusion and Future Enhancement

This project is accomplished to evaluate the quantity of pollutants discharged by the vehicle continuously and show it on 16x2 alphanumeric LCD display. Also if the pollutant level exceeds the prescribed value, then a SMS will be sent to the respective vehicle owner to alert about the problem. And if he ignores, then SMS is sent to the respective authority to take necessary disciplinary action. Using reliable high speed cost-effective IOT based vehicle pollution administration system, difficulty in manual monitoring and follow up procedure is taken care in an efficient way. The future enhancement of this project may include IoT monitoring of insurance records and accidents records of individual vehicles.

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