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Automated WSN based System for Emission level and Air pollution Detection in Vehicles

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Abstract: — Air pollution is now a serious problem for those living in big, congested, industrialized cities with heavy vehicular traffic. The real wellspring of air contamination in enormous urban communities and modernly propelled nations is the autos and engine vehicles. Each vehicle will have outflow however the issue happens when it is past the institutionalized qualities. Air contamination from autos is part into essential and auxiliary contamination. Essential contamination is discharged straightforwardly into the environment; optional contamination comes about because of concoction responses between toxins in the climate. In both cases poisons are made due to burning procedure. This discharge from vehicles can't be totally maintained but, it certainly can be controlled. Since with the advancement of technology semiconductor sensor can detect various gases like carbon monoxide, nitrogen oxide and hydrocarbons, this paper goes for utilizing those sensors at the discharge outlets of vehicles which distinguishes the level of contamination. At the point when the contamination or discharge level shoots past the officially set edge level, the signal in the vehicle will be activated to demonstrate that the farthest point has been ruptured and the driver of the vehicle may stop after a specific time frame, driver is given the decision to either kill the bell and reset the drove light. Amid this day and age, the GPS begins finding the closest administration stations. After the clock runs out, the fuel supplied to the motor will be cut-off and the vehicle must be towed to the repairman or to the closest administration station. The synchronization and execution of the whole procedure is checked and controlled by a microcontroller. Predominantly for pragmatic utilization this paper depends on AVR based microcontroller. This paper, when utilized as a continuous venture, will profit the general public and help in diminishing the air contamination.

Keywords - *Environmental monitoring system, CO Sensor, GPS, GSM, Microcontroller,Air pollution monitoring, Vehicle emission.*

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I. INTRODUCTION

Environmental pollution has become a major concern in the recent years because of the excessive pollutant emission from industries, factories and vehicles. Human life, plants, animals in the urban areas are endangered by air pollution. It is one of the biggest problems of modern century having a devastating impact on the health of people. Air pollution may occur in different ways but vehicle emission causes more problems than the others because of its increasing use. The uprising number of vehicles has taken part in generating more pollutants in the air than ever before risking the environmental safety of the whole world.

Every year a large amount of the carbon monoxide and nitrogen oxides, and nearly a quarter of the hydrocarbons emitted from autos into the air. Current autos, if kept in great condition, deliver just very little amount of the air quality contamination, yet the outflows from extensive quantities of autos add to a huge air quality issue.

Along these lines, it turns out to be extremely vital to screen and control the air contamination. The most ideal approach to control air contamination is to screen surpassing levels of air toxins and by taking suitable activities to control it.

II. LITERATURE SURVEY

In [1], an ecological air contamination observing framework has been recommended that measures CO2, NO2, CO, HC and NH4 fixation utilizing portable sensors as a part of urban environment. The procured data about air contamination in surroundings is then put away on focal on-line storehouse framework occasionally. It utilizes a remote GSM modem association for exchanging information to a focal PC. Also, the application can share the information openly by showing it on a committed site.

In [2], a participatory detecting framework has been proposed for air contamination checking and control utilizing PDAs, GPS innovation and sensors to shape a bidirectional versatile detecting data framework. It fundamentally utilizes numerous mobile phones to secure a lot of information in a straightforward and savvy way.

Most of the paper which are available mostly focusing on the analysis of pollutants level and found that the principle contaminations from vehicles are the oxides of carbon and nitrogen, which can be effortlessly distinguished nowadays with the assistance of semi-conductor gas sensors. Therefore, in this paper we present a simpler system, which would be very helpful in reducing the amount of pollution from vehicles by identifying the concentration of harmful pollutants.

The paper is organized as follows. Section III briefly describes the proposed model and various blocks. Section IV presents the simulation results. Conclusions are given in Section V.

III. PROPOSED SYSTEM

The main objective is to detect the amount pollution by a vehicle and telling the reason for that pollution. Microcontroller recognize data of the past institutionalized toxin level then the data will be sent to the administration focus through LTE module. The user of vehicle gets a message of vehicle's data including the amount of pollution done by each pollutant component and the reason for pollution and the service center will also send the address of the nearby repairing center to the user.

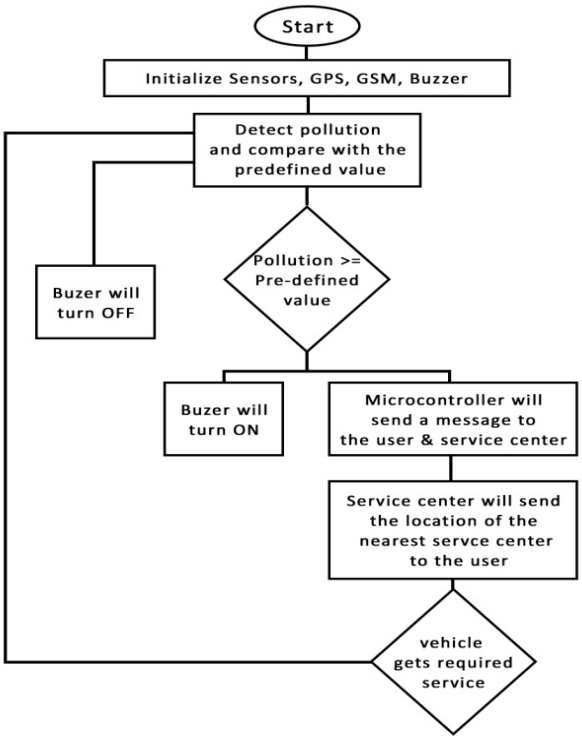

Figure 1: Flow diagram of proposed System

A. *Processing Unit*

There will be an Arduino Mega 2560 in the processing unit which is based on the ATmega2560 microcontroller [3]. Processing unit is responsible for taking decision and managing task. It communicates with both sensing unit and communication unit.

Sensing unit consists of –

- TMP36 (Temperature sensor)
- MQ7 (Carbon Monoxide Sensor)
- MQ135 (VOC Sensor)
- MiCS-2710 (Nitrogen Oxides Sensor)

Communication unit has –

- GPS
- LTE Module

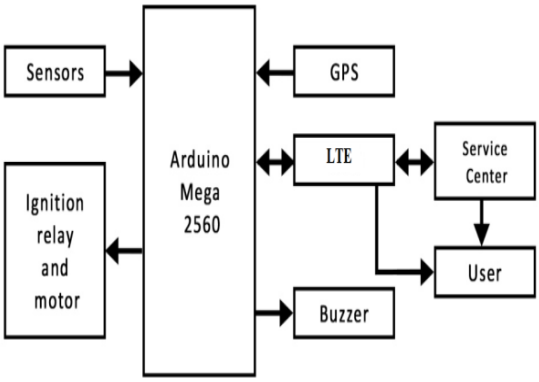

Figure 2: Block diagram of proposed System

Figure-2 shows that at the very beginning microcontroller will initialize all the component of sensing and communication unit. After the initialization process, the microcontroller will take the data from all sensors consistently to monitor the amount of pollutant emitting from the vehicle. In every 5 minutes microcontroller will check the amount of emission and if it exceeds the predefined threshold value, microcontroller will turn on the buzzer to indicate that the emission level has been exceeded the threshold value. At the same time microcontroller will read the location of the vehicle by GPS to forward a message via GSM to the service center including the location of the vehicle and other required information so that the service center can forward a new message to the user including nearest service center location to repair his/her vehicle. Microcontroller will also forward a message to the user via GSM including details information of pollutant and the reason of pollution.

B. *Temperature Sensor*

TMP36 is a low voltage temperature sensor which gives a voltage yield that is directly corresponding to the Celsius (centigrade) temperature [4]. TMP36 will continuously measure the temperature of the vehicle engine. The output pin of TMP36 will be connected with an analog pin of microcontroller because it provides analog voltage as output. If the analog voltage exceeds the pre-defined threshold voltage, the microcontroller of the processing unit will convert the output voltage to the temperature.

C. *Carbon Monoxide Sensor*

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. Carbon monoxide (CO) is a result of inadequate ignition and happens when carbon in the fuel is somewhat oxidized as opposed to completely oxidized to carbon dioxide (CO2). MQ7 constantly check the value of CO emission produced by the vehicle. MQ7 will be connected with an analog pin of microcontroller and the microcontroller will read the data from MQ7 sensor to check if the emission amount of CO is in limit.

D. VOC Sensor

Like MQ7, SnO2 is the sensitive material of MQ135 and lower conductivity in clean air. Hydrocarbon outflows result when fuel atoms in the motor don't smolder or blaze just somewhat. Same as MQ7, it will be connected with an analog pin of microcontroller and constantly check the value of VOC emission produced by the vehicle engine. Microcontroller will also continuously check the value of VOC.

E. Nitrogen Oxides Sensors

MiCS-2710 is Nitrogen Dioxide (NO2) sensor. Under the high weight and temperature conditions in a vehicle, nitrogen and oxygen particles noticeable all around respond to shape different nitrogen oxides, on the whole known as NOx. MiCS-2710 will be connected with an analog pin of microcontroller so that the data can be read from it. MiCS-2710 constantly sense Nitrogen Oxides produced by the vehicle.

F. LTE Module

For communication with the user and also with the service center processing unit has Skywire™ 4G LTE Module. At the very first the Rx pin of LTE module will go the Tx pin of microcontroller and the Tx pin of LTE module will go the Rx pin of microcontroller. Here we are using LTE module to send message to the both user and service center when any pollution occur. To wake up the LTE we have to give "AT" command via microcontroller. Then to communicate with any number we have to push that phone number from microcontroller to the LTE module and also the message. After that the LTE module will send message in the given phone number.

G. GPS (Global Positioning Systems)

GPS is actually used for determining the location of the vehicle. We will use Skylab-GPS-Module-MT3329-SKM53 for this system. If any pollution has occurred by the vehicle then microcontroller will request GPS to give the vehicle's current location so that the microcontroller can send a message to the service center and the service center could suggest a repair center for the vehicle. Same as GSM, GPS has Tx and Rx pin and they will go to the Rx and Tx pin of microcontroller.

H. Buzzer

Buzzer will be turned on to indicate that the pollution level has exceeded the predefined threshold value. Buzzer has a simple connection with the microcontroller. Vcc pin of buzzer will go to any digital pin of the microcontroller. Then by only making the pin HIGH we can turn on the buzzer.

I. SPST switch

To turn on and turn off the whole system we have used a SPST switch. The input point of the switch will be connected with a 5v battery and the output point will go to the Vcc pin of microcontroller.

The level close legitimately balanced gas stoves in homes and from present day vehicle fumes emanations is 5-15ppm. The fumes from autos in focal regions are going 100-200ppm. The measure of CO that can be made from the fumes from a home wood flame is 5000ppm.Our circuit (Fig. 3) uses a temperature with a specific end goal to give information to allow revision of the deliberate yield from the sensor to the standard conditions (20C 65% RH) reported by the datasheet for the relationship to convergences of CO.A signal and red LED give cautioning when the limit of 50ppm is surpassed.

J. Sensor Measurement

The yield from the sensor is a deliberate voltage, Vo. A load resistor RL (10 to 60k ohms) is in arrangement with a protection resistor (10k ohms). We will use a load resistor of 10 k ohms. The sensor's resistance Rs and the load resistor RL form a voltage divider. The sensor yield voltage is in this manner identified with the voltage divider standard:

Vo = RL * Vc / (Rs + RL)
Vo = output voltage
Vc = input voltage (5.0 V)

Solving for Rs:
Rs = (Vc - Vo) * (RL / Vo)

K. Calibration

The most ideal approach to adjust the gadget is to take estimation in a domain with a known fixation (ppm) of CO. The option is to align it in clean air (no CO present). To adjust the sensor in clean air, measure the sensor yield and afterward compute the Ro esteem:

Ro = Rs / Ro_clean_air_factor
where Ro_clean_air_factor = 10000 ohms.

Using Rs from the voltage divider equation:

Rs = ((Vc - Vo) * RL) / Vo
Rs = sensor resistance
RL = load resistor value in ohms (10 k)
Vc is the supply voltage, 5.0 V
Vo is the output voltage measured from the sensor.

Substituting Rs above into the first equation:
Ro = Rs / Ro_clean_air_factor
Ro = [((Vc - Vo) * RL / Vo]/ Ro_clean_air_factor)
Ro = [(Vc - Vo) * RL] / (Vo * Ro_clean_air_factor)

We found from the datasheet, at a low convergence of 100 ppm, Rs/Ro = 1.0 at 20C and 65% RH (RL = 10k ohm). Lower Rs/Ro values correspond to higher concentrations of CO.

With an adjusted quality for Ro, we took readings of the air, as certain the worth Rs from the Vo estimation, and after that think about the proportion Rs/Ro to the table from the datasheet to get the CO fixation in ppm.

Rs = (Vc - Vo) * (RL / Vo)

L. Deriving CO concentration from the sensor reading for Threshold Value

To solve for CO concentration, we use natural logs. Then:

CO ppm = [(Rs/Ro)/22.07]^(1/-0.0667)

We utilized the above condition to decide the CO focus from a given Rs/Ro measured worth at 20 C and 65% RH. In this way by measuring CO fixation we can figure a limit level.

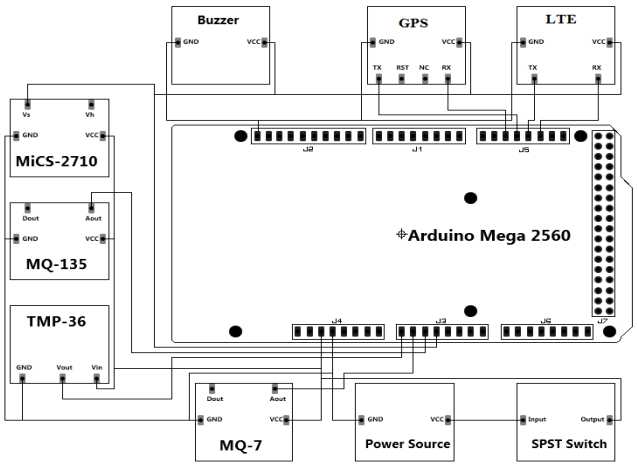

Figure 3:Circuit diagram of the proposed system.

IV. Result Analysis

We have kept the system under observation for few days and operated the system inside a vehicle to sense the pollution. To detect the pollution level we have set a threshold value for each pollutant[5][6].

Substance	ppm	mg/m(3)
Carbon monoxide	50	55
Nitric oxide	25	30
Hydro-Carbon	10	15

Table 1: Limits for air contaminants

Time	Carbon monoxide (ppm)	Nitric oxide (ppm)	Hydro Carbon (ppm)	Temperature (Celsius)
25/07/15 12.oopm	30	14	2	30
25/07/15 12.o5pm	30	14	2	30
25/07/15 12.1opm	36	14	3	30
25/07/15 12.15pm	36	14	4	30
25/07/15 12.2opm	36	15	4	30
25/07/15 12.25pm	38	16	5	30
25/07/15 12.3opm	40	16	8	30
25/07/15 12.35pm	41	17	8	30
25/07/15 12.40pm	41	17	8	30
25/07/15 12.45pm	48	17	8	30
25/07/15 12.50pm	50	17	10	30
25/07/15 12.55pm	52	20	11	30
25/07/15 01.oopm	53	20	11	30

Table 2: Shows the air pollutant data which is sensed in a testing cycle by the proposed system.

In this test cycle we have detected that two pollutants(Carbon monoxide and Hydro-carbon) has exceeded the threshold value which means that the fuel molecule are not fully oxidized and fuel molecules in the engine do not burn or burn only partially.

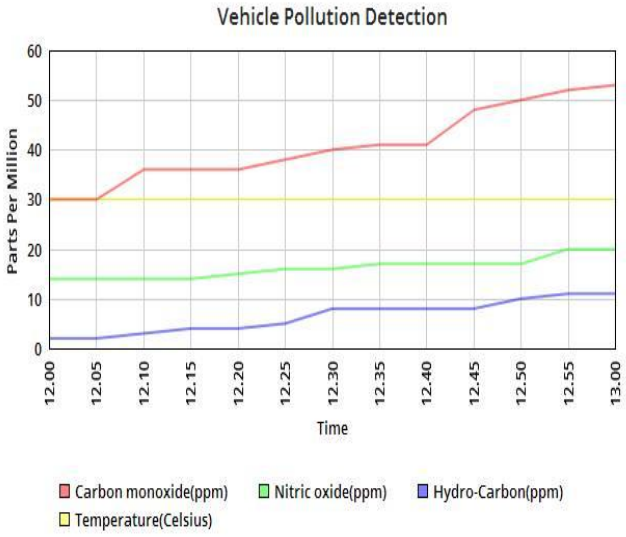

Figure4**:** Graphical representation of Table 2

V. Conclusions

This entire paper basically concentrates on two parts. The first part is the idea of identifying the level of pollution and showing it to the user. There is an expansion in the level of pollution in the course of the last couple of decades, prompting a few environmental issues. There will be a colossal populace, who don't take the contamination from their vehicles seriously, which has as of now brought about a few natural issues such Ozone layer exhaustion. In this way, this framework will be exceptionally useful is checking this issue. The second part is the concept of avoiding rash driving by monitoring the driving status of the vehicle. As we know that rash driving is the main reason for accidents. So this system will be more helpful to provide public safety. This framework will be one of the best changes in innovation to keep the environment free from vehicular emanation and convey it to a stop if the pollution level is more than the Standards specified by the government. This will make it simpler to utilize this framework in the current vehicles.

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