Nat. Volatiles & Essent. Oils, 2021; 8(5): 12501 - 12508

NVEO
Natural Volatiles & Essential Oils

IoT based Air Pollution Tracking System in Vehicles using Raspberry Pi-3

[1]Dr. N. Suma, [2]Dr. C. Vimalarani, [3]Dr. N. Shanmuga Vadivu & [4]Dr. M. Shanmugasundaram,
[1]Professor, Department of Electronics and Communication Engineering,
Karpagam Institute of Technology, Coimbatore.
[2]Associate Professor, Department of Information Technology,
Karpagam Institute of Technology, Coimbatore
[3]Professor, Department of Electronics and Communication Engineering,
RVS College of Engineering and Technology, Coimbatore
[4]Assistant Professor, Department of Computer Science,
College of Computer Science and Information Technology, Jazan University,
Kingdom of Saudi Arabia
[1]suma.ece@karpagamtech.ac.in, [2]drvimalaranic@gmail.com, [3]shanmugavadivun@gmail.com,
[4]smarappan@jazanu.edu.sa

Abstract

Carbon monoxide (CO) is a toxic gas produced by partial combustion of various carbon based fuels. It can cause headache, nausea, vomiting and confusion for humans and critical to environment. Hence this work finds a solution to measure and analyze the level of Carbon monoxide emission in the vehicle used for transportation on roads. This system uses MQ-7 gas sensor to track the content of Carbon monoxide that act as a pollutant in the atmospheric air. MQ-7 sensor is used to measure the carbon monoxide level and it intimates to the vehicle. If the carbon monoxide level is present, the message will be sent automatically to the pollution control board and display the release of this level from the vehicle. As a result the office has the authority to file the case against the vehicle that produce the over pollution. MQ-7 sensor measures the current value of the emitting Carbon monoxide from every vehicle and WIFI modules are connected with every raspberry pi-3 and it will send the message to the PHB based IOT monitoring. It can be used in globally for monitoring of pollution.

***Keywords**: Internet of Things (IOT), Raspberry PI-3, CO sensor, Relay, LCD display, MQ-7 Sensor*

1. Introduction

Recent advancement in technology mainly focuses on controlling and monitoring of different environmental activities in order to reach the human needs. Efficient monitoring system is required to monitor and assess the pollution levels in case of exceeding the prescribed level of parameters (e.g., noise, CO and radiation levels). Air pollution means the introduction of solid dust particles, liquid droplets, or gases into earth's atmosphere which causes diseases, allergies and death to the living beings in ecosystem [3]. The atmosphere is a gaseous system essential to support life on planet earth. Blacksmith institute announced world's worst polluted places; it lists various indoor and air quality problems [7]. Pollutants are created by naturally or manually with the human intervention. Air pollutants are major released from motor vehicle exhaust and factories produced large amount of ash, carbon monoxide and sulfur dioxide respectively. In a smart environment if there is a vehicle exhaust the warning message sent to user and air pollution office alerts automatically. The effects due to the incomplete combustion of fuel from the vehicle can be monitored and controlled by air pollution monitoring system. Application of smart environment targets using of embedded intelligence into the environment which makes the environment interactive with objectives. To monitor

particular signals, there is a need of sensor devices with good data gathering capability. Smart environment is of two types event detection based and spatial process estimation. Sensor devices are placed in the vehicle to collect the data in order to predict the behavior of pollutants [5]. Aim behind this analysis is to design and implement an efficient monitoring system which monitors remotely using internet.

The data gathered from the sensors are stored in the cloud and estimated using web browser [2]. If the estimated value crosses the threshold limit then we conclude the presence of the pollution in the particular environment. In this paper, by using wireless embedded computing system we also present a trending results of collected or sensed data with respect to the normal or specified ranges of particular parameters.

2. Literature Survey

A novel neural network-based technique [3] for smart gas sensors operating in a dynamic environment used to their high sensitivity and low-cost, metal oxide gas sensors (MOX) are extensively applied in gas detection. In this paper, a neural network centered technique is used to overcome these difficulties. The idea is to create intelligent models; the first one, called corrector, can automatically liberalize a sensor's response characteristics and eliminate its dependency on the environmental parameters. A model which process outputs is used to eliminate detected gas. The design phase and optimization uses MATLAB. The PSPICE simulator is employed for implementation and testing. The nonlinear nature of the output and the dependency on temperature and humidity are defined using sensor models. This method distinguishes between various gases. The benefit of the technique is that it utilizes a lesser illustrative database.

A 3-Layer architecture was proposed [4] for Smart Environment Models.

The result of a wireless sensor network air pollution monitoring system was obtained [5,6,7] for sensor networks are currently an active research area mainly due to the potential of their applications.

The sensor based pollution monitoring system [8,9] was developed in Visakhapatnam. As the technology increase, the degree of automation also increases.

The air pollution monitoring system was designed [10] based on sensor deployment through public transport system to monitor the level of air pollution. It is a very popular research topic and many monitoring systems have been developed. An effective noise and air pollution monitoring system using Internet of Things (IoT) was designed to detect the level of air pollution.

3. Existing System Model

The prevailing embedded device for monitoring CO levels in the vehicle emission to make the environment intelligent or interactive with the objects through wireless communication. The proposed model is shown in fig. 2 which is more flexible to check the environmental parameters. The proposed model is shown in fig.2 which is more adaptable and distributive in nature to monitor the environmental parameters. The suggested architecture was discussed in a 4- tier model to detect the level of pollution with various modules [1]. Let the environment be tier 1, sensor devices be in tier 2, sensor data attainment be in tier 3 and intelligent environment be in tier 4. The existing architecture is shown in fig.1. The tier 1 offers the data about region which is required to be checked for air pollution control and noise level monitoring. Tier 2 deals with the sensor devices with suitable characteristics, features and each of these sensor devices is operated and controlled based on its sensitivity as well as the range of sensing. In between tier 2 and tier 3 cases, monitoring and controlling parameters based on various environmental conditions to determine threshold value and frequency of monitoring and custom alarms under various cases. From the statistical analysis of data observed from tier 2 and tier 3 and also from previous experiences, the required parameters with threshold values were checked and determined. The Tier 3 describes about the data acquisition from sensor devices and also includes the decision making, which specify the condition the data is representing on which parameter. In the proposed model, tier 4 deals IoT based intelligent system to find some variations in sensor data and threshold level based on identified CO value.

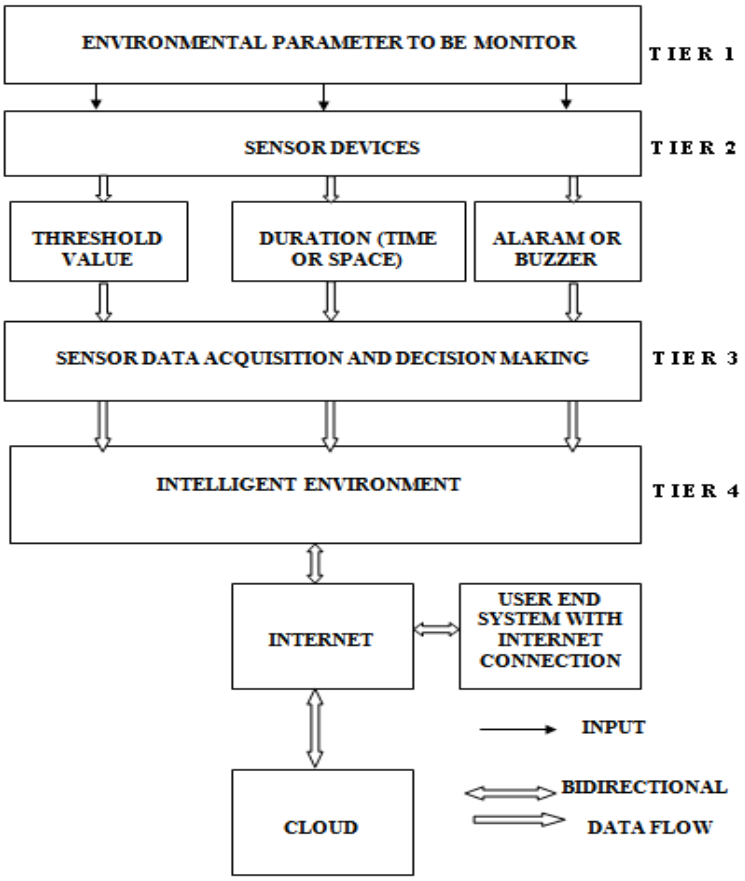

Fig. 1. Existing model

4. Previous Work

The existing method uses the intelligent environment which identifies the variations in the sensor data and fixes the threshold value depending on the identified level of CO. The tier sensed data which was combined with Google spread sheets and show a trend of the sensed parameters with respect to the specified values.

The end users can browse the data using mobile phones, personal computers [15]. In the Existing model tier 4 deals with the intelligent environment. The variations of sensor data are identified and threshold value will be decided based on detected CO level. The observed data is processed and recorded in the cloud where it was stored as Google Spread sheets and sensed parameters are derived as values. The existing embedded device [10] was used for tracking noise and CO levels to create intelligent environment in order to interact with objects through wireless communication devices [13]. The existing model is shown in fig.1 which is more adaptable and distributive in nature to monitor the environmental parameters. The existing architecture was derived based on 4- tier model through various models for detecting air pollution level. The extant model consists of 4-tiers. The tier 1 is the environment, sensor devices in tier 2, sensor data acquisition and decision making in tier 3 and intelligent environment in tier 4 for monitoring the environment [11].

5. Proposed Model

The objective of this paper is to provide Human safety and control the air pollution by using IOT. The system reduces the CO level produced by the vehicle, so impacts on the human beings can be avoided. Table 1 shows the different effects of CO poisoning on humans. This project is used for continuous monitoring of CO produced by the incomplete burning of fuel. It is done with the help of Raspberry pi-3, CO sensor LCD display and relay. CO sensor should be installed at near (10 cm) the pipe of exhauster. The device has three main possible scenarios. These are whether the CO concentration around the area is in safe condition, warning, or danger state. The LCD will print those

values every time and are evaluated of what is to be done next. The minimum poisonous CO_2 is obtained through catalytic converter by combining carbon monoxide and oxygen. Catalytic converter reduces the high concentration in the exhaust manifold (typically 30,000 ppm in open air and 400 ppm in inside the vehicle) to low concentration (typically below 1,000 ppm after the catalytic converter in open air and 100 ppm in inside the vehicle). If the concentration is less than 1000 ppm, the LCD will print the "SAFE" status. If the concentration is within the range of 10,000 ppm in open air and 200 ppm in inside the vehicle, the LCD will print the "WARNING" status and lit the warning LED. Else, the concentration is greater than 30,000 ppm that the LCD will print the "DANGER" status, then the danger LED will lit up In case after two or three times if vehicle driver does not care about the CO level, the message will be sent automatically to pollution control board and display the producing of the CO level against the vehicle to produce the evidence of over pollution.

Table1. Physiological effects of CO in closed area.

Parts	Time of	Response
50	-	Threshold limit non-toxic
100	Several hour	No symptoms
200	2-3 hour	Headache
400	1-2 hour	Headache and nausea
800	45 minutes	Headache, dizziness and nausea
800	2 hour	Unconsciousness
1600	20 minutes	Headache, dizziness and nausea
1600	2 hour	possible death
3200	5-10minutes	Headache and dizziness
3200	10-	Unconsciousness and possible death
6400	1-2minutes	Headache and dizziness
6400	0 minutes	Unconsciousness and possible death
12800	Immediate	Unconsciousness
12800	1-3 minutes	Danger of death

The table 1 shows that the physiological effects of carbon monoxide present inside the vehicle. Here we consider the 3 ranges for CO detection. There are 100 ppm, 200 ppm and 400 ppm. If the CO level exceeds the 400 ppm means the humans suffered by danger diseases, so we set the maximum detection level as 400 ppm.

Table 2. Physiological effects of vehicle CO emission in open air

Parts per million	Time of exposure	Response
Below 1000	-	Threshold limit no symptoms
10000	9-12 hour	Possible headache
30000	1-3 hour	Unconsciousness and possible death
Above 45000	1-3 minutes	Danger of death

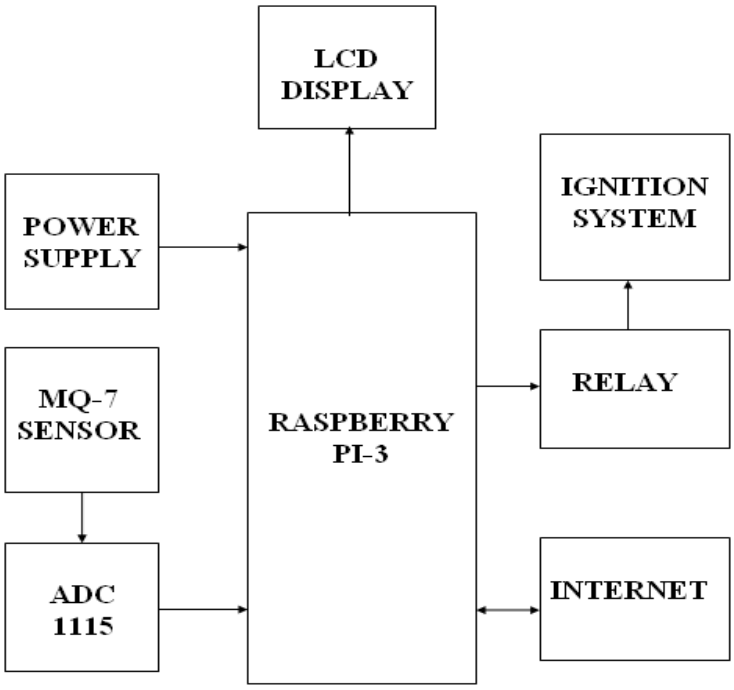

Fig. 2. Proposed model

When the user clears the fine, the Pollution authorities send the OTP to the relay by using IOT. So the relay is working and then vehicle can be started. The proposed model is shown in fig 2: this model consists of CO sensor, Raspberry pi-3, LCD display relay. It is the latest version of Raspberry Pi 3 Model B with 40-pin GPIO and power charger.

Fig. 3. Raspberry pi-3 (model B)

Raspberry pi have an inbuilt internet connecting port. It acts as the small computer. Model B is the advanced version in fig 3, having the in built WI-FI module. This model b is more advanced in all application. Here the raspberry pi3 acts as processor. This connects all the components in the proposed system.

5.1 CO Sensor

The CO sensor is used to measure the CO produced by the vehicle. The one version of co sensor is MQ-7.

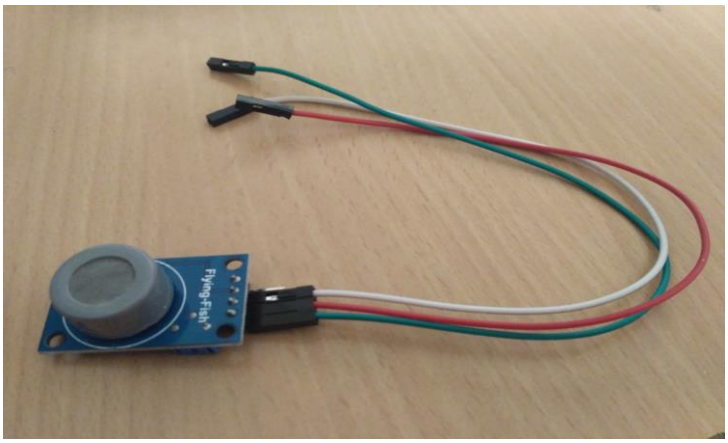

Fig. 4. MQ- 7 Sensor

Suppose the measured CO level is exceed the threshold value it will automatically displayed on the LCD display. Incase after two or three times the driver does not care about the CO level means the message will automatically to Pollution authorities and displayed the producing of the CO level.

5.2 Relay

A relay is an electrically operated switch. Relays connected together are used as an electromagnet to mechanically operate the switch and provide electrical isolation between two circuits. This 8 channel 5V relay has both optical and magnetic isolation, which safeguards the inputs from electrical faults, Works well with 3.3V and 5V logic (Raspberry pi.), requiring little current drive. In this case the office will file case against the vehicle to produce the evidence of over pollution. Now the relay is opened and then locks the vehicle. When the user clears the fine, the Pollution authorities send the OTP to the relay by using IOT. So the relay is working and then vehicle can be started.

5.3 Internet of Things (IoT)

This system is also monitored using IOT the internet of things. Whenever the parameters cross the limits the values are updated. These updated values can be viewed anywhere and anytime by opening the link given through internet. The inputs from sensors given are interfaced with IOT and made available online all the time so anyone who has the link can view the condition of the parameters. An IP address is created in order to access the data. A web page arrives when the link is searched.

The sensors outputs are interfaced with internet of things. A web page is created which contains the readings or observations of sensors. The output of sensors is continuously updated and can be seen in web page at air pollution office. The webpage is hosted online and a link is provided through which we can access the webpage and view the sensors output.

5.4 Implementation

In this implementation model we used Raspberry pi-3 model B with inbuilt internet connection port. Raspberry pi-3 consists of 40 GPIO (General Purpose Input Output) pins. The implementation model is shown in fig.5. This model shows embedded system with its components used for reading and storing sensed data. MQ-7 sensor are connected to Raspberry pi-3 for monitoring the CO level. MQ-7 sensor has 4 pins namely AO (Analog Output), DO (Digital Output), GND and VCC. The DO pin is connected to the input of Raspberry pi-3 in 13 pin and the output is obtained at pin 20. The sensor data can be transferred to pollution authorities by using internet connection. Similarly, the Relay is connected to the Raspberry pi-3 for (ON/OFF) control the vehicle.

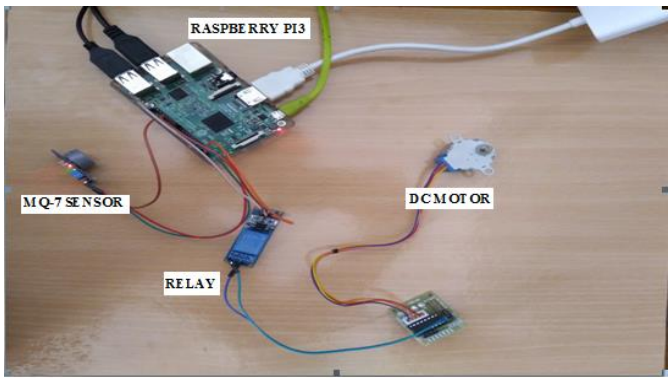

Fig. 5. CO Monitoring and control in vehicle by using Raspberry pi-3 System.

When the CO level exceeds the maximum range, the relay will disconnect the connection between ignition system and engine. So the vehicle is stopped when the user finally off the Key. When the pollution authorities sent the OTP to relay by using IOT, then the relay will establish the connection. So the vehicle is started.

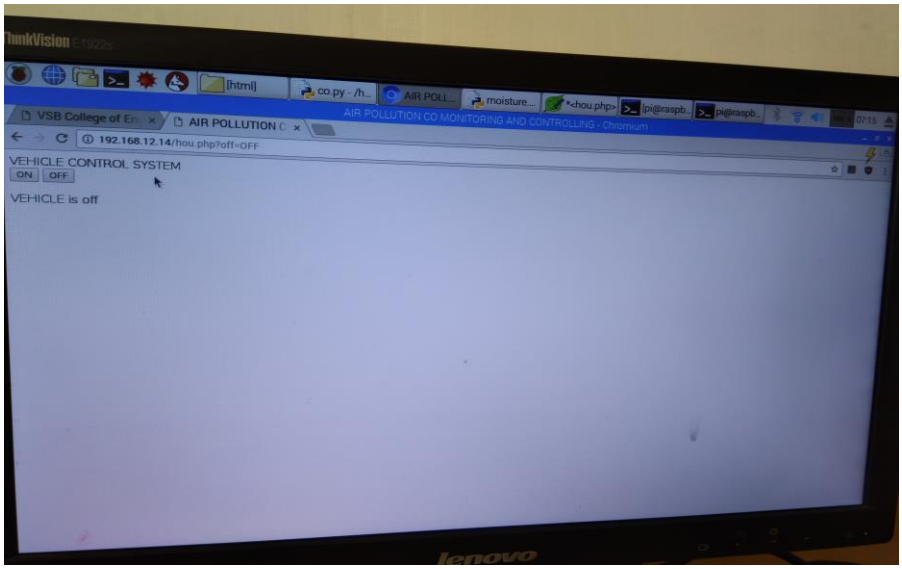

Fig. 6. Web Page Result

After the completion of data sensing it will be processed through IOT. The final result is shown in fig.6. The advantages of this project is to avoid the generation of CO due to the vehicles are not serviced. So this project makes humans service their vehicle properly.

6. Conclusion

The proposed system which is designed shows the output of sensing the carbon monoxide gas and then displayed through LCD. Certain actions are taken by Pollution Control Board when the user does not take any steps to control the emissions of CO in vehicle even after the two warning messages is displayed on LCD. The third time sensor output is pushed to cloud and can be viewed by Pollution Control Board through internet and lock the vehicle by using IOT. This is a robust system which is very useful for humans because of the increasing pollution due to increase in vehicles. This system is user friendly and cost of the product is affordable. The results of the project are accurate. This model proves an efficient pollution control in vehicle through continuous monitoring.

References

[1] Antaean Goth, ''Implementation of an Efficient Noise and Air Pollution Monitoring System Using Internet of Things (IOT)'', International Journal of Advanced Research in Computer and Communication Engineering, Vol. 5, Issue 7, July 2016.

[2] D.Culler, D.Strain, and M. Srivastava, "Overview of Sensor Networks", IEEE Computer, August 2004.

[3] Fabio L.Zucatto, Clecio A.Biscassi, "ZigBee for Building Control Wireless Sensor Networks", IEEE, 2007.

[4] James J.Q.Victor O.K.Li and Albert Y.S.Lam, "Sensor Deployment for Air Pollution Monitoring Using Public Transportation System", IEEE, Vol.01, pp. 1024-1031, 2007.

[5] Jog-Won Kwon, Yong-Man Park, Sang-Jun Kook, Haskin Kim, "Design of Air Pollution Monitoring System Using ZigBee Networks for Ubiquitous-City", International Conference on Convergence Information Technology, Vol.00, pp.1024-1031, 2007.

[6] Chi Chester, "An Atmosphere Environment Monitor System Based on Wireless Sensor Network", John Wiley and Sons Ltd, Southern Gate Journal, vol. 26, pp. 47-51, April 2007.

[7] JosC A. Gutierrez "On the use of IEEE 802.15.4 TOENABLE Wireless Sensor Networks in building automation", IEEE, 2004

[8] H. Karl and A. Willing, "Protocols and Architectures for Wireless Sensor Networks", IEEE, 2009.

[9] A.Mainwaring, D.Culler, J.Plaster, R.Szewczyk, and J.Anderson, "Wireless sensor networks for habitat monitoring", Priority Issues and Policy, Elsevier Science, pp.3-8, 2008.

[10] K.Martinez, J.K. Hart, and R., "On Environmental sensor networks", IEEE Computer Journal, Vol. 37, issue 8, pp. 50-56, August 2004.

[11] N.D.Van Edmond, T.Schneider, "Historical Perspective and Future Outlook, in Air Pollution in the 21st Century, Priority Issues and Policy", Elsevier Science, pp.35-46, 2010.

[12] P.Vijnatha Raja, R.V.R.S.Aravind, B Signet Kumar, "Pollution Monitoring System using Wireless Sensor Network in Visakhapatnam", International Journal of Engineering Trends and Technology (IJETT), Volume 4, Issue 4, April 2013.

[13] ZHANG Qian, YANG Xiang-long, ZHOU Yi-ming, WANG Li-ren, GUO Xi-Shan, "A wireless solution for greenhouse monitoring and control system based on ZigBee technology", IEEE, vol.8, pp:1584-1587, 2007.

[14] http://www.epa.gov/OCEPAterms/pterms.html, EPA Website.

[15] http://en.wikipedia.org/wiki/Air_pollution,Wikipedia.