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IoT-BASED EMISSION MONITORING SYSTEM IN VEHICLES USING NODE MCU

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Abstract:
An increase in automobile vehicles ends up in a rise in air pollution since automobile area units are the main source of environmental pollution. The smoke emitted from the vehicle consists of gases like nitrogen oxides (NO), carbon monoxide gas (CO), and hydrocarbon (HC). Just about one-half of the nitrogen oxide gases, carbon monoxide gas, and a fourth of hydrocarbon gases in the environment area unit emitted from automobile vehicles, which ends up in warming. Due to poor vehicle maintenance and ignition defect. The gases emitted from the exhaust may increase. We will use this method to scale back environmental pollution and extend vehicle life. Once the rate of gases emitted from the vehicle exceeds the starting stage limit set by the government, our system can alert the user through a liquid crystal display. Using IOT, the emission level is additionally displayed and holds on within the info of a vehicle owner. The whole system is controlled by the Node MCU microcontroller.

Keywords: air pollution, automobiles, emission level, IoT, Node MCU

I Introduction:

Pollution in India turns out to be a serious issue in the 21st century. The main source of pollution in India is due to automobile vehicles. The Government of India made many regulations to control environmental pollution caused due to vehicle emissions, but most of them turn to be unsuccessful. The government of India instituted a standard called the Bharat stage emission standard (BSES) to regulate air pollution from motor vehicles. BS- 4 standards are following in India since April 2010. To speed up the green initiative, the government made an order to move from BS-4 to BS-6 in 2020. The Indian pollution control board has made FC (Fitness certificate) and PUC (Pollution under control certificate) compulsory for commercial and public vehicles to control air pollution. Carbon monoxide, hydrocarbon, and nitrogen oxides are the gases emitted from the exhaust. The CO in the atmosphere reduces the capability of blood in carrying oxygen; hydrocarbon in the atmosphere affects the heart, brain, kidney, and bone marrow. NO affects the lung and causes respiratory problems. In the era of urbanization due to the rapid increase in automobile vehicles, it is difficult to inspect all the vehicles. It requires a lot of man force to inspect all those vehicles.
To monitor all the vehicles easily, we develop a system called IoT-based emission monitoring system, through which we can able monitor all the vehicles easily. The IOT plays a vital role in

this project, the sensors placed at the exhaust monitor the level of different gases, and with the help of IOT, the value is updated to the cloud. This makes each vehicle owner and transports workplace watch the vehicle simply.
on the environment. The new air quality standards in India to safeguard society are tabulated in Table 1 [3]. Taxis, buses, and trucks are responsible for 72% of CO and NOx release in metro cities. Due to these alarming conditions, CPCB made FC renewal mandatory every year for Heavy Transport Vehicles (HTVs) and five years for Light Motor Vehicles (LMVs). As per the regulations every vehicle has to undergo an assessment to obtain Pollution Under Control (PUC) certificate every 3 months.

Controlling air pollution can be achieved by monitoring the Air Quality Index (AQI) by using the relevant sensors. The sensor data transmission and their communication are done using new techniques like IoT and Wireless Sensor Network (WSN) which paved the way to get real-time and more reliable information. The most alarming conditions occur when the vehicle emission exceeds the standard limits that can be found by improvising the way of sensing the individual vehicle outflow. For the process of monitoring the AQI, it is essential to have accurate mobile and stationary sensing units, using which the metro corporation will make the laws more stringent on emissions to reduce them.

Meanwhile the use of e-vehicles in different European countries, especially Norway and Austria analyses and understands the factors influencing the competitiveness of evehicles and socio-economic aspects. They are also foisting the emission laws as a serious condition and conducting awareness campaigns. Even though the revenue effects of a vehicle are insignificant in the long run, the cost of elevating a new technology into the market is important [4]. On the other hand in developing countries like India, Brazil, and South Africa are mostly depending on fossil fuels for transportation and domestic applications. In these countries, an emission certificate is provided when a new vehicle is purchased but the renewal of it is ignored by most of the citizens [5]. This paper focuses on the development of field instruments as a solution to spread attentiveness in every individual. The presented prototype in this paper comprises of micro-controller and a sensor to evaluate vehicle emissions and communicate through GSM and to
alert the government for tracking the AQI is manifested.

The rest of the paper is organized as follows: Section II is dedicated to the related works on emission monitoring systems. The proposed system is presented in Section III. The results and discussions are given in Section IV followed by the conclusion in Section V.

TABLE:1.1 EMISSION STANDARDS IN INDIA

Year	Norms	CO (g/km)			HC+ NOx (g/km)	PM (g/kwhr)	Diesel Vehicles
		Passenger cars	Diesel vehicles	2/3 wheeler	Passenger cars 2/3wheeler	Diesel vehicles	HC NOx (g/km) (g/km)
1991	-	14.3 - 27.1	14 11.2	12 – 30 4.5	2.0(OnlyHC) 8-12(only)	- -	3.5 18 2.4 14.4
1998	India	8.68 - 12.40	4. 5	2. 0	3.00-4.36 3.6 1.50-2.18 -	0.3 6	- - 1.1 8.0
2000	stage - 2000	4.34 - 6.20	4.0 2.1	1.6 1.0	0.97 2.0 0.5 1.5	0.15 0.10	1.1 7.0 1.6 5.0
2008	norms	2.72	1.5	-	0.35 1.0	0.02	0.96 3.5
2010	BS-II				0.18 -		
	BS - III	2.2					
	BS - IV	2.3					
		1.0					

II. Related Works

The increase in CO2 level is predominantly irreversible, even Among after the emission is eliminated for

successfully implemented to gather data from two different driving patterns specifically deceleration and speed according

to the slope of the road. It was found that the emission of CO2 was consistently lower in the vehicle whose engine oil was changed frequently compared to the other vehicle.

The increase and decrease of CO2 discharge depend on the speed of the vehicle. Hence there is a good opportunity for identifying the CO2 emissions based on an interval of changing the engine oil and the frequency is significantly provided [7]. To react to climate change, United Nations Framework Convention on Climate Change (UNFCCC) conducts a global summit to make the developing and developed countries cut down their emissions by a minimum of 5% so that global climate change will stay under 2◦C, to avoid severe global climate change in forthcoming years. In reaction to this in 2015 Philippines announced Intended Nationally Determined Contributions (INDC) to cut down their entire emissions in 2030 by reducing the utilization of fossil fuels for energy, transportation, industry, and domestic needs [8].

About 77% of emissions come from only 3 sectors namely energy, manufacturing, and transportation in India given in Fig. 1, which is a huge amount contributing 1.14 tons per capita. These emissions are based on the latest available Social Accounting Matrix (SAM) [9]. Different kinds of road patterns majorly influence CO2 emissions because of irregular and sloppy roads. The effect of road grade has been evaluated on fuel consumption which compares the fuel economy. Due to this, the emission levels are whooping approximately 10% in the case of elevated hilly roads and 2% on flat roads.

From this condition, it can be seen that, fuel consumption on flat routes is an average of 15% to 20% higher than that of hilly routes[10] and [11]. Meanwhile, fuel consumption and emissions are compared using different driving patterns like sudden acceleration, sudden braking, and running the vehicle in an idle condition which has a strong impact on emissions. It has been estimated that fuel can be saved up to 19% for manual vehicles and 7% for automatic ones [12]. As reported in [13], [14], [15], and [16] the transportation sector was the primary reason for the air pollution in various countries. For this problem, most countries deployed Wireless Sensor Networks (WSNs) to know the most polluted roads and areas to identify the different effective measures to reduce the suspended particulate matter, and toxic gas emissions which are causing serious health concerns. Since a lot of

sensors and data communication are involved to monitor the air quality, Khedo et al [11] use WSN with a hierarchy routing protocol to gather the different motes data and identify the duplicated data, distorted data, and noise data which is then it will be aggregated to make simple data for processing and identifying the air quality. This protocol also helps the motes to sleep during idle conditions.
In the city of London [13] the government uses Mobile Discovery Net (MoDisNet) to monitor and get real-time data from the various mobile and fixed sensor stations to analyse the AQI in the city. Since it has a mobile sensor unit it utilizes GUSTO sensor technology to identify the surrounding pollutants on the roads, these data will be sent to the station where data mining will happen for analysis and it will result in the formation of a pollution data map indicating with various ranges of pollutants in certain colour patterns.

III. Proposed System

From prior discussions, it is known that transportation is one of the major factors for climate change and has many adverse effects on all living creatures. In this Project, we are used to monitoring the hydrocarbon mq2, carbon monoxide mq7, and nitrogen oxide mq135 sensors placed at the vehicle value emitted exhaust. The analog value received from the sensors is processed by the controller with the WiFi connection to the internet. The value obtained from the sensors is continuously updated to LCD and cloud. When the value obtained from the sensor reaches the threshold limit, the controller will alert the user through the LCD and database of the vehicle owner. IoT helps the system to update the value to the cloud. The Node MCU connected to the sensors helps to update the value obtained from the sensors to the cloud when Wi-Fi is connected to the internet. The value is continuously updated to the vehicle owner's cloud storage.

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The principle behind the LCDs is that when an electrical current is applied to the liquid crystal molecule, the molecule tends to untwist. This causes the angle of light which is passing through the molecule of the polarized glass and also causes a change in the angle of the top polarizing filter. As a result, a little light is allowed to pass the polarized glass through a particular area of the LCD. Thus that particular area will become dark compared to others. The LCD works on the principle of blocking light. While constructing the LCDs, a reflected mirror is arranged at the back. An electrode plane is made of indium-tin-oxide which is kept on top and a polarized glass with a polarizing film is also added on the bottom of the device. The complete region of the LCD has to be enclosed by a common electrode and above it should be the liquid crystal matter.

IV BLOCK DIAGRAM EXPLANATION

Node MCU Esp8266 act as a heart of this system• 3 Gas sensors MQ-2,MQ-7 & MQ-135 are interfaced with ADC then to Node mcu

LCD is used to display Live gas reading locally and it is interfaced with nodemcu

This whole sensor values are uploaded to the open source cloud Thingspeak. In that cloud, we can visualize the values in the form of plots – live updated values

Using that cloud API, we can predict the scenario if it is exceeding the present values.

OVERVIEW OF EMBEDDED SYSTEMS:

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts. In contrast, a general-purpose computer, such as a personal computer, can do many different tasks depending on programming. Embedded systems have become very important today as they control many of the common devices we use. Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing its reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

HARDWARE REQUIREMENTS

Nodemcu ESP8266

Hydrocarbon MQ2

Carbon Monoxide MQ7

Nitrogen Oxide MQ135

SOFTWARE REQUIREMENTS

INSTALLING THE ESP8266 CORE ON WINDOWS OS

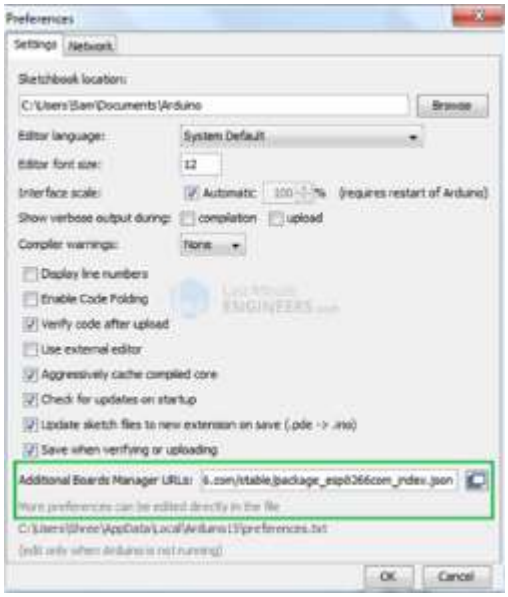
Let’s proceed with installing the ESP8266 Arduino core.

The first thing is having the latest Arduino IDE (Arduino 1.6.4 or higher) installed on your PC. If you don't have it, we recommend upgrading now.

LATEST ARDUINO IDE

To begin, we'll need to update the board manager with a custom URL. Open up Arduino IDE and go to File > Preferences. Then, copy the below URL into the Additional Board Manager URLs text box situated at the bottom of the window:
http://arduino.esp8266.com/stable/package_esp8266c om_index.json

Fig. 4.1.1 Installing ESP8266 Arduino Core



Hit OK. Then navigate to the Board Manager by going to Tools > Boards > Boards Manager. There should be a couple of new entries in addition to the standard Arduino boards. Filter your search by typing esp8266. Click on that entry and select Install.

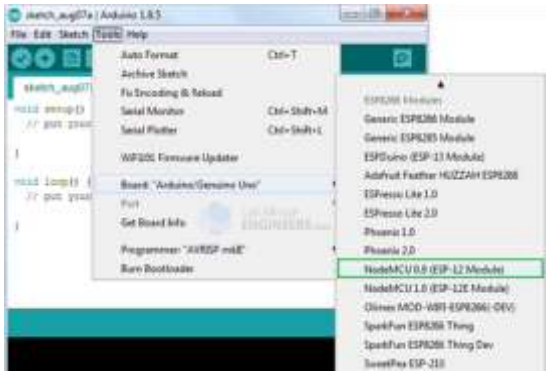
Fig. 4.1.2 Installing ESP8266 Arduino Core

The board definitions and tools for the ESP8266 include a whole new set of GCC, g++, and other reasonably large, compiled binaries, so it may take a few minutes to download and install (the archived file is ~110MB). Once the installation has been completed, a small INSTALLED text will appear next to the entry. You can now close the Board Manager.

ARDUINO EXAMPLE: BLYNK

To make sure the ESP8266 Arduino core and the NodeMCU are properly set up, we'll upload the simplest sketch of all – The Blynk!
We will use the onboard LED for this test. As mentioned earlier in this tutorial, the D0 pin of the board is connected to the onboard Blue LED & is user programmable. Perfect! Before we get to uploading sketches & playing with LED, we need to make sure that the board is selected properly in the Arduino IDE. Open Arduino IDE and select NodeMCU 0.9

Fig. 4.2.1 Blynk App setup



Now, plug your ESP8266 NodeMCU into your computer via a micro-B USB cable. Once the board is plugged in, it should be assigned a unique COM port. On Windows machines, this will be something like COM#, and on Mac/Linux computers it will come in the form of /dev/ty. USB serial-XXXXXX. Select this serial port under the Arduino IDE > Tools > Port menu.
Also select the Upload Speed: 115200

Fig. 4.2.2 Blynk App setup

WARNING

More attention needs to be given to selecting the board, choosing the COM port, and selecting the Upload speed. You may get an espcomm_upload_mem error while uploading new sketches if failed to do so. Once you are done, try the example sketch below. void setup() { pinMode(D0, OUTPUT);
} void loop() { digitalWrite(D0, HIGH); delay(500); digitalWrite(D0, LOW); delay(500);
}

Once the code is uploaded, the LED will start Blynking. You may need to tap the RST button to get your ESP8266 to begin running the sketch.

HYDROCARBON SENSOR

MQ-2 sensor detects the presence of HC (hydrocarbon gases) (methane, propane, and n-butane) at concentrations from 3000 to 10,000 ppm. measuring hydrocarbon gases is important for pollution monitoring. It has 4 pins power, ground, digital and analog output. The sensitivity of the sensor can be varied by the onboard trimmer.

The sensor can operate at temperatures from -20 to 50 degrees Celsius. Sensors are electronic devices used for interaction with the outer environment. There are various types of sensors available that can detect light, noise, smoke, proximity, etc… With the advent of technology, these are available in both analog and digital forms. Besides forming communication with the outer environment, sensors are also a crucial part of safety systems. Fire sensors are used to detect the fire and take appropriate precautions on time.

Fig. 4.3 MQ-2 sensor

CARBON MONOXIDE SENSOR

MQ-7 sensor is used to detect CO (Carbon Monoxide) from 20 to 2000 ppm. the sensitivity of the sensor can be adjusted by using a potentiometer. It has 4 pins (power, ground, digital and analog output). The output is directly proportional to the density of Carbon monoxide gas. The data from the sensor is in terms of analog output. The sensors conductivity is higher along with the gas concentration rising. When the high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature. Please use a simple electro circuit, Convert the change of conductivity to a corresponding output signal of gas concentration. The sensitive material of the MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It makes detection by method of cycle high and low temperature and detects CO when low temperature (heated by 1.5V).

Fig. 4.4 MQ-7 Carbon monoxide sensor

Please use a simple electro-circuit, Convert the change of conductivity to a corresponding output signal of gas concentration. MQ-7 gas sensor has a high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases containing CO, it is at low cost and suitable for different applications.

AIR QUALITY SENSOR

SnO2 is a sensitive material used in the MQ135 gas sensor. Which has lower conductivity in clear air, when the concentration of gas gets increase its conductivity also gets increase. It has a high sensitivity to

Sulphide, Ammonia, and Benzene steam and is also sensitive to smoke. It is used to detect gases from a concentration of 10 to 10,000 ppm.

Fig. 4.5 Air Quality Sensor

The MQ-135 Gas sensor can detect gases like Ammonia (NH3), sulfur (S), Benzene (C6H6), CO2, and other harmful gases and smoke. Similar to other MQ series gas sensors, this sensor also has a digital and analog output pin. When the level of these gases goes beyond a threshold limit in the air the digital pin goes high. This threshold value can be set by using the onboard potentiometer. The analog output pin outputs an analog voltage which can be used to approximate the level of these gases in the atmosphere.

FEATURES

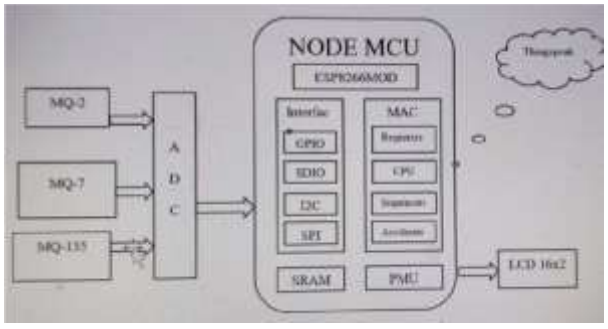
- High Sensitivity
- High sensitivity to Ammonia, Sulfide, and Benze
- Stable and Long Life
- Detection Range: 10 - 300 ppm NH3, 10 - 1000 ppm

Benzene, 10 - 300 Alcohol

- Heater Voltage: 5.0V

Hardware Architecture

Fig. 4.6 Block diagram of hardware architecture



- Node MCU Esp8266 act as a heart of this system• 3 Gas sensors MQ-2,MQ-7 & MQ-135 are interfaced with ADC then to Node mcu
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V. Conclusion

The environmental pollution caused due to the emission of gases like carbon monoxide, hydrocarbon, and nitrogen oxide emitted from vehicle exhaust needs to be reduced to save our environment. The proposed system provides the best solution to monitor the gases emitted from vehicle exhaust to increase the life of the vehicle and reduce environmental pollution. The proposed system is low-cost and easy to maintain. In the future GPS can be added to send the details to the regional transport office and to calculate the number of gases emitted from vehicles in a particular region.

VI. Future Enhancement

The Indian pollution control board has made FC (Fitness certificate) and PUC (Pollution under control certificate) compulsory for commercial and public vehicles to control air pollution. Carbon monoxide, hydrocarbon, and nitrogen oxides are the gases emitted from the exhaust. The CO in the atmosphere reduces the capability of blood in carrying oxygen; hydrocarbon in the atmosphere affects the heart, brain, kidney, and bone marrow. NO affects the lung and causes respiratory problems.

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References

[1] Abu Jayyab, S. Al Ahdab, M. Taji, Z. Al Hamdani, F. Aloul, “Pollumap: Air Pollution mapper for cities”, in Proc. IEEE Innovations in Information Technology Conf., Dubai, UAE, Nov.2006, pp.1-5
[2] Al-Ali.R, Member, IEEE, Imran Zualkernan, and FadiAloul, Senior Member, IEEE, "A Mobile GPRS-sensors array for Air Pollution Monitoring" vol.6, pp.410-422, Oct.2010.
[3] Choi,S N. Kim, H. Cha, and R. Ha, "Micro Sensor Node for Air Pollutant Monitoring: Hardware and Software Issues," Sensors, vol. 9, no. 10, 2009, 7970–7987. Volume 2 | Issue 2 | March-April-2017 | www.ijsrcseit.com 288
[4] Famesh D. Thakre, Bidyut K. Talukdar, Gaurav S. Gosavi, Prashant R. Tayade, "Minimization of CO & CO2 from Exhaust of Two Wheeler Motorcycle", Vol. 4, Special Issue 3, January 2017.
[5] Gao.M, F. Zhang, and J. Tian, “Environmental monitoring system with wireless mesh network based on Embedded System”, in proc. 5th IEEE Int. Symp. Embedded Computing, 2008, pp. 174-179.
[6] Jen-Hao Liu, Yu-Fan Chen1, Tzu-Shiang Lin1, Chia-Pang Chen, " An Air Quality Monitoring System For Urban Areas Based On The Technology Of Wireless Sensor Networks" VOL. 5, NO. 1, MARCH 2012. U.S.

ENVIRONMENTAL PROTECTION AGENCY OFFICE OF MOBILE SOURCES, "Automobile Emissions: An Overview" fact sheet oms- 5,August 1994.

[7] Jung.Y.J, Y. K. Lee, D. G. Lee, K. H. Ryu, and S. Nittel, "Air pollution monitoring system based on sensor network", in Proc.IEEE Int. Geoscience Remote Sensing Symp., 2008, vol. 3, pp. 1370- 1373.

[8] Kadri, E. Yaacoub, M. Mushtaha, And A. Abu-Dayya, "Wireless Sensor Network For Real-Time Air pollution monitoring," In Proceedings Of IEEE International Conference On Communications, Signalprocessing, And Their Applications, February 2013, Pp. 1-5.

[9] Marina Sruthi.M,.Dr. L. Josephine Mary, "Smart Pollution Detection and Tracking System Embedded With AWS IOT Cloud" Volume 6, Issue 4,April 2016.
Postolache.O, J. Pereira, P. Girao, "Smart sensors network for air quality monitoring applications", Instrumentation and MeasurementIEEE Transactions on, vol. 58, no. 9, pp. 3253-3262, Sept 2009.

[10] Prachi Shahane, Preeti Godabole,"Real Time Monitoring of CO2 Emissions in Vehicles Using Cognitive IOT" Volume 5, Issue 3,March 2016.

[11] Roseline,RA, Dr.M.Devapriya, Dr.P.Sumathi, "Pollution Monitoring using Sensors and Wireless Sensor Networks : A Survey" Volume 2, Issue 7,July 2013

[12] Sean Dieter Tebje Kelly, Nagender Kumar Suryadevara, and Subhas Chandra Mukhopadhyay, Volume 1 | Issue 1 | July-August 2016 | www.ijsrcseit.com "Towards the Implementation of IoT for Environmental Condition Monitoring in Homes" IEEE Sensors Journal, Vol. 13, No. 10,2013, , pp.3846-3853.

[13] Völgyesi.P A. Nádas, X. Koutsoukos, and Á. Lédeczi, "Air Quality Monitoring with SensorMap," in Proc of the 7th International Conference on Information Processing in Sensor Networks, 2008, 529–530.

[14] Yaswanth.D, Dr Syed Umar , "A Study on Pollution Monitoring system in Wireless Sensor Networks" Vol 3, Issue 9, September 2013 , 324- 328.