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EMITRACK – A SMART VEHICULAR EMISSION DETECTION SYSTEM

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Abstract - *One of the major reasons for air pollution is emission of polluting gases from vehicles which is responsible for 70% of the total air pollution. The traditional air quality checking framework, controlled by the Pollution Control Department, is very costly and monotonous. Systematic measuring equipment's is expensive, time consuming and power expending. Wireless-sensor Air Pollution Monitoring System which gives continuous observing of pollutants materials discharged from vehicles. MQ sensors are used to sense Hydro-Carbon (HC), Carbon Monoxide (CO) and air quality from the emission of the vehicles. Wireless communication systems support Android-based data collection and analytics system to gather information from the vehicle. The gas sensor detects the gases produced and the micro controller board determines the proportion of pollutants present and if it is higher than the stated limits as per the Bharat Stage 6 norms the system sends the data to the nearby RTO. The system itself have a copy of the measured readings which can be used for future verification. The IOT based monitoring system helps to update the vehicles pollution level in a smartphone application. The development board used is ESP 32. Alcohol sensing along with number plate capturing helps law enforcing authorities to identify the vehicle owner and make appropriate actions.*

The name EMITRACK is derived from the two words in which the EMI represents the emission and the TRACK represents tracking. Thus, EMITRACK is device that is mainly developed to monitor and find out the main pollutants from vehicular emission.

1. INTRODUCTION

The beginning of the 21st century was the time when importance for Environmental awareness was instigated. One of the major concerns regarding the environment is air pollution30% of the hazardous gases contribute from vehicular emission. Motor vehicle emissions are composed of the by-products that comes out of the exhaust systems or other emissions such as gasoline evaporation. These emissions contribute to air pollution and are a major ingredient in the creation of smog in some large cities. Transportation is the main source for generating carbon monoxide that contributes 72% of total pollution in the metropolitan cities like Calcutta, Mumbai, and Delhi. CO is the most common type of fatal air poisoning in many countries. Carbon monoxide is colourless, odourless and tasteless, but highly toxic. It combines with haemoglobin to produce carboxyl haemoglobin, which is ineffective for delivering oxygen to bodily tissues.

1.1 Need of the Study

At present, the Indian pollution control board has made the fitness certificate as compulsory for public and commercial vehicles to control the air pollution. Pollution Under Control (PUC) certificate for every six months is mandatory for all group of vehicles from the date of registration. In order to control the air pollution, the amount of air pollution needs to be monitored and vehicles responsible for polluting should be identified. PUC Centres under the control of Government are conventionally used for pollution testing. These systems are not completely reliable since most of the centers are not able to supervise and control and major calibration problems along with lack of availability of a computerised database for tested vehicles, chances of making fake certificates and receiving rules and regulations. The main objective of this paper is to propose a smart portable hand held device which can detect whether the vehicle is under pollution control integrated with alcohol sensing to make it a handy device which can be used by the law enforcement authority.

1.2 Scope of the Study

Real time pollution monitoring is possible along with alcohol detection. The system is actually a miniaturization of PUC centers with much more user-friendly features along with portability feature which can be serviceable for the policemen and take immediate action. The upgraded system of this can be used for more accurate total air quality measurements. Moreover, the proposed system displays the measurements on IoT platform which can be obtained for future use. Degradation of air quality in cities is the result of a complex interaction between natural and anthropogenic environmental conditions. With the increase in urbanization and industrialization and due to poor control on emissions and little use of catalytic converters, a great amount of particulate and toxic gases are produced. If we have a strong monitoring these harmful pollutants can be reduces. Carbon Monoxide the most toxic pollutant can be sensed along with other pollutant. As of a survey conducted by MIT USA more than half lakhs early death are recorded because of CO poisoning. If we take our country India and our state Kerala itself, the situation is even worsen in the case of populated polluted cities, if our system is implemented strong monitoring of these pollutants can be made and further activities can be followed to ensure a better safe environment to the people in the society.

2. LITERATURE SURVEY

Over the years, there have been several regulations made by the Government to control the emission from vehicles; most of them being unsuccessful at the same. The standards and the timeline for implementation are set by the Central Pollution Control Board under the Ministry of Environment & Forests. Bharat Stage Emission standards are emission standards instituted by the Government of India to regulate the output of air pollutants from internal combustion engine equipment, including motor vehicles.

The first emission norms were introduced in India in 1991 for petrol and 1992 for diesel vehicles. These were followed by making the Catalytic converter mandatory for petrol vehicles and the introduction of unleaded petrol in the market.

On April 29, 1999 the Supreme Court of India ruled that all vehicles in India have to meet Euro I or India 2000 norms by June 1, 1999 and Euro II will be mandatory in the NCR by April 2000. Car makers were not prepared for this transition and in a subsequent judgment the implementation date for Euro II was not enforced.

The standards, based on European regulations were first introduced in 2000. Progressively stringent norms have been rolled out since then. All new vehicles manufactured after the implementation of the norms have to be compliant with the regulations. Since October 2010, Bharat Stage (BS) III norms have been enforced across the country. In 13 major cities, Bharat Stage IV emission norms have been in place since April 2010 and it has been enforced for entire country since April 2017. In 2016, the Indian government announced that the country would skip the BS V norms altogether and adopt BS VI norms by 2020. In its recent judgment, the Supreme Court has banned the sale and registration of motor vehicles conforming to the emission standard Bharat Stage IV in the entire country from 1 April 2020.

On 15 November 2017, the Petroleum Ministry of India, in consultation with public oil marketing companies, decided to bring forward the date of BS VI grade auto fuels in NCT of Delhi with effect from 1 April 2018 instead of 1 April 2020. In fact, Petroleum Ministry OMCs were asked to examine the possibility of introduction of BS VI auto fuels in the whole of NCR area from 1 April 2019. This huge step was taken due the heavy problem of air pollution faced by Delhi which became worse around 2019. The decision was met with disarray by the automobile companies as they had planned the development according to roadmap for 2020.

The standardized values for the emission levels are referred as given in [1]. The sensing of the emitted gases are done using various sensors and devices. The past decade, has seen several research activities that have been taking place to develop semiconductor gas sensors

This paper [2] constitutes a system for vehicular cabin quality measurement using metal oxide semiconductor (MOS) gas sensors for improved safety. This research mainly focuses on improving automotive safety by developing sensors and system to prevent driver fatigue caused by poor cabin air quality and exhaust gas suicides This paper [3] consists of a Mobile Data-Acquisition Unit (Mobile-DAQ) and a fixed Internet-Enabled Pollution Monitoring Server (Pollution-Server). The Mobile-DAQ unit integrates a single-chip microcontroller, air pollution sensors array, a General Packet Radio Service Modem (GPRS-Modem), and a Global Positioning System Module (GPS-Module). The Pollution-Server is a high-end personal computer application server with Internet connectivity. This paper [4] aims at using semi-conductor sensors at the emission outlets of vehicles which detects the level of pollutants and also indicates this level with a meter. When the pollution/ emission level shoots beyond the already set threshold level, there will be a buzz in the vehicle to indicate that the limit has been breached and the vehicle will stop after a certain period of time, a cushion time given for the driver to park his/her vehicle.

3. THE PROPOSED SYSTEM

The implementation of our system is based on Arduino programming on an ESP-32 module. Sensor array can be used and warnings based on threshold can be set, readings can be sent to nearby RTO using IOT. The system can be upgraded to another level by incorporating various technologies to make it a handy all in one device for the law enforcement authorities. Alcohol sensing along with number plate capturing helps authorities to identify the vehicle owner and make appropriate actions. The casing of our device is 3D printed using Fusion 360 and the device is to be embedded inside the casing.

3.1 System Operation

The transmitter system or the smart vehicular emission detection system is designed in such a way that whenever the vehicular emissions crosses the threshold value which is set by BS Norms, there will be sending alerts to the borough with help of a microcontroller board with in built IoT Module. linked with a web server using IoT. The transmitter system consist of gas sensor networks (MQ 135 Air Quality Sensor Module, MQ 7 Carbon Monoxide Gas Sensor Module, MQ 2 Hydrocarbons (Methane/LPG) Sensor Module and MQ 3 Alcohol Sensor Module).Exhaust fan is used to suck the smoke from the vehicle so that it is easily directed towards the sensor network. IP Camera Module is used to capture the photos of the number plates for any kinds of future reference. ESP-32 is used as the microcontroller to read the data from the gas sensors. It is programmed to check whether the emission exceeds the standard norms and to send the monitoring report to the web server.

At the receiver side, a PC-based software application is used to view the alerts and status which can be further directed to corresponding authorities like RTO. At the receiver end, the data from the transmitter side is analysed and updated from time to time. Over the years, there have been several regulations made by the Government to control the emission from vehicles;

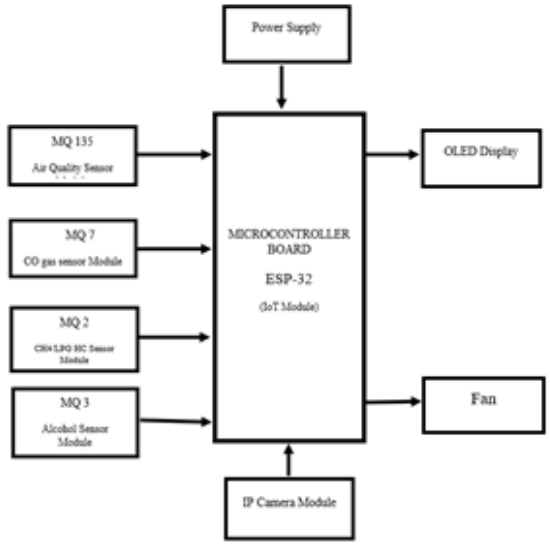

Fig -1 Transmitter Block Diagram

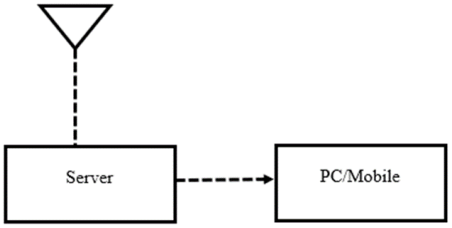

Fig-2 Receiver Block Diagram

3.2 Flow Control

There is a switch to select between petrol vehicles and diesel vehicles (as there are separate norms for the two) to establish connection between device and the network. It will read sensor values or inputs. The sensors are all digital modules and Analog to Digital Converters are present at the back of the sensor modules. The analogue values are converted into digital values. These values are uploaded to the server. These values are compared with the preset values. If the sensor value is greater than threshold value, it will be followed by alerting the user which is uploaded to the server. If the sensor value is less than the threshold value, it is also uploaded to the server. In the server these data are saved creating a web page for user interface. The server is continuously reading and updating the sensor data. The real time reading will be displayed in the system itself using an OLED interface. It can also be accessed on the web page or the mobile platform.

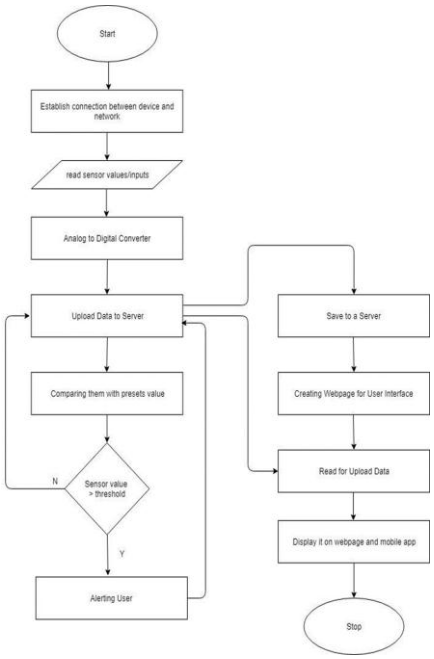

Fig-3 Flow Chart of the system

3.3 Hardware

Microcontroller Board, ESP 32: ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. SRAM is 520 KB Communication protocols include SPI (4), I2C (2), I2S (2), CAN, UART(3).Wi-Fi: 802.11 b/g/n connectivity is provided inbuilt.

MQ-2 Sensor: MQ2 gas sensor is an electronic sensor used for sensing the concentration of gases in the air such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide. MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas. This change in the value of resistance is used for the detection of gas.

MQ-3: MQ-3 module is suitable for detecting Alcohol, Benzene, CH_4, Hexane, LPG, CO. Sensitive material of MQ-3 gas sensor is SnO_2, which with lower conductivity in clean air. This semiconductor gas sensor detects the presence of alcohol gas at concentrations from 0.04 mg/L to 4 mg/L, a range suitable for making a breathalyzer.

MQ-7: This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing CO concentrations in the air. The MQ-7 can detect CO-gas concentrations anywhere from 10 to 500ppm. This sensor has a high sensitivity and fast response time

MQ-135: Air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulphides and Benzene steam, also sensitive to smoke and other harmful gases. It is with low

cost and particularly suitable for Air quality monitoring application.

OLED Graphic Display Module: At the heart of the module is a powerful single-chip CMOS OLED driver controller – SSD1306. It can communicate with the microcontroller in multiple ways including I2C and SPI. An OLED display works without a backlight because it makes its own light. This is why the display has such high contrast, extremely wide viewing angle and can display deep black levels.

Li-Polymer Battery: (Lithium Polymer) Lipo 3.7V 4000mAH Rechargeable Power Bank Battery are Flat, thin, light and powerful. This battery has a capacity of 4000mAH. These Batteries are widely used in GPS, DVD, iPod, Tablet PC, MP4 Player, Power Bank, Mobile Backup Power Supply, Bluetooth Speaker, IOT and other DIY and Industrial applications.

Mini Wi fi IP Camera: An Internet Protocol camera, or IP camera, is a type of digital video camera that receives control data and sends image data via the Internet.

Most IP cameras are webcams, but the term IP camera or netcam usually applies only to those that can be directly accessed over a network connection, usually used for surveillance

3.4 Device Design

The portable Smart Vehicular Emission detection system is designed using the 3D designing software Autodesk Fusion 360. Fusion 360 is a cloud-based CAD/CAM tool for collaborative product development. Fusion 360 enables exploration and iteration on product ideas and collaboration within distributed product development team. Fusion 360 combines organic shapes modelling, mechanical design and manufacturing in one comprehensive package. The ergonomics of the system is designed in such a way for providing maximum user experience. The device into which the sensors and the microcontroller is placed must have good airflow in it. To ensure that the emissions from the vehicles is directed into the sensor unit, a small exhaust fan is there at the tip of the device. To make it a handy potable device extension are provided using hollow connections so that the emissions from the vehicles can be easily directed using these hollow connections. The device can be extended as we are using a three-fold hollow extension stick. The sensor units are placed in such a way that alcohol sensor detection unit is on the opposite side of the device to make it a handy multi-purpose for alcohol detection of the drunken along with vehicular emission detection. Mini Wi-Fi IP camera is also positioned in the device for capturing the images of the vehicle number plates which can be used for future reference. The design of the device casing is shown below.

Fig-4 Shortened View of the System

Fig-5 Extended View of the System

3.5 SOFTWARE

ESP 32 Programming with Arduino Ide: The ESP 32 can be programmed using two different languages. They are LUA SCRIPTING LANGUAGE and the ARDUINO based C LANGUAGE. Here the Arduino IDE is used to program based on the C language. We have used the POST method for uploading the data to the Thing speak platform.

ThinkSpeak: The data collection, storage, and visualization are done using the ThingSpeak IoT Platform. It is an open-source platform with MATLAB facilities. The data is stored and retrieved by using the HTTP protocol through the internet. ThingSpeak is basically an IOT platform that lets us store the data in the cloud and develop internet of things (IOT) applications.

4. CONCLUSION

The paper mainly focuses the concept of detecting the level of Pollution. There is an increase in the level of Pollution over the last couple of decades, leading to several Environmental problems. There will be a huge population, who do not take the pollution from their vehicles seriously, which has already resulted in several environmental problems such Ozone layer depletion and so on. So, this system will be highly beneficial is curbing this problem. The second reason is that this system will be one of the greatest improvements in technology to keep the Environment free from vehicular emission as strong monitoring helps in controlling the pollution in a great manner. Now with the fast-growing technology, air pollution monitoring has become a much easier job. The device is designed in such a way that with Wi-Fi/internet source it could eventually monitor our vehicular emission. This device built with low-cost sensors gives us the data with maximum accuracy and reliability. The

design with which it is built also provides great support and efficient airflow. The data from the device can prevent humans from being exposed to the polluted atmosphere.

This device can be made into a handheld by equipment of more other sensors like SO_X, NO_X etc. So that the concentration of certain harmful gas can be measured and can be controlled to a large extent. The device can be handed over to law enforcement for checking the pollutant level in vehicle & penalize them if level exceeded the normal level.

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