Integration of on-Board Diagnostics for Vehicular Pollution Monitoring using Internet of Things (IoT)

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Abstract— This paper presents a method for monitoring and control of vehicular emission exhaust using Internet of Things and On-Board Diagnostics. Pollution is the major threat faced today which causes Global warming and Environmental degradation and Quality of the Air is affected in huge. Major capital cities experience such problem due to the huge traffic at each node and roadside. Hence implementation of OBD (On-Board Diagnostics) and Internet of Things (IoT) enables effective monitoring and control of pollution on periodic basis. OBD involves vehicle information being displayed in the monitor screen of the vehicle owner so that engine health condition is known to the customer and the condition is kept under check. IoT is a system of interrelated computing devices, objects and people which are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-machine interaction. The main aim of this project is to protect the environment from the risk of harmful gases release, through pollution prevention by constant monitoring through Networking.

Key words: On-Board Diagnostics, Internet of Things (IoT)

I. INTRODUCTION

This project deals with the online monitoring and control of vehicular emission exhaust by networking. This paper proposes use of Internet of Things (IoT) to address this problem. Combination of Wireless Sensor Network and Electrochemical Toxic Gas Sensors, the use of a zigbee and RFID tagging system to monitor car pollution records and transmits them anytime anywhere. Pollution and especially air pollution has always been a serious threat to the environment. One of the very important factors responsible for air pollution is the emission of gases from the vehicles such as CO which degrades the environment. A really important need here is to curtail the amount of harmful gases which are emitted from the vehicles. This can be done with the help of regular PUC checks of the vehicles but this method has proved to be a failure when undertaken by government authorities. Nowadays we see that the regular PUC checking system is not that accurate. Except at the petrol pumps, PUC checks at all other places are done at random basis. Sometimes PUCs are issued merely on the basis of number of the vehicle without actual diagnostics of the vehicle. Besides this nowadays the tendency of keeping the vehicles maintained by regular services has disappeared. Everything cannot be left for government. Every vehicle needs to diagnose its pollutants on its own and that is where the idea of this paper resides. This paper will help to achieve this aim as the whole PUC system will be assembled in the car itself.

II. EXISTING SYSTEM

In this section, we would like to present effective use of Internet of Things to address the issue of vehicular pollution. Continuous monitoring of air quality is necessary to ascertain level of pollution and presence of certain harmful pollutants. Various gas sensors (viz. Carbon monoxide, sulphur dioxide, Nitrogen dioxide, Methane etc.) may be pressed into service for this purpose. Polluting vehicles should be identified in order to take appropriate steps. Few locations, with usually high volume of traffic, may be identified to be monitored. In this framework, for each monitored location, the RFID readers are placed on the either side of a road with a fixed short distance in between them. Each vehicle passing through the road is equipped with a passive RFID tag. Sensor nodes, composed of gas sensors, are placed on the roadside. The sensor nodes may be identified and addressed by unique IP address. These nodes gather sensor data continuously and send it wirelessly to the server. Whenever the sensor nodes sense abrupt rise in pollution, search is initiated for concerned RFID tags, i.e. vehicles causing pollution are identified using the RFID tag attached on them. The RFID readers detect a car passing by.

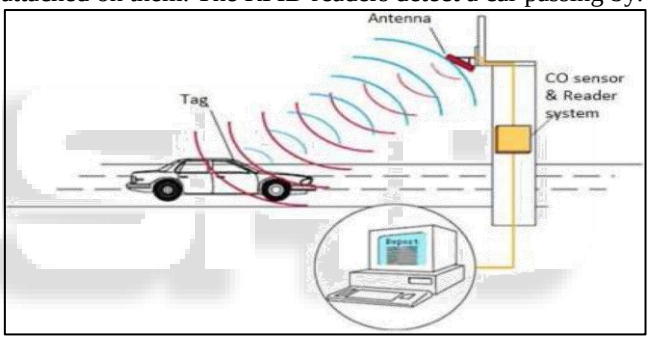

Fig. 1: RFID installed at traffic light and its working

III. PROPOSED SYSTEM

On-Board Diagnostics is essential for an interactive emission control. The OBD in this research serves additionally as a best alert tool for the drivers on the dashboard for effective and improved engine efficiency. Once the engine efficiency increases, emission decreases. Complete parameters like technical and safety must be available on the OBD. RFID technology is used for unique identification of each vehicle. The RFID readers are placed on the either side of a road with a fixed short distance in between them and each vehicle passing through the road is equipped with a passive RFID tag. Sensor nodes, composed of gas sensors, are placed on the roadside which may be identified and addressed by unique IP address. These nodes gather sensor data continuously and send it wirelessly to the server. Zigbee is used for data transmission. When the vehicle passes the tag gets read and analyzed for repeat test. If the reading is taken before zigbee request is disabled else zigbee is enabled and transmits data from vehicle to zigbee receiver placed on road side. The receiver passes to the network controller and the data is sent to National Data Center from where the traffic authority and Pollution Control Board can acquire the data.

IV. IMPLEMENTATION OF THE FRAME WORK

A. ON- Board Diagnostics

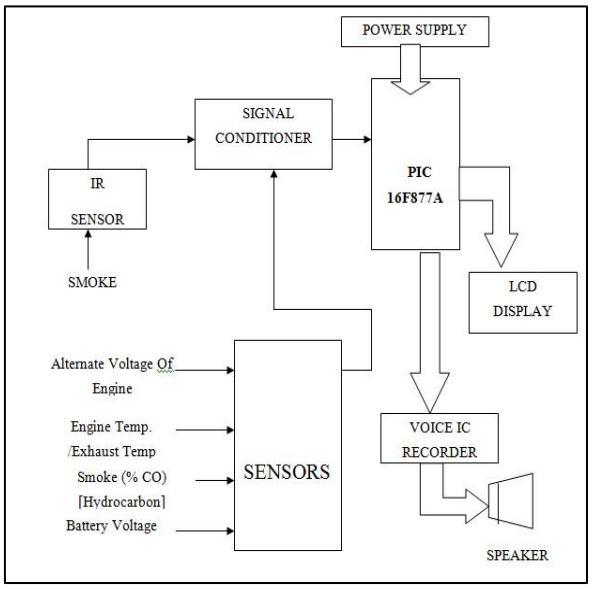

Fig. 2: Block diagram of OBD

This is an informative system to indicate multiple parameters of the automobile resources like fuel, battery voltage, alternate voltage of engine, engine temperature, exhaust temperature, percentage of the hydrocarbons, air, including the speed. This system would be useful to any users to identify the various parameters in a single and compact LCD. The system has been designed in such a way that the user may acquire the details of the automotives either manually or they can be displayed sequentially based on their occurrences as well as per the user's choice. A voice recorder IC has been used in this project to produce warning voice signals during abnormal conditions of resources. This can be useful to the users to have a better decision to avoid downtime in the automotive system. This project involves the usage of the latest embedded microcontroller. Automation is the most wanted mechanism nowadays in each and every field with latest available resources in an inexpensive way. In the day today life without automotives are unimaginable. A useful and conservative energy can be obtained using systematic indicating systems in automotives. The automotive method we are going to adopt in this system would be by displaying the various parameters through an informative system. Automation coupled with informative system dominates in all the spheres and not significantly in the area of automobiles. We would like to develop an informative system to indicate multiple parameters of the automobile resources like fuel, battery voltage, alternate voltage of engine, engine temperature, exhaust temperature, percentage of the hydrocarbons, air, including the speed. The existing method of measuring the amount of fuel in the fuel tank is based on analog system. The amount of fuel in the tank is read through a gauge in the form of a meter. However this meter cannot specify the exact level of fuel in the tank, which may lead to miscalculation in times of crisis. The pointer in the meter if often found to be stuck, thus gives doubts about fuel availability in the tank. In modern vehicles, the replacement of a single fuel gauge is cumbersome and may lead to change of an entire unit, which may cost heavy. This miscalculation or poor reading of the pointer in the meter may lead to few technical and non-technical problems. The continuous usage of the starter key with an empty fuel tank shall lead to starter motor problems, its complicating costs, the battery loosing its charge and slowly its life. Similarly, the alternate voltage of the engine, engine temperature, exhaust temperature, percentage of the hydrocarbons air etc can also be displayed through the LCD display. This system would be useful to any users to identify the availability of all the parameters specified above. The speed of the vehicle can also be obtained by using the IR sensor. During abnormal conditions set points have been set to awake the user for the specified parameters discussed above. Alternatively every action-taking place is indicated through the voice output. So every action will be indicated in the form of recorded voice. On-Board Diagnostics is essential for an interactive emission control. The OBD in this research serves additionally as a best alert tool for the drivers on the dashboard for effective and improved engine efficiency. Once the engine efficiency increases, emission decreases. Complete parameters like technical and safety must be available on the OBD.

V. INTERNET OF THINGS

Gases emitted from automobile exhausts have been monitored using a gas sensor arrays. The information from the sensor array has been transmitted to a remote location by Zigbee wireless technology while informations are stored in RFID card and reader reads it. So when a car passes the data is read and transmitted through Zigbee [1]. The roadside transceiver sends the data to the National Data Centre where measure is taken to reduce the emission exhaust of the vehicle. Quantitative and qualitative analysis of gases has been conducted at the remote location by a computer. Programs have been developed in embedded c programming to display data and alarm conditions. Results indicate that unlike the automobiles using natural gas the unleaded and premium unleaded fuel automobiles can have significant effect on the environment conditions due to their high level of toxic gas emission.

In this paper, the detection of gasses emanated for automobile exhausts have been studied and reported. The paper consists of three parts: first part concentrates on the sensor array for the detection of gases emitted form various automobiles with different ages and models. The second part is the transmission of the information from the sensor array to a central computer by using the ZigBee, RFID and IoT technology [4]. The final part is the software tools for the analysis, display and control of the information supported by various software tools including the visual basic.

A. IR Sensors Used To Sense the Emission Exhaust

It is quiet nature that a third person may enter in a exchange without prior permission and request from the authorities, which may create hazardous problem for his life, in such case a sensor is required to find out that case and to keep in form to the computer for further actions. We use Infrared Emitter and Detector to over come the problem.

In basic IR rays has highest wavelength than the existing VIBGYOR color spectrum. According to manufacturer's instruction we found that I.R. rays can be generated by applying electric current to Gallium Arsenide

semiconductor material. Here we are using a current limiting resistor to safeguard IR Emitter as well as to produce enough rays density, which is necessary to drive IR Detector. We have used 1K resistor from 5V dc to the Emitter to restrict current flow beyond 5mA. Even though Emitter can withstand up to 35mA, we have used 5mA due to shortest distance. If the distance is more we have to increase the current flow to the emitter. Beyond the limitation of Emitter can be achieved by using additional lenses (optical system) in front of the emitter. IR Detector is having reverse characteristics of the I.R. EMITTER. That is we cannot consume more current from it on account of positive sensitivity. For the above grounds we have used 100K from the supply Voltage. So the sink current will be as per the Ohm's Law I=V/R. So 5/100K will be less than a microampere which may improve the detecting characteristics. Detector will conduct as long as the rays fall on it. So the level will be low which may goes to cut off range, when ever there are no rays. Status will be high. From the above we are clearly known that if there is no entry signal will be low, if there is entry signal will be high. Detector drives a NPN transistor which provides inverse output at collector end and given to a two stages Schmitt Trigger.

B. Temperature Sensors or Thermistors

Like the RTD, the thermistor is also a temperature sensitive resistor. While the thermocouple is the most versatile temperature transducer and the PRTD is the most stable, the word that best describes the thermistor is sensitive. Of the three major categories of sensors, the thermistor exhibits by far the largest parameter change with temperature. Thermistors are generally composed of semiconductor materials. Although positive temperature coefficient units are available, most thermistors have a negative temperature coefficient (TC); that is, their resistance decreases with increasing temperature. The negative T.C. can be as large as several percent per degree Celsius, allowing the thermistor circuit to detect minute changes in temperature which could not be observed with an RTD or thermocouple circuit. The price we pay for this increased sensitivity is loss of linearity. The thermistor is an extremely non-linear device which is highly dependent upon process parameters. Consequently, manufacturers have not standardized thermistor curves to the extent that RTD and thermocouple curves have been standardized.

C. Radio Frequency Identification

RFID stands for Radio Frequency Identification. RFID is one member in the family of Automatic Identification and Data Capture (AIDC) technologies and is a fast and reliable means of identifying objects. There are two main components: The Interrogator (RFID Reader) which transmits and receives the signal and the Transponder (tag) that is attached to the object. An RFID tag is composed of aminiscule microchip and antenna. RFID tags can be passive or active and come in a wide variety of sizes, shapes, and forms.

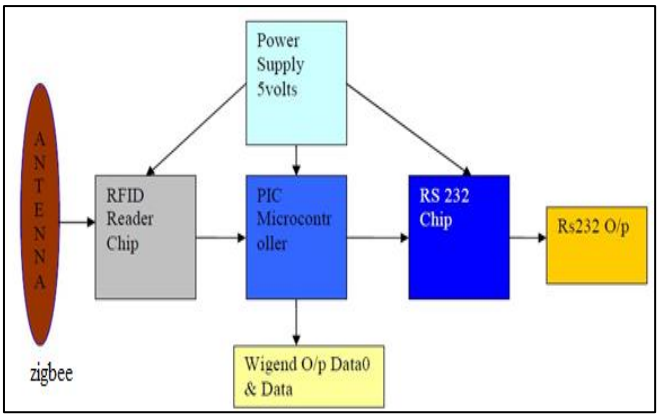

Fig. 3: RFID reader with NSK EDK 125KHz

Communication between the RFID Reader and tags occurs wirelessly and generally does not require a line of sight between the devices [2]. An RFID Reader can read through most anything with the exception of conductive materials like water and metal, but with modifications and positioning, even these can be overcome. The RFID Reader emits a low-power radio wave field which is used to power up the tag so as to pass on any information that is contained on the chip. In addition, readers can be fitted with an additional interface that converts the radio waves returned from the tag into a form that can then be passed on to another system, like a computer or any programmable logic controller. Passive tags are generally smaller, lighter and less expensive than those that are active and can be applied to objects in harsh environments, are maintenance free and will last for years. These transponders are only activated when within the response range of an RFID Reader [3]. Active tags differ in that they incorporate their own power source, where as the tag is a transmitter rather than a reflector of radio frequency signals which enables a broader range of functionality like programmable and read/write capabilities.

Some other current uses for RFID include waste management, automating parking and managing traffic, the dispensing of all types of products, providing ski lift access, the tracking of library books and more. Major growth in the future of RFID will come from real-time location systems (RTLS), asset management, baggage handling and cash less payment systems. Business segments such as retail, logistics, warehousing and manufacturing will greatly benefit from an increase in supply chain visibility that RFID can create.

D. ZIGBEE Technology

Zigbee is targeted at radio-frequency applications that require a low data rate, long battery life, and secure networking. The modules require minimal power and provide reliable delivery of data between devices. The modules operate within the ISM 2.4GHz frequency band and are pin-for pin compatible with each other. The XBee®/XBee-PRO OEM RF Modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any serial device (Through a Digit proprietary RS232 or USB interface board).

E. Internet of Things with Proposed System Working

Internet of things can be described as the "**next evolution of internet"** which is going to change everything around us. Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals, people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-machine interaction. In short it is a "network of things" [5].

Internet of things has the following elements:

1) RFID –to provide a unique identity for each "thing" that is to be monitored.
2) WSN- Wireless Sensor Networks is a networking by which information is transferred between sensor nodes (ZIGBEE).
3) ADDRESSING: To uniquely identify each node in the network.
4) DATA STORAGE: The data need to be stored and used intelligently for smart monitoring and actuation. (NDC DATABASE).

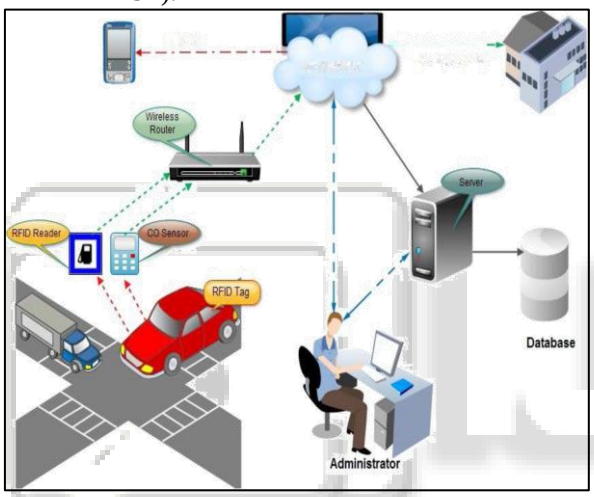

Fig. 4: RFID and Zigbee installed at roadside and its working

VI. EXPERIMENTAL RESULTS

The interfacing of Zigbee module with one personal computer and emission board with another personal computer is done and results are obtained.

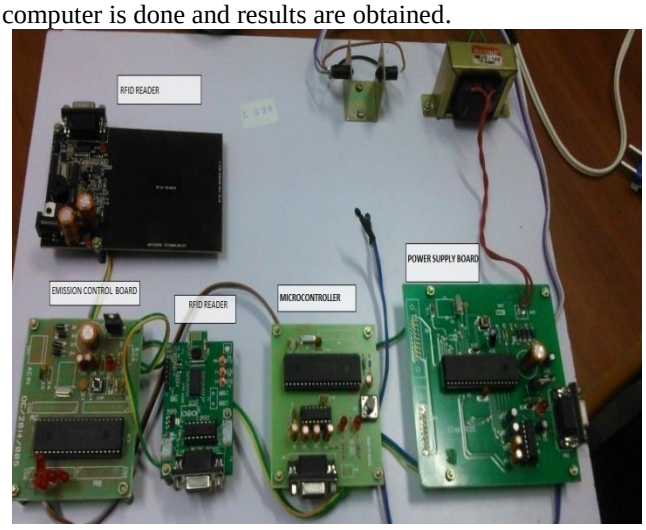

Fig. 5: Overall Interfacing of Zigbee, RFID and Emission board

Thus the output port from the Emission board is connected to one system and the output port from the Zigbee module is connected to another system. When the Power supply module is switched ON the RFID module along with the Zigbee module is supplied with operating voltage. Thus when a vehicle with RFID card embedded at its outer car surface is passed by; the roadside reader reads the information from card which is transmitted by the Zigbee transceiver [6].

The obtained data is sent to the board of control National Data Centre through IoT which is as shown in the below diagram. Thus with the help of the internet and networking authorities are able to consistently monitor the pollution level of each vehicle. Vehicle which passes instantly is caught in sight with information such as vehicle number, authorization number, year of registration, owner name, valid till, type of vehicle, make, model, area, photo, date and time are displayed along with the OBD data such as emission level, exhaust temperature, etc.

A. Interfacing with Zigbee Module

When the Zigbee module is interfaced with the one of the personal computer and visualbasic6.0 with coding is debugged then the output is displayed in the road side system to the NDC through IoT with values varying according to the condition of the vehicle.

B. Interfacing with Emission Board

When the emission module is interfaced with another personal computer and visualbasic6.0 with coding is debugged then the output is displayed in On-Board inside the vehicle with values varying according to the condition of the vehicle

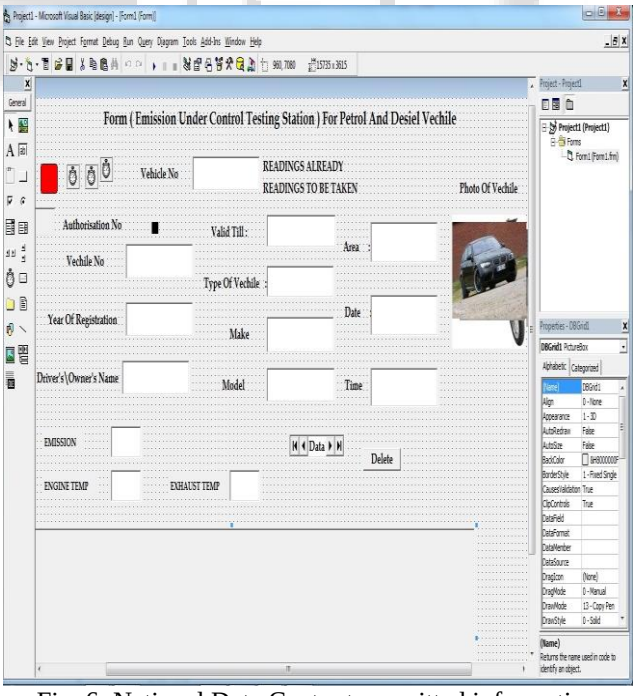

Fig. 6: National Data Centre transmitted information

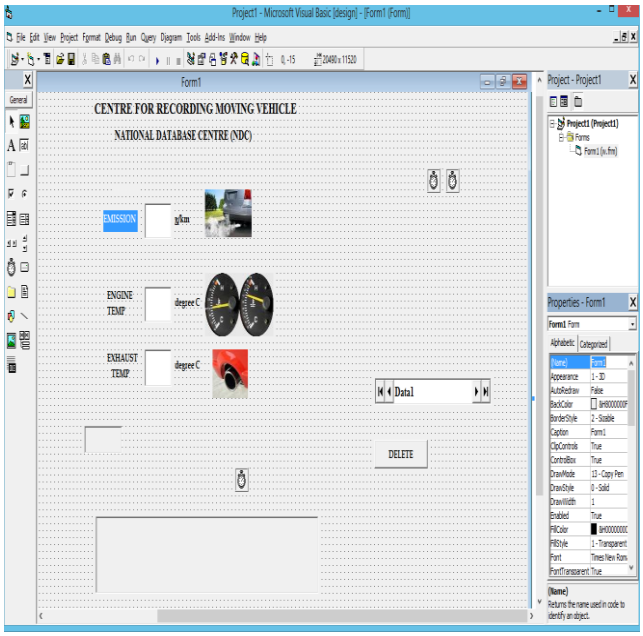

Fig. 7: On-Board Diagnostics inside vehicle

VII. CONCLUSION

This project gives a golden opportunity to gather adequate information about Pollution Monitoring in Vehicle and more information gathered as a break-through for consistent Monitoring and control there exist the Internet of Things. Hence in this project both the vehicle owner and NDC backend system are alerted with the engine condition.

Further the use of Zigbee along with RFID helps in easy transmission of data to the roadside system from which IoT is influenced. Zigbee can be transmitted to the local roadside system within 1km range. Thus from the roadside system the data transmission is done to the NDC through the IoT with help of server known as cloud computing. It is even possible to access the data and information about any vehicle passing at the roadside system. Thus in case of any theft or missing of vehicle becomes easy to track the vehicle passed through the particular area.

VIII. FUTURE SCOPE AND RESEARCH ANALYSIS

Vehicle sharing concepts can be involved for future enhancement. To identify the various shortfalls involved in road transport systems for mitigating vehicular pollution. To design a customized On-Board Diagnostics (OBD) system for online monitoring of vehicular emissions which serves as a best alert tool for the vehicle owners to go for proper maintenance of their vehicles [7]. To study the impacts of integrating OBD incorporated vehicles with the system dynamics road transport simulation model for evaluating appropriate transport policies to mitigate vehicular pollution. Internet of Things may be considered as a global network infrastructure where physical and virtual domains are linked using distributed computing like cloud computing, and various data collection and network technologies. Iot allows devices to communicate with each other, to access information on the internet, to store and retrieve data, and to interact with users, thereby creating smart, pervasive and always- connected environments. Internet of Things is supposed to consist of uniquely addressable objects and their virtual representations on an internet-like structure.

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