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Control of Vehicle Effluence through Internet of Things & Android

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ABSTRACT

Ubiquitous sensing enabled by Wireless Sensor Network (WSN) technologies cuts across many areas of modern day living. This offers the ability to measure, infer and understand environmental indicators, from delicate ecologies and natural resources to urban environments. The proliferation of these devices in a communicating-actuating network creates the Internet of Things (IoT), wherein, sensors and actuators blend seamlessly with the environment around us, and the information is shared across platforms in order to develop a common operating picture (COP). Fuelled by the recent adaptation of a variety of enabling wireless technologies such as RFID tags , embedded sensor and actuator nodes, the IoT has stepped out of its infancy and is the next revolutionary technology in transforming the Internet into a fully integrated Future Internet.

Every vehicle has its own emission of gases, but the problem occurs when the emission is beyond the standardized values. The primary reason for this breach of emission level being the incomplete combustion of fuel supplied to the engine which is due to the improper maintenance of vehicles. This emission from vehicles cannot be completely avoided, but it definitely can be controlled. To alleviate the air pollution problem caused by vehicle emissions, different vehicle inspection programs have been introduced, in which vehicles are examined by undergoing a number of emission tests. However, these emission tests are usually cost-ineffective and time-consuming. It is also difficult to enforce the vehicle owners on monitoring the health of their engines daily and taking immediate action to fix their vehicle emission problems. Therefore, this paper proposes a new vehicle emission inspection and notification system to help daily monitoring of engine health through the concept of Internet of Things. As there are numerous traffic lights in an urban area, they are employed to play an important role in the proposed system. By the fact that every car must stop in front of red lights, reliable reading of air ratio from a vehicle, which indicates the engine emission status, can be interrogated wirelessly through mature and low-price radio frequency identification (RFID) technology. By inspecting the in real time, the vehicle emissions can be effectively controlled by the governmental authorities. Meanwhile, several implementation issues have also been considered and analyzed in this paper. An innovative method is proposed to select the appropriate traffic lights on which RFID monitoring devices should be installed.

Keywords:- Internet of Things, radio frequency identification, vehicle emissions inspection.

I. INTRODUCTION

In this era of urbanization, it has invited many of the danger some situations, wherein the increase of the on-road vehicles has lead to one such vulnerable position**.** The pollution due to these vehicles have caused in the decline of the air quality. In order to overcome such situation the emission standards have become more stringent and different inspection and maintenance (I/M) programs have been introduced. These programs usually require continuous assessment of the vehicles in order to maintain the standards of emission.

Even though these traditional I/M programs have contributed in the improvement of the air quality but it's not that successful in eradicating the problem of emission effectively. While in research of the I/M programs the studies have showed that the actual on-road vehicle.

Emissions are usually much higher than those which are measured during the emission inspections. The car is now a formidable sensor platform, absorbing information from the environment and feeding it to system and infrastructure to assist in safe navigation, pollution control and traffic management. Although remote sensing has been introduced for the inspection of on-road vehicles, it is still not able to cope up with the problem that the drivers may be able to avoid the inspection [1-2].Therefore it is necessary to design a new vehicle emission inspection which helps in reflecting the vehicles emission condition and notify the vehicle owners and the governmental authorities..Through which the authorities can thereby force the owner to repair vehicles' engine which results in a reduction of the emissions consequently and helps in achieving green urban environment.

One such system can be developed with a concept called as "Internet of Things (IoT)". The basic theme of this concept is to tag all the "things" (might be living or non-living) around the world with a unique identification so that each and every thing in this world can interact without any wired connection [3-5]. The aim of the project is to monitor and control the pollutants in the vehicle by using the pollution control circuit.

The rest of the paper consists of the design of the proposed system in section 2, the experimental results are shown in the section 3, and section 4 consists of the selection of appropriate locations of traffic lights, section 5 consists of implementation and finally the conclusion is drawn at the section 6.

II. PROPOSED SYSTEM

The system is proposed under the concept of Internet of Things, in which RFID technology plays a pivotal role. Radio Frequency Identification is the backbone of "Internet of Things", it consists of a tiny silicon computer chip and an antenna, wherein a remote reader can scan and send the data to a database. So through this it is possible to make every object to be trackable with the unique identification, and we have utilized this key aspect in this paper to build a system which can track the vehicle by its ID.

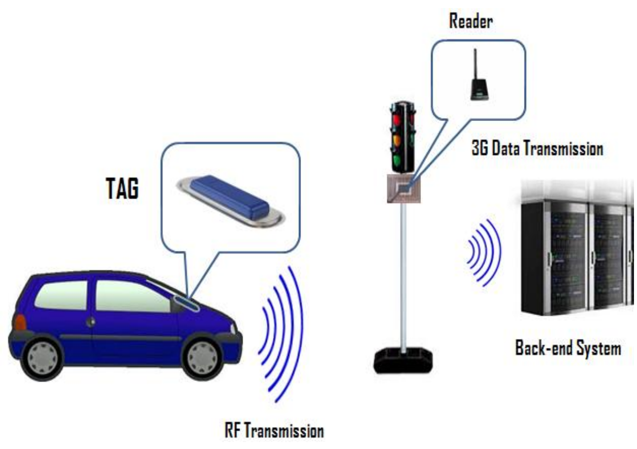

Fig 1: RFID communication amongst different systems

A. *System data transmission*

The system mainly works on RFID, it consists of three major parts namely, and in-car RFID tags RFID interrogator and the back-end system. The communication begins when the Vehicle's emission data are fetched along with the in-Car RFID tag by the RFID interrogator present in the traffic lights , which is then passed on to the back-end system. As most of the traffic lights are used for shifting purpose only , the data fetched by the RFID interrogator is passed on to the back-end system using wireless communication technology .The wireless telecommunication technology or most commonly known as Internet, acts as the key factor in this study. The GPRS or the 3G technology can be used in delivering the data in between the systems. In this system design, 3G technology is used as it is widely used in all the cities for communication and is also similar to that of the GPRS technology. Fig1 shows the overview of the communication between all the devices in the system.

B. *Designing of in-Car RFID tags*

The in-car RFID tags are used to collect the emissions data from the vehicle's exhaust system. In order to fetch the data, two lambda sensors are placed in the exhaust pipe that is used to measure the air ratio (λ). The two sensors namely upstream / pre cat sensor and downstream / post cat sensor are placed at the two ends of the catalytic convertor [9].

Here the upstream / pre cat sensor is used for regulating fuel supply, whereas downstream / post cat sensor is used for monitoring the efficiency of the catalytic convertor. High pressure and the temperature exhaust gases leaving the cylinder comes in contact with these sensors. So this exhaust gas consisting of oxygen molecules are sensed by the sensors and the external air is passed to the engine. Due to difference in the concentration form lower to higher concentration of the oxygen molecules and due to the movement of ions the potential difference is generated and that value is stored in the Engine control unit (ECU) which compares the read value with pre-stored data. Fig 2 shows the overview of the engine's exhaust line and the lambda sensors. When the lambda value of the engine's data is higher than the stoichiometric value (usually 1), more nitrogen oxides are produced. But if the lambda value is lower than the stoichiometric value then the mixture of carbon monoxide and hydrocarbon emissions would be more.

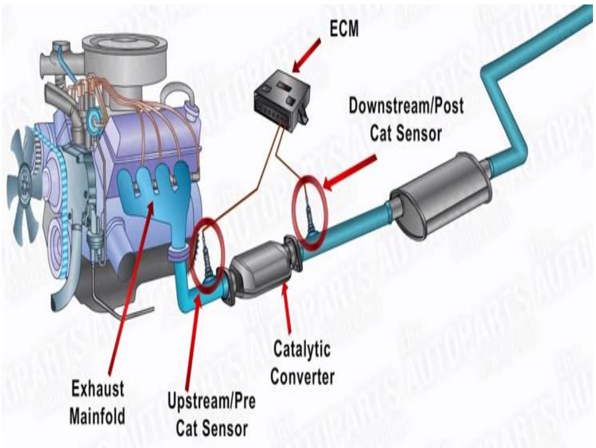

Fig 2: Overview of exhaust line and the sensors

As the lambda sensors can produce the lower voltage values (0V to 1V), but the RFID tag can only store the digital values, so it becomes necessary to convert the analog emission's data into the digital one. Hence analog-to-digital convertor (ADC) is used for this purpose. With the ADC, the voltage signals being outputted from the lambda sensors are converted into the digital signal before passing it along with the RFID tag .Fig 3 portrays the prototype of the ADC and the RFID tag. To ensure the accuracy of the ADC, a microcontroller firmware is used in the ADC to cancel the offset error and the gain error.

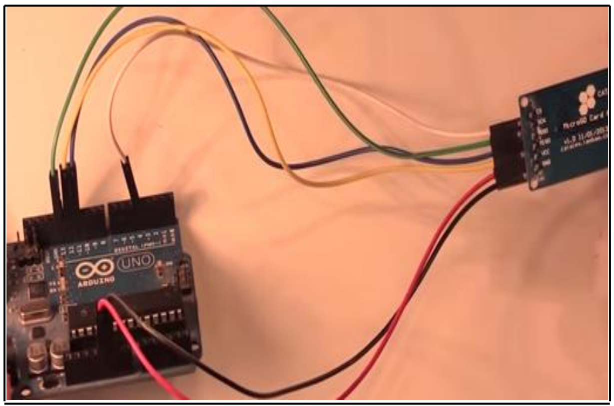

Fig 3: RFID Tag and the ADC

C. *Designing of the RFID interrogator*

The RFID interrogator is the principal station of the information system, it acts as a mediator, since all the necessary data are fetched and transferred through this section. RFID interrogator mainly consists of 3 main modules namely RFID module, 3G module and the data interface module. The RFID module is essential in picking up the RFID tag sent through the Vehicle and a 3G module to transmit the data to the back end system. Data transfer interface module acts as an interface, which is needed in the worst cases if the 3G network works abnormally, such wired connection will be avoided if the wireless 3G network works fine. Fig 4 specifies the prototype of the interrogator with its different modules.

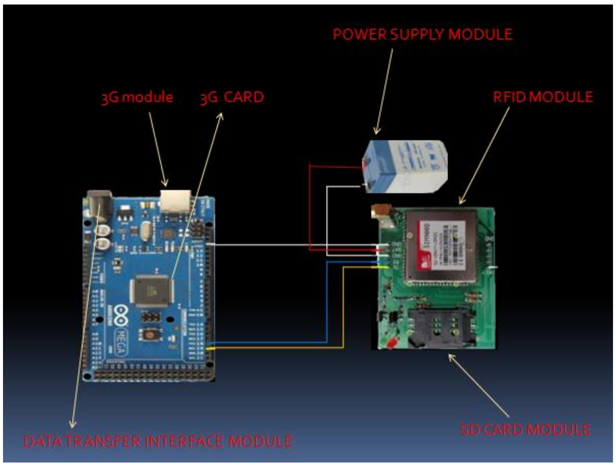

FIG 4: Prototype of RFID with different modules

The RFID interrogator not only requires these three modules , in addition to that it also craves for the power supply of 6V and a SD card to save the interrogators IP address and other configuration parameters .So that the data is preserved even when the power dims out. The carrier frequency of the RFID module is 2.4GHz which is identical to the microwave band. The monitoring range is from 50 meters up to 150 meters, 3G card is necessary in accessing the 3G network. For each RFID interrogator unique ID is assigned for convenient monitoring and transferring to the back-end system.

D. *Designing of the data packets*

The data transmission happens through the data packets which are transmitted from the RFID tag, via RFID interrogator to the back-end system. Hence, it's important to design the data packets accordingly. For this proposed system, initially the data packets in the RFID tag should be designed such that at least it could fit in the values of the tag ID and the lambda value accurately. The tag ID here specifies from which vehicle the data comes from so that the authorities can identify the owners.

So on receiving the data packets from the RFID tag the RFID interrogator should repack the data packets to add the further more information such as the interrogator ID and the time. The interrogator is added in the data packets because it helps in tracking the data source, while time is required for record and statistics uses. Moreover some space should be reserved for the information like engine speed, engine frequency and few others for future use. Hence the length of the packet is designed in such a way that it could fit in all these data efficiently.

E. *Designing of the Back- end system*

The Back- end system is the heart of the information system. It not only provides service as an inspection and notification centre, but also acts a website for providing services to the owners to check the status of their automobiles.
Therefore the back-end system in this study is divided into two servers such as “server A” and “server B”. Wherein server A is used for hosting the inspection and notification centre and the server B is used for hosting the website for the owners to check their automobile status.

1) *Server A as Vehicle inspection and notification center*

It is created for the operators for monitoring and controlling the urban vehicle emission effectively. This system interface is shown in the Fig 5 which consists of seven hyperlinks namely , Start & Connect database , 3G transmissions , Information search , Messages & Email search , Features of a system , Admin site , RFID Test & Configure .

So with these features the authorities can monitor the lambda value of the vehicles in a city and also add the details of the vehicle owner and check their emission status and notify the owner by sending a mail or a message via this system .Further RFID Test & Configure consists of six boxes, wherein first four boxes are used by the authorities to set parameters like serial RFID Parameter Setting, Network.

The remaining boxes are RFID Data Testing and Wire Network Testing is used to display the emission data received. Based on this the emission data can be maintained in this system and at the back-end the notification is sent if the lambda readings of vehicle go beyond the standard value.

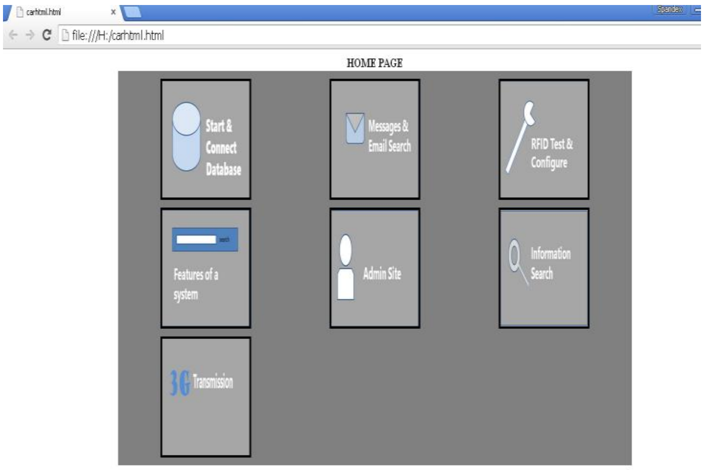

FIG 5: Prototype of Vehicle emission & notification center

2) *Server B as query system for the owners*

Server B provides a website for the owners of a vehicle, where they can view their engine’s emission data and update their personal information Fig 5 shows how the owner can update and view his emission status just by entering the vehicle registration number and check the location of the emission detection if it has crossed the threshold value.

F. *Summary of the system design*

After completing the designing of the hardware and software parts the information system is established. So with this system the information can be gathered by the RFID tag, fetched by the RFID interrogator and passed on to the back-end system or the database in real-time bases. Moreover an economical and efficient system is achieved as each RFID interrogator in this system operates only when the RED light of the specific traffic light is ON. When that light turns to GREEN operation will be stopped, this can be easily accomplished as, firstly the communication link between the vehicle and the traffic light will be lost when the GREEN light is turned ON due to the motion of the car (due to the speed of the car) and secondly, it is unnecessary to check each and every car, as it is waste of time since each car will be monitored once in a week .So it is feasible for weekly wireless inspection. Thirdly, considering there are numerous numbers of traffic lights which reduces the rate of data transmission thus reducing the task of powerful servers, all three aspects make this system more reliable and practical.

III. EXPERIMENTS AND RESULTS

In order to certify the efficiency of the information system, many experiments were lugged out through a simulation of road where an area of about 200 square meters, where a five meters height pole was set up in order to simulate traffic lights. Vehicle where fitted with the designed RFID tag would drive in this particular area. A RFID interrogator was seated on the pole while on the other hand the back–end system was installed in a distant room. We know that basically there are two lambda sensors in the exhaust system of an automobile as mentioned earlier. To emulate the actual engine emissions, only the λ values from the lambda sensor were collected in the experiments.

The interrogation among the traffic lights and the vehicles is the most critical part of the information system, due to the maturity of 3G telecommunication technology the data transmission between the RFID interrogator at the traffic light and the back-end system can be neglected. The interrogation among the vehicles and the traffic light was basically evaluated under five tests i.e. tag position test, obstruction test, effective distance test, effective inspected vehicle number test and reliability test .These test are designed to emulate whether the RFID tag could pick the information from the interrogator and also check whether the interrogator could indicate the level of accuracy of the tag reading.

IV. PROPOSED METHODS FOR APPROPRIATE TRAFFIC LIGHT SELECTION

We all know that in metro cities how the traffic and the traffic network, road are met at one junction were a traffic lights are set up to control the priority of each road. The main aim of our proposed system is to determine which junction has the highest traffic flows so that RFID interrogator could be installed only on the traffic lights at those junctions. In the proposed method, traffic flow in every road needs to be defined by the authorities. Therefore Google maps (GM) can be used as an assistant tool to determine the traffic flow on each road. To give an example about the implementation of interrogator let us consider a city were the traffic is at maximum level from the Google map display we can say that red/black means heavy congestion, yellow is a little slow, and green means good to go. We can say that the traffic of particular road can be calculated by assigning some values to each color i.e 1 for green,2 for yellow,3 for red,4 for red black. Let us consider below specified road Google map which has all the colors i.e. the proportion of each color should be used to evaluate the corresponding weight value

$$Tw=1Xg+2Xy+3Xr+4Xrb$$

Where *Pg* is the proportion of road in green, *Py* is the proportion of road in yellow, *Pr* is the proportion of road in red, and *Prb* is the proportion of road in red/black.

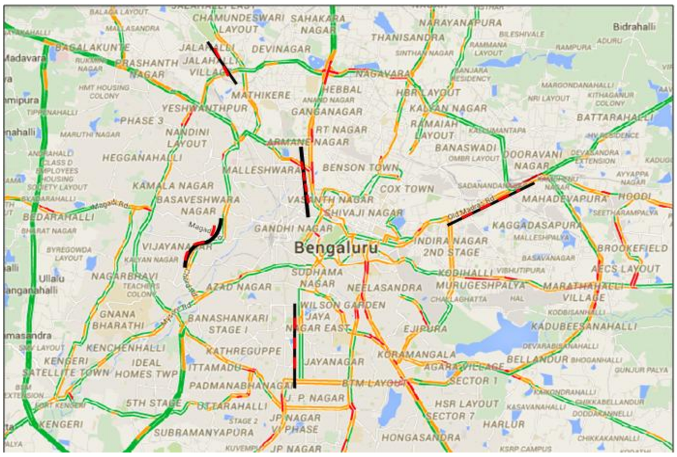

FIG 6: Google map helping in installation of interrogator

V. IMPLEMENTATION ISSUES

A) Security

As we all know that there is wireless communication taking place among the proposed system especially in public areas, hence there is a need for protecting the personal information. However the current data transmission comprises only two simple components i.e. tag ID and vehicle emission data. None of them can reveal any important information without the back-end server and the database of the vehicle owners. Hence we can say that no threats about security are visible at present.

B) Governance and Legislation

The important pre-requisite for the proposed system to be successful is proper support by governance and legislation. Until the government makes installation of proposed system in each and every car a mandatory. The car owners may not actively install the RFID tags and without the government support RFID interrogator cannot be installed.

C) Back-end system

The main problem with the back-end system is overloading issue i.e. we all know that the back-end system needs to process the excess amount of data, which could be a serious problem to a proposed system. We may choose supercomputer as the server for processing of data, but the problem of storing up of large data still remains the same. So the best strategy which can be implemented to overcome this problem is if the vehicle is checked once by the interrogator and passes the test, that particular vehicle must be shielded so that whenever that vehicle comes again in that particular area where the interrogators are fitted it won't be rechecked by interrogator for certain days .In case if the vehicle exceeds the standard emission level, it will not be shielded and should be monitored until emission problem is fixed. This strategy can reduce data processing at the back-end system.

VI . CONCLUSION

In this paper keeping IoT concept as mandatory, vehicle emission inspection is proposed. IoT is an emerging networking technology, were the objects are connected in order to provide a smart service to human life which will make life much easier and smarter. RFID technology is most enabling technology of IoT, which has made us to develop the information System. With the help of vehicle emission indicator, λ -reading can be checked along with the vehicle ID through wireless connection among the vehicles and the traffic lights. By monitoring the emissions data, engine health can easily be inspected and examined. Here we can also apply a core idea of "Green all over IoT ''can be experienced which may also lead to advancement in the environment quality.

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