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Monitoring and Connecting Vehicles using RFID

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Abstract: With the number of vehicles increasing on the road, there is always a need for smarter and safer way to travel. The present day trend in the automotive industry is to connect cars and their occupants to the outside world. The Internet of things [1] gathers data from every device and links it to the internet. The device can be anything from coffee makers, televisions, washing machines, alarm clocks, cars etc. RFID [2] bridges the gap by collecting, storing and supplying the data. RFID can be viewed as the one which provides the input to IOT. RFID uses the radio waves to transmit data. This paper focuses on uniting IOT and RFID technology together to provide solution for connecting the vehicles. This will not only lead to advancement in the automobile industry but also provide a greener, safer and cheaper mode of transportation to the users.

Keywords: IOT; RFID; electronic product code; connected cars; induction.

I. INTRODUCTION

It is estimated that by 2020 there will be over 1.5 billion connected vehicles on the road. Connected cars [3] are cars equipped with internet access. The perception of the Connected Cars has drawn the attention of auto makers, communications service providers and the IT industry. Auto manufacturers like BMW have developed personal mobility companion like the BMW connected NA which helps the driver to find parking spots and even gas stations. When the Internet of Things was first showcased it came with a lot of possibilities. IOT allowed machine to machine communication (m2m) [4] without any human intervention. Recently there has been a growing interest in using Internet of things to connect the vehicles. IOT coupled with RFID technology opens a new mean of connectivity. Radio Frequency Identification (RFID) can be defined as automatic identification technology which uses radio waves to identify objects carrying tags when they come close to a reader. RFID was first introduced during World War II to recognize the aero planes. Its aim was to use the aero plane's radar signal to read the identification number in order to identify whether they were allies or enemies. Till now the use of RFID was largely limited to tracking inventory in factories. RFID is replacing bar codes rapidly as it has a number of advantages over it. Unlike bar codes which have to be scanned individually RFID tags can be read hundreds at a time. Also RFID tags don't need to be in line of sight with the reader. Large organizations, such as the US Department of Defense, have started using RFID. Walmart is one of the leader in the large scale implementation of RFID technology and is even investing in RFID significantly to develop its applications.

The RFID system [5] has two major components namely RFID Tags (senders) and RFID Readers (receivers).The tags are the one that store the information and sends the collected data. Modern RFID tags have a storage capacity of 16-64 Kbytes. The RFID tags further contain two parts, an integrated circuit for storing and processing information and an antenna for sharing the collected data. RFID tags are broadly classified into active and passive. The active tags requires a power source or a battery and often its lifetime is limited to its source's life. Size, cost and lifetime make it unfeasible for practical use. On the other hand passive tags are extremely miniaturized integrated circuits as they are independent of power supply enabling them to fit into small holes and have much longer lifetime than active tags. The RFID reader takes up the responsibility of powering up and communicating with the tag. For the rest of the paper we will be using passive tags.

II. LITERATUREREVIEW

There has been a numerous attempts in communicating with the cars. The closest one being DevToaster Rev IPhone and OBD-II system [6] which won Mechanics Editor's choice award in 2009. OBD-II transmitter, about $150 can be attached to the car's OBD port and DevToaster's Rev can be downloaded from the Apple store for $40, together could monitor the car's performance and tell the driver how the car is behaving. IOS7's Carplay and Android Auto [7] allowed connecting to the car's infotainment system. Though these technologies allowed the driver to communicate with the car up to some extent, they still can't connect to the internet or communicate to other vehicles on the road. Also the customers are unwilling to pay the additional costs associated with embedded connectivity.

III. METHODOLOGY

Three types of RFID exist till date now, but at the highest level, we can divide RFID devices into two classes: active and passive. Active tags require a power source to operate —they use the energy stored in a battery or the device is connected to some form of powered environment, example being the transponder which is attached in an aircraft. Passive RFID is used as these tags don't require batteries

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or maintenance, thus reducing the cost and increasing the operational life. The tags also have an indefinite operational life and are small in size because of the absence of the battery.
The RFID consists of three parts – antenna [8], a semiconductor chip and some form of encapsulation. The RFID reader is responsible for powering and communicating with a tag. The tag's antenna captures energy and transfers the tag's ID. The tag's semiconductor chip is responsible to get the coordinates and act accordingly. The encapsulation maintains the tag's integrity.
One can transfer power from the reader to the tag in two possible ways -

- Magnetic induction[9]
- Electromagnetic waves[10]

Both of the process makes use of the electromagnetic property of the RF antenna- the near and the far field.
Both of them can transfer enough power to a remote tag to sustain its operation—typically between 10 micro Watt and 1 milli Watt, depending on the tag type. One can transmit data through numerous modulation techniques for both the active and passive RFID's.

Near field RFID
Near field RFID make use of the Faraday's law of magnetic induction between a reader and a tag for modulation purpose. A reader passes a large alternating current through a reading coil, which generates an alternating magnetic field in the locality which has to be read by a tag .If a tag comes in contact with this alternating magnetic field, an alternating voltage if generated. If this voltage is rectified and coupled to a capacitor, a reservoir of charge accumulates, which can then be used to power the tag chip. This is the basic principle behind the near field RFID. Tags send the data back using the load modulation. The limitation associated with a near field RFID is that it can be operated only on a smaller range and another limitation lies with the available energy for induction as it inversely depends upon the distance.

Far field RFID
Far field FRID captures the EM waves propagating from a dipole antennae connected to the reader. A minor dipole antenna in the tag receives this energy as an alternating potential difference that appears across the arms of the dipole. If this potential voltage is rectified and coupled to a capacitor, similarly apool of charge accrues, which is then used to power up the tag chip. Here the information cannot be sent back to the reader using the load modulation. Instead a back-scattering technique design is used.
The RFID technology can be seen to act as a mediator between the real world and the virtual world, reducing human intervention. RFID when integrated with the IOT (internet of things) can be of great help for mankind .Once the infrastructure is set up, RFID technology accomplishes this amalgamation with minimal human intervention. It is capable of adjusting the system data to fit in with the real world data at a much subsidized cost.

The tags are attached to multiple parts in the car where the monitoring has to be done. These tags record the information using the Electronic Product Code (EPC) [11] on the circuit. The RFID reader sends out electromagnetic waves only to be detected by the tag's antenna. The tag replies by transmitting the data to the reader. The reader forwards the information to the connected smartphone.

The smartphone uploads the collected data to the internet via GPRS [12] or WI-FI, which can be used by the car manufacturer to provide meaningful information to the driver or by the traffic controller to make sure the driver is following the rules. This is where IOT comes in.
This collected data can be useful to the car manufacturer as they can provide suggestions to the driver. Also this huge data coming from every potential vehicle on the road can be used to monitor traffic or to provide better alternate route to the driver depending on traffic.

IV. APPLICATIONS

RFID system can be coupled with the IOT in such a way that it can be made productive to the driver, the manufacturer and also to the traffic police.

i. Spares :
When there is decrease in the engine oil or even if the vehicle tire is wearing out the tags can initiate a message to the manufacturer. The manufacturer in turn can provide details regarding their nearest service centers and discounts one those spares directly to the driver's mobile phone.

ii. Not Following Rules :
If the driver is found guilty of neglecting the traffic rules like driving without seatbelt, over speeding or even using mobile phone during driving, the car's engine can be made to shut down unless a traffic controller fines the driver.

iii. Performance of the vehicle :
After the end of every journey, the tags can send data to the manufacturer regarding the driving conditions and style of driving, via the smartphone anonymous to the driver. The manufacturer can analyze this data and provide useful suggestions to the driver like unnecessary acceleration or even different types of tires available for those driving conditions.

iv. Traffic regulation :
Tags present on the front and rear of the vehicle can record data on the traffic moving ahead of them. Vehicles all over the city transmitting data on traffic rate in each route will result in enormous amount of data on the traffic. This data can be analyzed and sent to the vehicle's GPS system, hence allowing the driver to decide best route for their destination.

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v. Reducing Fatalities:
Connected vehicles on road can reduce accidents radically. Cars can use short-range radio signals to communicate with each other and be aware of their nearby vehicles. This can be very useful in highways where the movement is very fast and accident rates are also quite high

vi. Accident Reporting:
Any sort of misfortunes, from minor to major accidents can be reported to the helpline or to the controller without the need of any human intervention. The helpline can further assist by sending the required help to the car's location thus saving a life.

V. CONCLUSION

IOT is an emerging technology which will revolutionize the internet infrastructure. The proposed prototype will enable a smarter means of connecting vehicles by combining the extensive usefulness of IOT with the practicality of RFID,

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