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Raspberry PI Based Internet of Vehicles for Traffic Management by Using PI Camera

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ABSTRACT: *Internet of Things (loT) is a world-wide network connecting all the smart objects together. It is the way in which all things are enabled to talk with each other. Whenever those smart things being connected over internet are restricted to only vehicles, then it is called as Internet of Vehicles (loV). With continuously increasing urban population and rapidly expanding cities, vehicle ownership has been increasing at an exponential rate. Hence, traffic management has become a great problem in our day life. This project provides efficient traffic management solution to overcome the problem that is prevailing in our daily life. Wi-Fi (Short for **Wi**reless **Fi**delity) is a wireless technology that uses radio frequency to transmit data through the air. Wi-Fi has initial speeds of 1mbps to 2mbps. Wi-Fi transmits data in the frequency band of 2.4 GHz. It implements the concept of frequency division multiplexing technology. Range of Wi-Fi technology is 40-300 feet. The Raspberry Pi is a low cost, **credit-card sized computer** that can be used in electronics projects. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. In this project USB camera is connected to the Raspberry pi processor. Raspberry pi processor stores the images in the Hard disk (or SD card). Pressure sensor is attached to the tires of the vehicle, continuously checks the pressure in the tire. IR sensor is used to detect the vehicle presence and calculates the distance of the vehicle from our vehicle. If other vehicle is so close to our vehicle, then processor turns OFF the motor driver and the vehicle stops. Lock is attached to the vehicle and the vehicle does not move until correct password is entered. The images and the pressure in the tire are constantly monitored in the Android phone through Wi-Fi module.*

I. INTRODUCTION

The internet in today's world is a global phenomenon. With more and more devices becoming internet friendly, traffic management in transportation working with the internet becomes easier. As vehicle ownership has been increasing at an exponential rate, more traffic management problems arise. It is logical that the monitoring of speed limits, pollution checks and emergency response to road accidents should also be taken care to make life easier.

The traditional solutions offered to this problem are periodic pollution checks, monitoring of vehicular speed through CCTV cameras and speed trackers. While being the obvious choices, these strategies do tend to fail when it comes to monitoring of a huge number of vehicles i.e. when the number of vehicles increases, the effectiveness by which a road transport authority can handle the incoming breaches of vehicular code decreases. This is where Internet of Things
(loT) [3] comes into play.

Out of the many proposed methodologies with wireless sensor networks [4] in traffic management, the prospects of Internet of Vehicles (10 V) stand out. This project mainly focuses on discussing the methodology, advantages and hindrances in creating a 10 V. The basic concept of loT in traffic management has been widely accepted and is being put to use in the construction on smart cities' infrastructures [5] [8]. The deployment of this concept proposes significant advantages in handling traffic. The connection of CCTV cameras, traffic lights and speed trackers to the internet as well as their interconnectivity enables to take decisions via pre-embedded algorithms. Some instances are

1. When a traffic signal violation occurs, the speed cameras immediately take pictures of the driver and the credentials of the vehicles and report them to a centralized repository.

2. When a CCTV camera records an accident, the traffic signals work in a way to clear the route, for an emergency response vehicle to come through.

While these instances are helpful in demonstrating the usefulness of loT in traffic management, there are some instances where this system is trumped such as:

1. Monitoring individual vehicles in the traffic and alerting the vehicles that are 500 meters away from the place of traffic, to be redirected.

2. Keeping pollution check on all the vehicles on road so that the air pollution could be controlled to certain extent.

Therefore the objective of this project is to demonstrate how 10 V can be an effective strategy in dealing with the drawbacks of conventional loT deployment techniques in traffic management.

II. LITERATURE REVIEW

During past few years recent communication paradigm - the internet of things - has gained significant attention in academia as well as in industry because it represents an enormous opportunity for cost savings and new revenue generation across a wide range of industries. The main reasons behind this interest are its capabilities. IoT can be used to create a world where all smart objects of our everyday life are connected to the Internet and interact with each other with minimum human involvement to reach a common goal [8].

The term Internet of Things was first appeared by Kevin Ashton [9] in the context of supply chain management. Gartner forecasts that the IoT will reach 26 billion units by 2020, up from 900 million just five years ago, and this will impact the information available to supply chain leaders. According to Cisco‘s study, cities all over the world are to claim $1.9 trillion in value from IoT over the next decade by building smarter cities based on smarter infrastructure, through providing optimal traffic management, parking, and transit services [10].

The enabling technologies that are expected to form the building blocks of the sensing and communication technologies in IoT are Wireless Sensor Networks (WSN) and RFID-based networks connected together through the Internet or other technologies and protocols. RFID is considered as one of the leading technologies ylniam due to its low cost, and its strong support from the business community. RFID can transform everyday objects into smart objects. Sensor network integrates different technologies, such as sensor, distributed information processing, embedded computing and wireless communications. Sensors and RFID are playing a significant role in constructing IoT.

Multiple RFID and sensors with computing and communication power are connected into wireless networks and cooperate with each other to exchange collected data with the physical world to accomplish specific tasks. Implementation of IoT relies on the integration of RFID systems, WSNs, and intelligent technologies. RFID and wireless data communication technology are used to construct a network which covers everything. Objects such as RFID tags and readers, sensors, actuators, mobile phones, smart devices, embedded computers, etc., will be included into the network and will interact with each other through unique addressing schemes [11]. These objects have actuating, processing, storing and networking capabilities. With the advances in sensor technology, sensors will be embedded within all the objects around us.

The result will be the generation of huge amounts of data which will have to be stored, processed and presented in efficient and easily interpretable form. IoT allows people and various objects to be connected anytime and anywhere with anything and to any service, and use any network; and communicate with each other in real time as long as they are online [12, 13]. Other necessary components include cloud, data modeling, storing, processing, and communication technologies [14].

The major wireless technologies used to build wireless sensor networks are wireless personal area network (Bluetooth), wireless local area network (Wi-Fi), wireless metropolitan area network (WiMAX), wireless wide area network (3G/4G mobile networks) and satellite network (GPS). A typical structure of a RFID based sensor network is presented in fig. 1. It consists of wireless low-end RFID sensor nodes that generate data (tags) and high-end RFID sensor nodes that retrieving data from the low nodes. Data collected by the high nodes are sent to mobile static nodes (readers).

Readers send the data to wireless low-end computational devices (base stations). These devices perform a certain amount of processing on the sensor data. Then data sent to high-end computational servers through the internet (or other network) to be processed further and there data will be shared and stored.

A number of researchers have dealt with the problem of intelligent traffic monitoring and controlling, and as a result of their efforts several different approaches have been developed. Pang et al. [15] proposed a traffic flow prediction mechanism based on a fuzzy neural network model in chaotic traffic flow time series. Bhadra et al. [16] applied agent-based fuzzy logic technology for traffic control situations involving multiple approaches and vehicle movements.

In [17] the authors developed strategies to integrate different dynamic data into Intelligent Transportation Systems. Patrik et al. [18] proposed a service-oriented architecture (SOA) for an effective integration of IoT in enterprise services. Recently researchers shifted their attention to revolutionizing paradigm of the Internet of Things, which resulted in constructing of a more convenient environment composed of various intelligent systems in different domains such as intelligence business inventories, health care, intelligent home, smart environment, smart metering, supply chain logistics, retail, smart agriculture, monitoring electrical equipment, etc. [19-22], while it is still in the early stage in case of intelligent transportation system with respect to their needs [23-26].

Different IoT systems such as UbiComp [27], FeDNet [28, 29] are using message simple passing techniques for communication. Such techniques consume a large amount of bandwidth and energy. Agent technology has been implemented in different aspects of the traffic systems such as handling traffic congestion by monitoring the current traffic congestion and providing the optimal route for a vehicle [30-32]. Fortino et al. [33]

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proposed an architecture integrating agents and cloud computing to develop decentralized smart objects within IoT, while Godfrey et al. [34] used mobile agent to handle not just the communications among devices within the IoT but to conduct searching for needed resources.

III. DESIGN OF HARDWARE

This chapter briefly explains about the hardware implementation of internet of vehicles (10 v) for traffic management. It discusses the circuit diagram of each module in detail. For implementing the health diagnosis system, there is a need of essential components that are suitable and manipulate health problems. The components use generally includes temperature sensor LM-35, blood pressure sensor, heartbeat sensor, ECG sensor, raspberry pi and GSM module.

3.1. PRESSURE SENSOR

A pressure sensor is a device for pressure measurement of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical. Pressure sensors are used for control and monitoring in thousands of everyday applications. Pressure sensors can also be used to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude. Pressure sensors can alternatively be called pressure transducers, pressure transmitters, pressure senders, pressure indicators, piezometers and manometers, among other names.

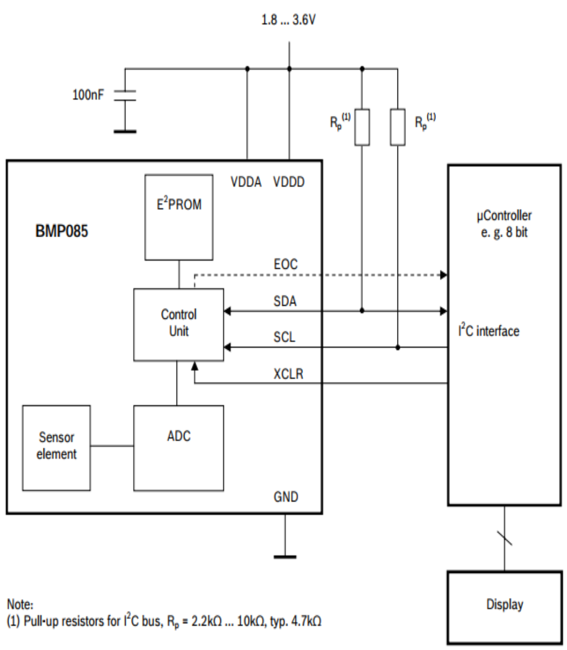

Fig 1 internal block diagram of pressure sensor

3.2 INFRARED SENSORS

Infrared radiation is an electromagnetic wave with wavelength of 700nm to 1 mm. It is emitted by objects with temperature above 0 kelvin. Furthermore intensity and wavelength of infrared radiation depends on the temperature of the object. The infrared sensors are the sensors that detect/measure infrared radiation or change in the radiation from outer source source or inbuilt source.Also sensors that uses the property of infrared radiations to detect the changes in surrounding are termed as infrared sensors.

A simple circuit for obtaining output voltage(signal) consists of a current source, photodetector(dark resistance), a resistor and a voltage output.

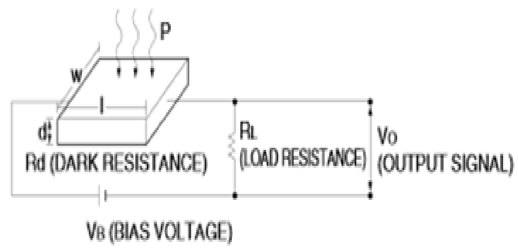

Figure 2 Example of basic circuit for signal output

In the circuit when radiation strikes the resistor Rd then its resistance changes consequently changing the voltage output Vo. D*: It is the photosensitivity per unit active area of the detector. Therefore, higher D* means better performance. Noise Equivalent Point(NEP): Noise is caused by the background radiation and it affects the signal output. NEP is the amount of incident radiation when the signal to noise ratio is 1.

3.2.1 Passive Infrared Sensor

Passive infrared sensors detect the infrared radiations from outer source.When an object is in a field of view of a sensor it provides a reading based on a thermal input.It dose not generate any infrared.There are different kind of Passive infrared sensor.

- Thermal passive infrared sensor
- Pyroelectric infrared senor

3.2.2 Pyroelectric infrared sensor(PIR)

The infrared sensor has its detecting area. Multizonal Fresnel lens array is associated covers the pyroelectric transducer. This lens is Plano convex lens that are designed to collect the infrared radiation from the different spatial zones.Fresnel lens are made up of material that can transmit infrared range of 8µM to 14µm. This lens dose not view the space in continuous fashion, the detection pattern of sensor is fan shaped .It views as a discrete beams or cones.[4]

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The gap between the cones increases with the distance and it is inversely proportional to the sensitivity of the sensor. The PIR sensors have two pins 1 and 2 they are activated when a radiation source passes is in the field of view. Pins are wired as opposite input. Pin 1 activates when radiation source come across the Pin 1 which is positive zone and the sensor values goes up, when the radiation source continues towards Pin 2 which is negative zone the value drops and the value comes to 0, this activity causes the net positive effect on the sensor value.[6]

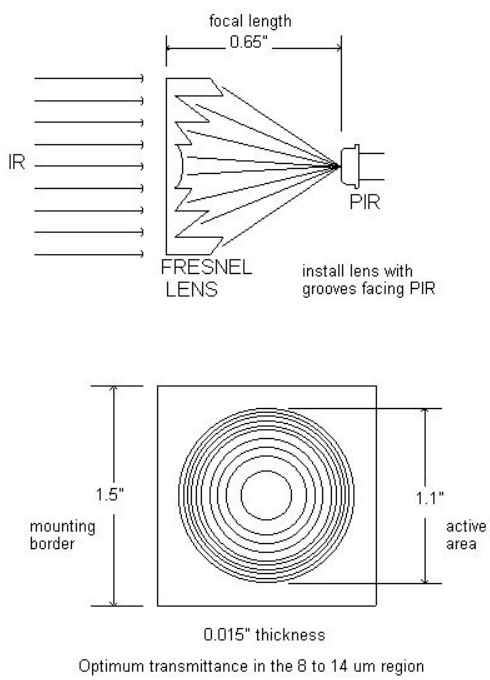

Figure 3: Fresnel Lens

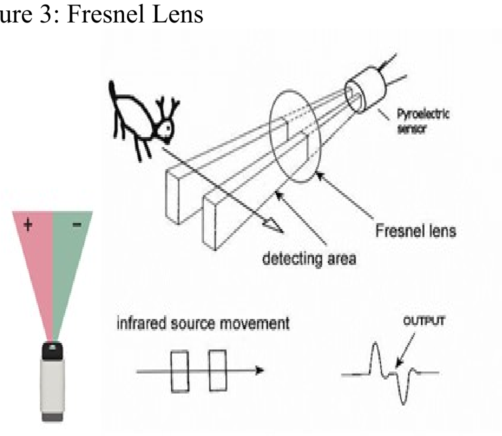

Figure 4: principle of PIR sensor

The radiation strikes pryoelectric films that are made of lithium tantalite. It is dielectric (insulator) in nature so its surface area charges when it is strike by radiated infrared. It has electrodes which gather the charge. The produced charge is measured with FET (Field effective transistor) device that is inbuilt in sensor. Among 3 pins in the FET pin 3 is grounded about 100k and pin 2 is feed into a stage amplifier having signal condition circuits.

The amplifier avoids the high frequency noises above 10Hz. The signal produced is in the range of 1mVpp that is a small voltage around a DC signal. The power source of 3 to 15 volt is required for the FET supplied through Pin 1.Externtal resistor is connected to pin 3 and pin 2 which converts the FET current to voltage. Pin 2 of a FET is followed by Amplifier and comparator. To improve the accuracy of sensor dc offset (dc offset is an undesirable character, it causes waveform not to be 0) is eliminated by PIR incorporation of ac-coupled amplifiers. Comparator is an extremely sensitive device comparing the voltages or currents and gives outputs a digital signal which is larger.[2][3]

3.3. Raspberry Pi

It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional. There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a display unit and power supply.

Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem. The main advantage of Raspberry Pi is that it has a large number of applications. It also has 4 pole stereo output and composite video port. Video processing applications are also possible using raspberry pi like video compression.

Compressed video can successfully decrease the bandwidth required to transmit the video through terrestrial broadcast, cable TV, or satellite TV services [19]. The Raspberry-Pi runs on Linux based OS, an open source operating system. In this system we used Raspbian OS which is Linux based OS. The programming language for the Raspberry-Pi for the system implementation is Python.

3.3.1 Hardware

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The Raspberry Pi hardware has evolved through several versions that feature variations in memory capacity and peripheral-device support.

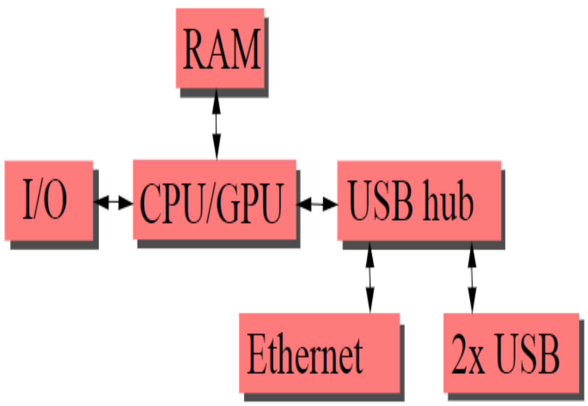

Fig 4 Raspberrypi block function

This block diagram depicts Models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. The Ethernet adapter is internally connected to an additional USB port. In Model A, A+, and the Pi Zero, the USB port is connected directly to the system on a chip (SoC). On the Pi 1 Model B+ and later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, the USB port is also connected directly to the SoC, but it uses a micro USB (OTG) port.

3.3.1.1 Processor

The Raspberry Pi 2 uses a 32-bit 900 MHz quad-core ARM Cortex-A7 processor. The Broadcom BCM2835 SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in first modern generation smartphones

(its CPU is an older ARMv6 architecture),[22] which includes a 700 MHz ARM1176JZF-S processor, VideoCore IV graphics processing unit (GPU),[23] and RAM. It has a level 1 (L1) cache of 16 KB and a level 2 (L2) cache of 128 KB. The level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

The earlier models of Raspberry Pi 2 use a Broadcom BCM2836 SoC with a 900 MHz 32-bit quad-core ARM Cortex-A7 processor, with 256 KB shared L2 cache.[24] The Raspberry Pi 2 V1.2 was upgraded to a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor,[25] the same SoC which is used on the Raspberry Pi 3. The Raspberry Pi 3 uses a Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.[26]

Fig 5 The Model B boards incorporate four USB ports for connecting peripherals.

3.4. POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as "Regulated D.C Power Supply".

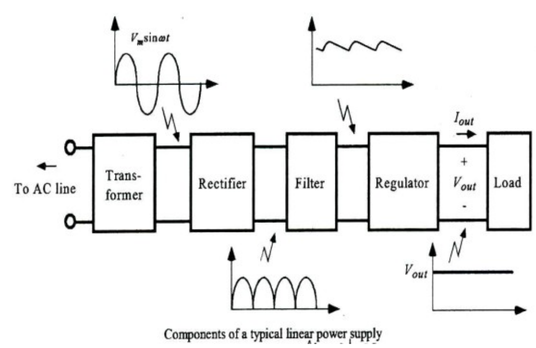

Fig:6. Block Diagram of Power Supply

IV. PROJECT DESCRIPTION

This chapter deals with working and circuits of "**internet of vehicles (10 v) for traffic management**". It can be simply understood by its block diagram &circuit diagram.

4.1. BLOCK DIAGRAM:

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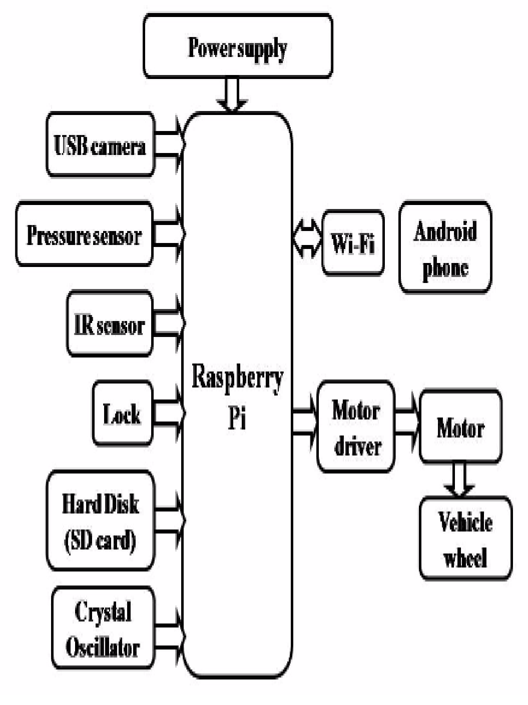

Fig 7 block diagram

4.2. SOFTWARE REQUIREMENTS:

- Flash Magic

4.3. HARDWARE REQUIREMENTS:

- Power supply
- PI
- IR sensor
- Alcohol sensor
- LCD
- APR9600
- Speaker

4.4. WORKING:

For the prospects of Internet of Vehicles (loV) to be a reality, the vehicles need to be able to work and communicate seamlessly. Communications in this proposal are as follows:

4.4.1. Communication between vehicles and the Vehicle Owners

Few attributes of the vehicle like the vehicle speed and fuel level are directly reported to the users in the vehicles, only when the vehicle is in use. However, to enable the user to receive active updates even when the vehicle is not being used and when the user is away from the vehicle, an onboard processor is useful.

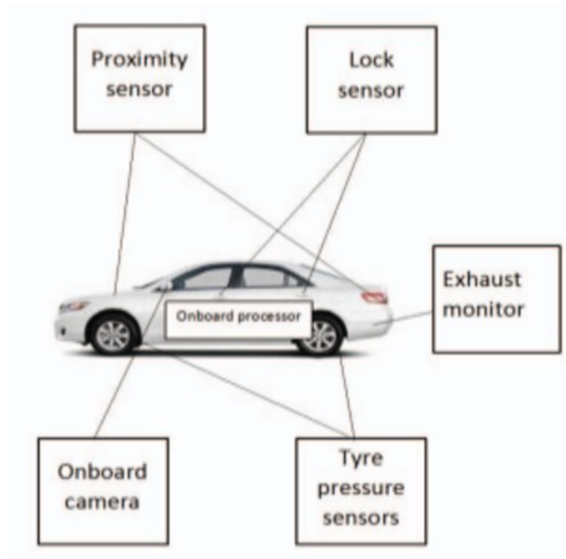

Figure 8: Vehicle to its Owner Communication

The active updates mentioned may involve

a. security alert about the vehicle,

b. damage alert about the vehicle

c. the attributes like proximity, tyre pressure and vehicle lock

The sensors and the onboard processors in the vehicle are shown in Figure 1.

4.4.2. Communication between vehicles

Figure 9: Vehicle to Vehicle Communication

Communication between vehicles involves the sharing of these data:

1. Proximity between the vehicles

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2. Monitoring of the immediate surroundings of vehicle through onboard cameras.
3. Speed of vehicles within a particular radius of the vehicle under consideration.
4. Tyre burst related accidental information

When a vehicle is on the road or even when a vehicle is parked, its proximity to other vehicles in its immediate vicinity can prove to be crucial in avoiding accidents and damage to the vehicle. Being able to know the speed of the vehicles surrounding a particular vehicle can help in issuing a warning to the nearby vehicles on the road about a fast approaching vehicle. Thus the vehicle which receives the warning message will alert the driver regarding the problem next to him.

4.4.3. Communication between vehicles and a centralized server

The data monitored from the vehicle is relayed to the nearest communications node via an onboard computer. The node in-turn communicates the data via a satellite to the communications node of the server which monitors breaches. The server stores the data in the database and analyzes the data for the breach. It then provides a suitable solution to the vehicle through the same channel from which it received the messages which is shown in Figure 1.

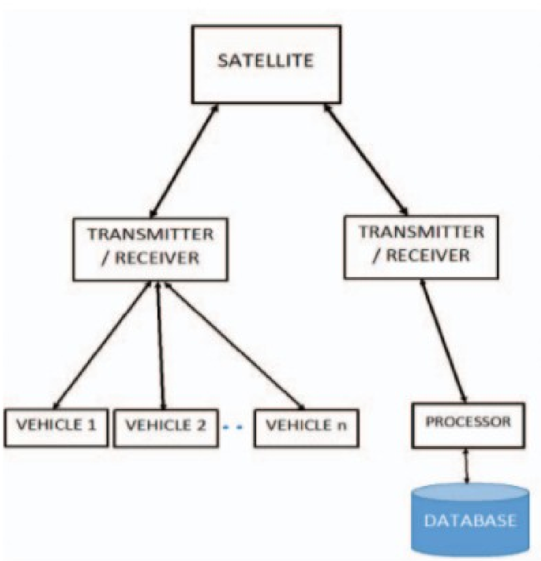


Figure 10: Vehicles to Centralized Server Communication

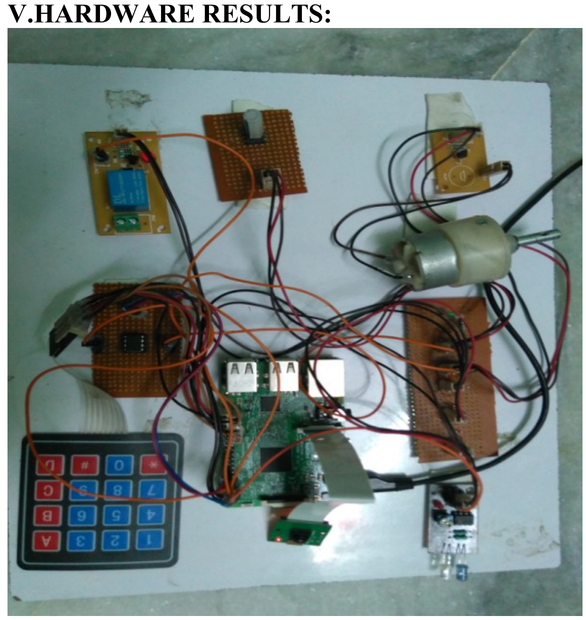
To monitor the metrics of the vehicles, a number of sensors are deployed on each vehicle. 10 V make these sensors work in unison to be able to derive reasonable inferences from the data generated. It is not uncommon for automobiles to have sensors in-built [6]. However, with the vast amount of data that needs to be analyzed, sensors are to be standardized to have effective results. The metrics of the automobile that need to be monitored are:

• Tyre pressure
• Fuel level
• Speed! velocity reading
• Exhaust gases' contents
• Vehicle lock

Sensors are fixed at their respective positions to continuously monitor the data being generated. All these localized sensors are to be set with threshold values. When breached, all the data regarding the breach are to be sent to a processing and communications device on-board [7].

The processor will basically be a mini computer on board, powerful enough to handle the processing of the incoming data and the communication modules implemented on board. Use of a raspberry pi processor [8] on board has been tested and proven to be successful and can be extended to vehicle management as well. It offers some significant advantages in terms of power consumption and speed ofprocessing and it is used as a communications device [9].

V.HARDWARE RESULTS:



VI. CONCLUSION

This project identified the potential advantages posed by the concept of Internet of Vehicles (loY) over the tradition Internet of Things (loT) in traffic management. This research is intended to suggest a much efficient way of traffic management and in making road travel better for everybody. This study can also be used in bringing up better architecturesand strategies for road traffic management and to make an impact on the effectiveness of monitoring and emergency response to traffic incidents.

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