Vehicle Monitoring System based On IOT, Using 4G/LTE

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ABSTRACT
In our World of today, the quest to get rich at all cost without working for our money has led some of our youth into crimes such as robbery and kidnapping. As a result of this and by the sheer fact that vehicles are now very expensive to buy these days, there is a need for people to safeguard their vehicles against these hoodlums to avoid loss of their precious Assets to these rampaging criminals. Tracking is technology that is used by many companies and individuals to track a vehicle, an individual or an asset by using many ways like GPS that operates using satellites and ground-based stations or by using our approach which depends on the cellular mobile towers. Vehicle tracking system is a system that can be used in monitoring and locating a vehicle, avoid theft or recover a stolen vehicle, for monitoring of vehicle routes to ensure strict compliance to an already defined vehicle routes, monitor driver’s behavior, predict bus arrival as well as for fleet management. Internet of things has made it very possible to devices to inter communicate amongst themselves and exchange information, helping in acquiring and analyzing information faster that we used to know in the past and this has helped more especially in vehicle monitoring to ensure that vehicle owners feel safe about their investments without fearing about their loss. In this paper, we propose a vehicle monitoring system based on IOT technology, using 4G/LTE to get the get the coordinate, speed, and overall condition of the vehicle, process and send to a remote server to be analyzed and used in locating the vehicle and monitor its other configured parameters. This is realized using Raspberry pi, 4G/LTE, GPS, Accelerometer and other sensors with communicate amongst themselves to get the environmental parameters which is processed and sent to a remote server where it is analyzed and represented on a map to locate the vehicle and monitor the other set parameters. 4G/LTE provides fast internet connectivity with overcomes the usual delay usually experienced in sending the acquired signals to be processed. The True Vehicle position is represented using google geolocation service and the actual position triangulated in real-time.

Keywords-- GPS, RASPBERRY PI, 4G/LTE

I. INTRODUCTION

The Internet of Things (IOT) is an arrangement of interrelated computing devices, mechanical and digital machines, objects, animals or individuals that are given unique identification and the capacity to exchange information over a system without requiring human-to-human or human-to-PC intervention. IOT is a new concept that has evolved from the convergence of wireless technologies (Mayuresh & Arati, 2017). It is the new paradigm in the computing world. With this technology, there is a deep penetration of the internet in our everyday life and this is seen as the future of computing. With devices communication amongst themselves with little or no human intervention, it is very easy to practically automate everything in our everyday life. The devices used in this paper were configured to communicate and pick environmental signals in real-time, filter and send them to a remote server for analyses and storage.

4G/LTE is a wireless service which aims at enhancing the universal Terrestrial Radio Access network(ULTRAN) and optimizing radio architecture (Huang, Quan and Gerber, 2012).

It is a high speed mobile broadband that has the capabilities of transmitting at a speed of over 100Mbps. It outperforms is predecessor (3G). With 4G/LTE connected devices exchange information in real-time owing to the fastness of the 4G/LTE technology and ensures that what the receiver receives exactly what the sender send with loss or distortion.

“Vehicle tracking systems are popular among people as a means of retrieval of stolen device, theft prevention, monitoring, and surveillance. Due to the advancement in technology vehicle tracking systems can now identify and detect vehicle’s illegal movements (Geofencing) and then notify the owner about these movements as well as perform a predetermined action if such commands are programmed into the device. This gives an advantage over the rest applications and other pieces of technology that can serve for the same purpose.
There is tremendous demand for object tracking application for the business process. The real-time tracking information on valuable things and assets could solve many problems in the world” Muhammed et al (2018).

Nowadays, newer technologies now have features that are in sync with people’s interests such as being compact, easier to use, feature-rich, connected to the internet, fast and smart. With sensors now available and inexpensive, coupled with the deep penetration on internet, has resulted in a very interesting technology known as the Internet of Things (IoT) which is one of the mainstay of computing. Its aim is to allow people and things to be connected anytime, anywhere with anything/anyone. In other words, devices and application have the ability to communicate each other without or with less human interference (Thiyagarajan, Umamaheswaran & Visawanthan, 2014).

With devices communicating amongst themselves, it is now easy to collect and process data. Software, programmable hardware, sensors, and internet now makes it very easy to collect and exchange information which makes it very easy to remotely control connected devices over an existing network infrastructure. IoT can assist in integration of communications, control and information processing across various transportation systems. Thiyagarajan al et al (2014) suggest that the application of IoT extends to all aspects of transportation systems i.e. the vehicle, infrastructure and driver or user. With 4G/LTE enabling the connectivity to the remote server, dynamic interaction between these components of a transport system enables Inter and Intra vehicular communication, Vehicle monitoring, Vehicle tracking, Smart traffic control, Smart parking, Logistic and Fleet management, Vehicle control, Safety and Road assistance (Mayuresh & Arati, 2017).

This paper propose a system designed to track and monitor vehicles for purpose of locating and monitoring them, as well as to stop the vehicle if stolen and to track it online for retrieval. This system is an integration of several modern communication technologies. The GPS picks the latitude and longitude data, and send it to the Raspberry pi which process, filters, and transfer it to the remote server where is it analyzed and triangulated on google Geolocation services and positioning. The aim of the proposed work is to outline and create strong security framework for vehicles that can avert robbery or loss of important movable assets, as well as retrieval in situation where it is lost. The framework that has been produced in the proposed work utilizes Raspberry Pi, 4G/LTE using data enabled sim card for internet connection.

II. RELATED WORK

Researchers have constantly try to find a new and better ways of solving problems and challenges facing human being.

Since the advent of communication satellites and the subsequent liberalization of its use, it has enabled individuals and companies to locate and monitor persons, vehicles and movable assets using GPS via Satellite or cellular towers.

Mayuresh and Arati (2017) proposed a vehicle monitoring system using micro controller and GPS + GSM module to get the exact location of a vehicle and transfer the latitude and longitude from GPS and automobile data to end systems. Swetha et al (2017) proposed an Accident detection and tracking system using Gps technology and Raspberry pi by sending the information to a mobile number using WhatsApp. Thiyagarajan et al (2014) demonstrated an IOT based intelligent transport system using NFC (Near Field communication) and GPS in capturing the location of a vehicle and sending same to a server for processing. Rathod and Pandya (2017) used Rasp Pi Camera, Gyro Sensors, Raspberry Pi, and Wi-Fi Module to get the Latitude, Longitude and speed information of a vehicle and send same as an SMS to the owner. Ngadiran et al (2017) presented a system of route monitoring, and directing the vehicle to another route if an obstacle is detected using Origin – Destination study to determine the travel pattern. Erabathini et al (2017) used Custom RFID, CoAP, MQTT, AWS, mosquito paho in detecting traffic in a smart city arrangement and help in traffic management. Wang etal (2016) propose a novel architecture for “things” to access the IoT. The architecture supports data acquisition, processing, storage and transmission functions for all kinds of devices and equipment under the IoT environment. This design can be widely used in different areas in the IoT environment for real-time monitoring, environmental data acquisition and equipment control. In this design, they adopted IEEE1451.2 standards as the reference to access multiple sensors, actuators and transducers. The standard stipulates a series of specifications from sensor interface definition to the data acquisition. In order to reduce the consumption of system hardware resources, they adopted FPGA to implement the whole system. A variety of specific IP cores are designed and incorporated in the design. Meanwhile, under the coordination of SoC technology, the main module of the system was implemented on a single FPGA chip.

III. METHODOLOGY

The Proposed system mainly consists of a Raspberry pi, 4G + GPS module, Accelerometer and ultrasonic sensor forming the in Vehicle equipment, the 4G Module provides the connectivity to internet, while the
server is hosted on the internet. Vehicle parameters, speed, fuel level and location coordinates from GPS module, accelerometer and the ultrasonic sensor are fed to the Raspberry pi since they are all interfaced to the Raspberry pi which serves as the controller. They are interfaced through the available IO interfaces and configured using python programming language and AT commands. The units constantly pick information as configured and sends same to the Raspberry pi which now modifies and filters the received signals and send it to the server for processing. Sim7100A module is used for GPS to determine the location of the vehicle, the 4G module provides a fast internet connectivity and creates a path for transmitting in real time the information received by the Raspberry pi to the server. Typical parameters monitored are vehicle location (coordinates), vehicle speed, engine compartment temperature, fuel level, impact, shock and tilt. These parameters are processed and stored in database on a web server and a webpage is created to display vehicle parameters data and can be accessed using a web browser or an android App using an integrated Google map Application program interface. Google map is used to display vehicle location on map using the coordinate of the in-vehicle equipment.

IV. HARDWARE

A. RASPBERRY PI

Raspberry Pi is ultra-cheap-yet-serviceable programmable computer board with support for a large number of input and output peripherals, and network communication what makes it the perfect platform for interfacing with many different devices and using in wide range of applications [9]. The Raspberry Pi operates in the open source ecosystem: it runs Linux (a variety of distributions), and its main supported operating system, Raspbian, is open source and runs a suite of open source software. In other words, using single-board computer
such as Raspberry Pi offers an array of connected hardware and software projects. In works [1] are presented applications of Raspberry Pi as a Sensor Web, as well as the advantages and disadvantages.

![Raspberry Pi B+ model](image1.png)

**Figure 5:** Raspberry pi B+ model

**B. SIM 7100A**

SIM7100A Development Board LTE WCDMA GNSS B2 B4 B15 + GPS Antenna for Raspberry Pi is a complete multi-band LTE/WCDMA/GNSS module designed with very powerful processors integrating application core: gcCortex A5(550MHz), three QDSP6 cores (Up to 500Mhz), allowing customer to benefit from small dimensions and cost-effective product solutions. It has strong extension capability with rich interfaces including UART, USB2.0, SPI, I2C, Keypad, PCM, etc. It has abundant application and is equipped with GSM/UMTS/LTE main antenna, UMTS/LTE auxiliary antenna, and GPS/GLONASS antenna. SIM7100-PCIE merges GNSS (GPS/GLONASS) satellite and network information to provide a high-availability solution that offers industry-leading accuracy and performance. This solution performs well, even in very challenging environmental conditions where conventional GNSS receivers fail, and provides a platform to enable wireless operators to address both location-based services.

![Sim 7100A 4G+GPS Board](image2.png)

**Figure 7:** Sim 7100A 4G+GPS Board
C. TL1000KA1

This is a 1 MHz Ultrasonic Transducer for Flow Meter that is both a transmitter and a receiver. It measures distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. It measures the distance to the target by measuring the time between the emission and reception, to determine the actual quantity of fuel remaining in the fuel tank and transmit same to the Raspberry Pi. The distance is calculated using the formula: Distance \( L = \frac{1}{2} \times T \times C \), where \( L \) is the distance, \( T \) is the time between the emission and reception, and \( C \) is the speed of sound. (The value is multiplied by 1/2 because \( T \) is the time for go-and-return distance.)

![Fuel sensor](image1)

**Figure 8: Fuel sensor**

D. ADXL345 Accelerometer

The ADXL345 is a small, thin, ultralow power, 3-axis accelerometer with high resolution (13-bit) measurement at up to ±16 g. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3- or 4-wire) or I2C digital interface. It measures the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (3.9 mg/LSB) enables measurement of inclination changes less than 1.0°.

![Functional block diagram of ADXL345](image2)

**Figure 9: Functional block diagram of ADXL345**
It provides several special sensing functions. Activity and inactivity sensing detect the presence or lack of motion by comparing the acceleration on any axis with user-set thresholds. Tap sensing detects single and double taps in any direction. Freefall sensing detects if the device is falling. These functions can be mapped individually to either of two interrupt output pins. An integrated memory management system with a 32-level first in, first out (FIFO) buffer can be used to store data to minimize host processor activity and lower overall system power consumption. Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation.

![ADXL345 Digital Accelerometer](image)

**Figure 10: ADXL345 Accelerometer**

V. RESULTS AND VALIDATION

SIM7100A, ADXL345 Accelerometer, and the TL1000KA1 is configured and interfaced with Raspberry Pi to get GPS parameters along with vehicle speed, impact, tilt and the fuel level of the vehicle. Rasberry Pi is programmed to process data of vehicle parameters and send it to a database on a webserver. SIM7100A module works on AT commands which can be given via Raspberry pi code. These commands and the responses of the SIM7100A module can be monitored using Rasberry pi’s serial monitor. Python code is used in programing the Accelerometer.

```python
import adxl345

# create ADXL345 object
accel = adxl345.ADXL345()

# get axes as g
axes = accel.getAxes(True)

# put the axes into variables
x = axes['x']
y = axes['y']
z = axes['z']

# print axes
print x
print y
print z
```

The above program imports a module called adxl345 from the python library and is used to get the readings of the axes of the accelerometer.
This is used in detecting the speed of the vehicle as well as sensing other things such as tilt, shock, and impact to determine how if the vehicle is over speeding, crashed, or forceful opening of the vehicle based on the state of the vehicle.
VI. CONCLUSION

We have proposed a new method of Vehicle monitoring System using Raspberry Pi (IOT)”. The aim of the project is to serve as a solution for locating vehicle and monitoring the fuel level of the vehicle using Raspberry Pi. Rasberry pi is a single board on chip computer that can control many input and output devices using GPIO pins which requires software like Raspbian. You can check the overall vehicle such as trip, daily fuel usage, driver’s behavior, maintenance and vehicle behavior report.

The vehicle monitoring system performs real-time and comprehensive monitoring including temperature, humidity, real-time position, speed, tilt and shock. All the information is displayed with visualization interface, which could be used for security monitoring, accident prevention, theft avoidance and recover, and traffic dispatching. At the same time, all the collected data are stored in the server database which could be access in the future. This system is useful in many applications such as security, vehicle tracking, fleet management, and for theft prevention and recovery.
REFERENCES


