Design and Implementation of IoT based Vehicle Tracking System

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ABSTRACT

Public transport plays an important role in day to day commutation. Most of the commuters who travel by buses spend a lot of time in the bus shelters waiting due to non-availability of correct arrival and departure timings. Consequently, the commuters may reach the destination late and may miss important assignments. To address this issue, it is proposed to develop a GPS based vehicle tracking system using real-time data. This tracking system provides an accurate location of the vehicle. In addition, it also provides notifications to the commuters about the exact estimated arrival time (ETA) and distance of the vehicle needs to cover in the web application. The proposed tracking system is the integration of three parts: 1. Global Positioning system (GPS), 2. Raspberry Pi, 3. Web Application. The current coordinates of the vehicle are extracted in real time using GPS system and superimposed on to the backdrop of the Google map and the estimated distance is calculated.

Keywords
Global positioning system; Estimated Time of arrival; Web application; Raspberry Pi.

Introduction

The Internet of Things also abbreviated as IoT refers to vast interconnections between billions of devices present all around the world. Its application is wide and seen in day to day life. IoT has also found application in tracking systems.

The vehicle tracking system can be used as a security and a management solution by cab/bus aggregate owners. It is the technology which can be used to find the location of a vehicle using various methods such as GPS and other navigation system. The vehicle tracking device is installed in a vehicle and this provides location and the data can even be stored at real time. The data collected can be viewed on maps and other software.

While the application of Vehicle tracking system is popular among vehicle owners and commercial fleet dispatchers it can also be applied in other scenarios including among students and parents who wish to monitor the status of the college/school buses or among working professionals who use company transportation. Sometimes buses are late due to traffic or some other reasons. This is a major issue especially for college students and working professionals. Most of the time passengers either miss the bus or end up waiting for longer periods of time because of non-adherence of the bus timings. Tracking the bus manually by keeping a close connection with the persons inside the vehicle is impractical and ineffective. Hence there is a need to develop a system which allows the user to not be dependent on others.

The proposed system works using GPS Module which is one of the most common methods for tracing and tracking. The device is installed by connecting it to the vehicle. Raspberry Pi is used to connect to the GPS modules. The vehicle tracking system uses the GPS module to obtain the vehicle location at real time. Raspberry Pi is then used to transmit and update the location of the vehicle to a database at regular intervals. A Web application is developed for monitoring the coordinates of the vehicle at real time. Google Maps API backdrop is used to create a map on the website which shows the active location of the vehicle. These features including ETA and distance to be covered helps to continuously update the user about the vehicle coordinates.
**Background**

A school bus tracking system has been designed with Google Map as a backdrop to obtain to track and monitor the school bus in real time. The system offers a web and SMS services to provide updates to parents and school administrators. Notifications are provided depending on the location of the bus. [1][4][2]

RFID tags were used to update the locations of the bus when it passes by each bus stop. At regular intervals scanners are placed which automatically update the server about the bus details such as ETA, bus number and location. [3][5]

An application for androids to is developed for bus tracking system. Java Framework has been used with python for creating website [6]

Tracking is carried out using GPS and RFID technology which are conveniently placed. Automatic updates are sent and displayed on LCD screens.[7][8]

A system is developed with Arduino and GSM/GPS. It is created with the intent to allow management to successfully track buses. The location is displayed with the help of Google Maps.[9][10]

A single board consisting of GPS-GPRS was designed and fabricated with its application being in the wireless domain.[11]

A vehicle monitoring system was designed such that the module in the bus which consists of PC and GSM Module sends the initializing information such as bus number and license plate number to base station module via GSM. [12][13].

A tracking system which uses GPS-GPRS was designed and the coordinates were displayed via a website. The overall project was observed to be cost efficient and accurate. [15]

**Methodology**

The vehicle tracking unit consisting of GPS and Raspberry Pi is installed in the vehicle. The GPS receiver receives vehicle information which are sent over using Raspberry Pi.

![Flowchart](image)

**Figure 1:** Flowchart of IoT based vehicle tracking system

The data is then sent to a server where it is stored and the desired location is displayed as and when required. A website is created with the help of PubNub server to display said location.
The concept of Vehicle Tracking system using the Internet of Things is realized using low-cost GPS tracker (u-blox NEO-6M Module), Raspberry Pi, PunNub server and Blynk Application. NodeMCU was initially used for testing of the GPS Module. As observed in the figure 2 given below the GPS Module which consists of the ceramic antenna is connected to the Raspberry Pi and the whole setup is powered with a 5V Power source.

![Vehicle tracking device](image1.png)

**Figure 2: Vehicle tracking device**

For the connections of Neo 6M module with Raspberry Pi the following pins are used:

- **VCC** (Neo 6M) - 5v (Raspberry pi)
- **GND** (Neo 6M) - GND (Raspberry pi)
- **TX** (Neo 6M) - **RX** (Raspberry Pi)

**Software Design**

There are two parts in creating the software part of the vehicle tracker and these are:

a. Creating a web application, wherein the live location of the device will be displayed.

b. Sending the GPS data from Raspberry Pi to the web application.

The data fetched from GPS is published in pubnub server and a user subscribe to the server by requesting a broker. This will be used to send GPS data from Raspberry Pi to the web application. Google Maps service is utilized to locate the vehicle in map and to track its path. There are 3 reasons for using this API In order to make real time web application, an open source PUBSUB communication model

- There is no need to work with things like sockets, public IP, etc.
- It is free of cost
- There is no need to upload to a server

**Hardware Results and Discussion**

In the initial testing of the GPS Module, it was connected to Node MCU and the co-ordinates were obtained. Running the code would result in the generation of an IP address in the serial monitor. The coordinates are displayed here. Furthermore upon clicking on the generated link
below, the current location (i.e. the obtained location from the coordinates) would be displayed on the Google Maps as can observe in the below Figure.

Figure 3: a) GPS testing with NodeMCU (serial monitor) b) Latitude and longitude values c) Location on Google Maps

The GPS Module was also tested in u-center (u-block) and the coordinates were obtained using the latitude and longitude values, this is displayed in the figure 4 below.

Figure 4: a) GPS results in u-center software b) Coordinates on map
GPS module has also been tested with Blynk application, where the coordinates were obtained by GPS module and simultaneously located on the map. Through this application, it is possible to verify the coordinates from GPS module with the mobile GPS. The figure 5 below is a screenshot of the created blynk application.

**Figure 5:** GPS location via Blynk App

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**Software Results and discussion**

There are two parts to the software bit of the project to display

a. the webpage, where the live location of the device will be shown as in figure 6

b. sending GPS data from Raspberry Pi to the webpage.

**Figure 6:** Screenshots of the Developed Vehicle tracking system Web Application

In order to display the actual position of the vehicle, one has to employ the services of a map backdrop. In this case Google maps can be used as they offer the best services and is commonly used more. Thus, in order to use these services Google Maps API was used. This is one of the services launched by the parent company to allow people who are developing applications/websites to use Google maps as a backdrop. Since the developed tracking system is not yet for commercial use. The map services can be used to overlay the desired functions on it as seen in the Figure 7.
As mentioned, beforehand GPS plays an important role in navigation, but when the destination remains the same, it is possible to use waypoints instead. In many cases the exact street location/street name will be unknown; with the help of waypoints one can pinpoint a specific location and store it. The number of waypoints can vary as required.

Conclusion

A vehicle tracking system that is accurate, cost effective and reliable has been designed and applied. Integration of GPS with Raspberry Pi helps to perform tracking that is both continuous and performed at real-time. The proposed system was designed to be extremely cost effective due to the cheaper cost of u-blox NEO-6M GPS Module. Moreover, the smaller size of the module and giving power supply by directly attaching module to the vehicle via USB helped to significantly reduce the overall size of the whole tracking setup.

Rather than using SMS, a website has been created and this ensures that cost due to transmission is avoided and greatly reduced. Google Map free service and the use of HTTP protocol as transmitting method has decreased the overall construction of the vehicle tracking system. The GPS module was configured, tested and implemented. To display the vehicle position on the website, Google map API was used. Whenever data changes it is automatically updated in the database and this can be seen in the map. This system displays the required data at real time thus making it possible for the commuter to track the vehicle and in case of buses/taxis to estimate the time of arrival.

Future Scope

In future it is possible to expand the service platform by creating a server making it is possible to create a more complex system. The Hardware can further be improved by allowing it to switch between vehicle battery and installed battery. This allows the vehicle to be tracked for several minutes after the vehicle has been stopped, this could come handy when the vehicle is caught in traffic jams. Moreover, the application can be improved further by allowing it to

Figure 7: a) Adding waypoints along the route b) Displaying the ETA next to the map
display the ETA along with the arrival route and distance to be covered by the vehicle. This product can be commercialized.

References


