International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Special Issue: 1 Volume No.7 April – 2023
DOI:10.46647/ijetms.2023.v07si01.004 ISSN: 2581-4621

Anti-Theft Vehicle Tracking System Using GPS and Location Prediction

Mr. P.ANIL KUMAR[1], V. BHAVYA[2] , V. V. CHAITANYA REDDY[3], B. DAMODAR REDDY[4], J. CHAKRIDHAR RAO[5], M. HRITHIK ROSHAN[6]
[1]*Assistant Professor, Department Of ECE, AITS, TIRUPATI*
[2]*Student, Department Of ECE, AITS, TIRUPATI*

Abstract **-** Currently the number of private vehicles is increasing day by day and hence the importance of tracking and theft prevention. Recently vehicle tracking systems are getting wide popularity and can be used in tracking in case of stolen vehicles. Real-time applications like Vehicle Tracking System are developed using an Arduino board with a microcontroller. We have developed a vehicle tracking system with a Smartphone which is less expensive and reliable when compared to the existing system as there is no need for extra hardware. The objective is to develop an application for tracking vehicles, which will help cab owners to track their vehicles all the time and to predict the location of the vehicle in the case of a failing GPS (Global Positioning System). A Time series prediction algorithm is used to predict the location of the vehicle if GPS is in off mode. The vehicle tracking system installed will update the GPS coordinates of the vehicle continued to the cloud, and this data can be used for predicting the location of the vehicle in case of emergency. This system can also be used to generate the bills after finishing the freight in the form of an SMS based on the distance traveled, which can be calculated from the latitude and longitude data. The GPS data can be mapped to Google maps to track the location in real-time. Compared with the existing system, this system is having the advantage of location prediction from the historic location data, and the cost is reduced by almost half.
Keywords **-** Vehicle Tracking; GPS; Location-Based Services; ThingSpeak.

1. INTRODUCTION

A vehicle tracking system collects the fleet data from the vehicle and tells us about the location. Present-day vehicle tracking systems use GPS technology to trace the vehicle. The origin of tracking system is established in the shipping industry. The corporations of the owner found the difficulty of tracking fleets when the fleet was extended over the broad area of oceans. They required a remote system to track where the vehicle is located and how long it has traveled. The need for the system is to prevent any sort of theft and also can help the police to find the stolen vehicle by using tracking reports. There are several types of vehicle tracking devices are currently available. "Passive" devices store GPS speed, and location, and trigger events like On/Off of the keys and Open/Close of the doors in the vehicle. Once the vehicle reaches the predetermined point, the device will be detached, and the information is downloaded to a system for evaluation. Passive systems transfer the data through wireless download. However, the passive system does not prevent the vehicle from being stolen. To overcome this problem, the development of active systems has progressed. Actual time vehicle tracking system could transfer the information to the monitoring station when it is required. It transfers the real-time vehicle data to a satellite network or remote monitoring station for evaluation. Now a day's automatic vehicle tracking systems are available to locate a vehicle. It is done by finding the coordinates position of the vehicle and transferring the data to a remotely monitored station.

Global Position System is a navigation system that provides us with the location, time, address, speeds, and so on. This system was created by the US government, and if a person has a Smartphone, this application can be freely used with the help of the GPS receiver. GPS has developed many tracking applications and systems in order to track vehicles. The GPS is not only used to track vehicles but also used for tracking a person like children and elders to prevent them from being missed. GPS is used to track the exact location of the target with the location. Wireless network service or SMS

DOI:10.46647/ijetms.2023.v07si01.004 ISSN: 2581-4621

can be used to transmit this information to a tracker. Wireless networks are very active when compared with SMS. However, both the tracker and the target should be within the Wi-Fi coverage area. When Wi-Fi access fails, the transmission of information will also fail. So the Short Message Service will be very reliable in such situations.

Today, a lot of research work is published based on vehicle tracking systems. Tracking of a vehicle has become a part of our day day-to-day. Several approaches have been used until now. However, still, cost plays a significant role in implementation. Some of the commonly used approaches are explained below. An anti-theft system could be safe from many intruders [1]. GPS/GSM technology is used in this which reduces positional errors and improves the accuracy of the position. A message is sent to the owner when the ignition is on, and if the access to the vehicle is illicit the owner sends a message to turn off the vehicle, and the paths are shown with the help of Google Maps. The tracking of the vehicle is done using an Arduino board with a Geolocation tracker, which gives a solution to avoid car theft [2]. The system can track the position of the vehicle on Google Earth using a GPS locator and sends an SMS with the location, longitude, and latitude at the moment through the GSM modem connected to the Arduino board. A Kalman filter is used to correct the GPS coordinates. The GPS module is used to get the position, and the GPRS module is used to send the HTTP request with the coordinates of the car every few seconds with data containing the position (latitude and longitude) and can show the position of the device in Google Maps. The GPRS and GPS shield is programmed in such a way that when you call the module and your phone number is right; the GPS obtains longitude and latitude, sends you an SMS with the position, and sends the GPS data through the Internet to the PHP script in your computer. Once the vehicle is found the Arduino board is reset for the next time. A system to trace the vehicle using GSM/GPRS was proposed [3]. The tracking server collects the vehicle position through the GSM network and stores these details in the database. The device has a microcontroller and a GSM, through which the coordinates are taken [4]. Using PHP, these values are stored in the database. A smartphone application is created to display the path in which the vehicle has traveled using Google maps. A system is designed using a GPS receiver, microcontroller, and GSM phone to provide information to the owners regarding the status of the car, speed, and alert through SMS [5], [6]. The real-time location tracking is done for multiple parties using a TCP/IP wireless protocol and GPS location [7]. The subjects who require real-time attention can be tracked using the GPS location. This is mainly used as a protective measure for children and elderly people by tracking their real-time location. In mobile devices, geolocation is done using GPS services. However, frequently updating the GPS location will cause battery drain and makes the mobile system slow. A method to minimize the geolocation updating frequency and at the same time maintain the QoS was proposed [8].

The traditional prediction methods for moving objects usually have an assumption that the objects will move in a linear pattern. However, this affects the accuracy of the prediction because the actual movement pattern will not be linear always. The proposed method is based on Grey's theory for location prediction, which enhances the prediction accuracy [9]. A Location-Based Delivery (LBD) which combines a Location Based Traffic Report Service (*LBS-TR*) and Location Based Navigation Service (*LBS-NS*) is proposed in order to inform about the traffic so that they can take another direction to reach their destination and combines with the short message service and GPS [10]. A location-based delivery is proposed [11], which combines the short messaging service (SMS) and GPS. This method reduces the number of SMS transferred while maintaining accuracy in an acceptable range. The location is predicted with the parameters namely current location, moving speed, and the bearing of the target to predict the next location. When the distance between the predicted and the actual location is going beyond a threshold an SMS is sent to update the current location.

A method is proposed which is also based on Grey theory [12]. Along with that GM (1, 1) is applied to predict the future location of uncertain moving objects. Since the moving pattern is not restricted to a linear path much better result can be obtained in prediction. An energy-efficient prediction-based clustering algorithm is proposed [13]. This reduces the number of hopes between the sender and

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receiver. Aprediction-based clustering algorithm is used, where a few nodes are selected for tracking and these are used to predict the location of the moving object. A Trilateration algorithm is used for finding the current location.

GSM along with GPS can be used to monitor the vehicle and to stop the vehicle in case of emergency [14]-[16]. This method can be used for tracking in any weather conditions. These locations can be mapped to a real-time Google mapfor better visualization.

A system for an outdoor environment was proposed to track vehicles with the help of GPS, SMS, or GPRS technology [17], [18]. A GSM modem is used to send the location of the vehicles, which is obtained from the GPS module from a remote place. This information is sent to the mobile device from where the request for the location is demanded.

The tracking of the GPS signal in multipath using a RAKE receiver and using the LSM algorithm to track the path from the RAKE receiver was proposed [19],[20]. The proposed system uses GPS and localization protocols that allow the GPS receivers or dedicated localization hardware to find locationsand incorporate these values into IPV6 addresses to find the exact location [21]. An accident detection system by determining the locations from the accelerometers of low- cost Micro Electro Mechanical Systems (MEMS) and IMU

[22] was proposed. AHRS is used for more accuracy, and positional information is corrected by the Kalman filter. The proposed system gives an effective solution for controlling the speed of the vehicle automatically using an ARM microcontroller [23]. GPS is used to find the Location and GSM is for messages. A Fault-tolerant automated system was proposed in order to overcome the problems in automated systems and tower management and uses a master GPS/GPRS modem which is capable of communicating modems on the client side [24].

2. MATERIAL AND METHOD

This work uses a Carbon K9 Smart Eco mobile with 1 GB RAM and GPS which is fitted inside the car and is of low cost when compared to an Arduino device with a GPS module and Wi-Fi module. This can be used for preventing car theft. The values which are taken from the device are stored in the database, and static path values are already stored. Comparing the dynamic values and the static paths in the database, if any major deviation is found in paths, an alert message is given to the owner. To calculate the distance of the vehicle traveled HAVERSINE FORMULA is used, which takes the first and the last values of latitude and longitude progressive values and calculates the total distance traveled. So, that billing is generated with the help of the distance formula and a message is passed to the owner and the customer. If our GPS fails, an alternate method to find the vehicle is used through a prediction algorithm that finds the location of the vehicle. This algorithm takes a series of inputs of latitude and longitude values and predicts the path. This project consists of 5 modules, namely, (1) GPS (2) Distance calculation (3) Path comparison and Alert (4) Billing (5) Prediction Algorithm. All these modules are explained below after the architecture diagram. Figure 1 shows the architecture diagram.

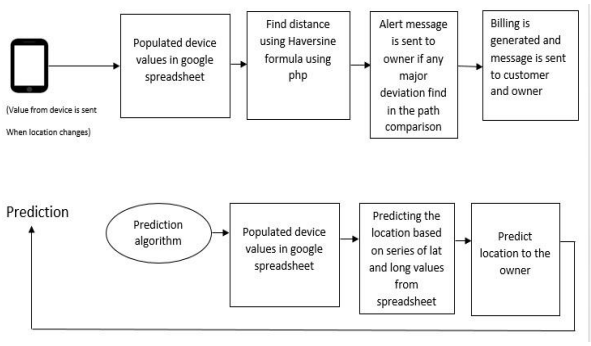

Fig. 1. The architecture of the proposed system

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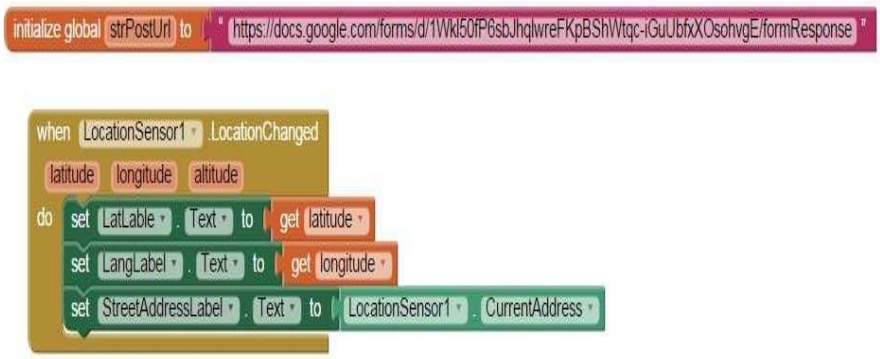

Fig. 2. Blocks for taking GPS values from a mobile device

Fig. 3. Blocks for getting mobile device values and to post in Google Spreadsheet

A. GPS Module

In a vehicle tracking system, GPS plays an important role to get the latitude and longitude values and gives us information about the values like speed, address, and time of travel. The mobile device which is fitted inside the car reads latitude and longitude values from GPS. MIT App Inventoris used to create Android Apps to retrieve latitude and longitude values from Mobile and to push these values into acloud database called Google Spreadsheet. This is done using two methods of get Latitude () and get Longitude (). Figure 2 represents the blocks for taking the values of latitude and longitude from the device, and Figure 3 represents the module for posting the values to the Google spreadsheet. To push the values into the spreadsheet, a global variable is used namely Posturl for accessing the spreadsheet.

The strPosturl is initialized as follows.

Initialize global URL strPosturl=”https:// docs.google.com /forms/d/ 1x0WxgQkK1fTDWnnt1FKB_ZznCUdrXr4AjO UI28GmMhA/formResponse”

Make a list of entry IDs for all fields and call the web1.BuildRequestDataList to build all entry IDs in the list. Call web1.PostText to push these values to a spreadsheet. Bythis, the data have been successfully posted into Google Spreadsheet. Google Spreadsheet is used as our database asit is free of cost and storage capacity is high and can retrieve the values faster compared to other databases. Initial experiments were conducted, and the data is pushed onto Ubidots. However, Retrieving from Ubidots was tedious, and hence Google Spreadsheet is preferred which can store a large number of data and free of cost, rather than going to some paid database.

B. Distance Calculation

The database has the values like location coordinates,speed, distance, and time. Here, only location coordinatesare considered to calculate the distance and to mark those values in Google Maps in order to show the current point where the vehicle is traveling right now. A web server based on PHP is used to calculate the distance of the vehicle traveled. For path calculation, HAVERSINE FORMULA is used to calculate the exact distance traveled by the vehicle. This formula takes the input of the first

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latitude, longitude, and last latitude, longitude values and gives us accurate values.
Haversine Formula

$$hav\left(\frac{d}{r}\right) = hav(\emptyset_1 - \emptyset_2) + \cos\emptyset_1 \cos\emptyset_2 hav(\lambda_2 - \lambda_1)$$

$$hav\left(\frac{d}{r}\right) = hav(\emptyset_1 - \emptyset_2) + \cos\emptyset_1 \cos\emptyset_2 hav(\lambda_2 - \lambda_1)$$

Where d-distance between two pointsr - Radius of the sphere
ϕ_1, ϕ_2*-Latitude point 1 and Latitude point 2*
λ_1, λ_2*- Longitude point1 and Longitude point 2*

The above is the Haversine formula to calculate the distance between two points
The future steps give us a clear idea about how to get the distance from the formula using php.

STEP 1: Retrieve values from SpreadsheetCSV format of Spreadsheet
$feed =
'https://docs.google.com/spreadsheets/d/1cwXq RuosRYIbM0p_8alN2T3VVUnkRqVaiJON8hcyHc4/pub?output=csv';
STEP 2: Convert it into an array
$data = csvToArray($feed, ',');array_shift()

$labels = array_shift($data);
STEP 3: Assign Id for each name
$keys[] = 'id';
STEP 4: Bring all array together
STEP 5: Finally we have encoded it into JSON
Json_encode($newArray);
The following formulae are used to retrieve the exactdistance traveled

$$\$theta = \$longitude1 - \$longitude2$$
$$\$X = \sin(deg2rad(\$latitude1))$$
$$\$Y = \sin(deg2rad(\$latitude2))$$
$$\$P = \cos(deg2rad(\$latitude1))$$
$$\$Q = \cos(deg2rad(\$latitude2))$$
$$\$R = \cos(deg2rad(\$theta))$$
$$\$distance = (\$X * \$Y) + (\$P * \$Q * \$R)$$
$$\$distance = acos(\$distance)$$
$$\$distance = rad2deg(\$distance)$$
$$\$distance = \$distance * 60 * 1.1515$$
$$\$distance = \$distance * 1.609344$$
$$\$distance = \$distance * 5$$

C. *Path Comparison and Alert*

Giving an alert message to the owner is important in the case of the vehicle tracking system since there is a huge increase in vehicle theft [25]. To control this Alert message idea can be implemented to recover the vehicle as soon as possible. This module is the path comparison between the static paths which are already stored in the database and the dynamic path which is created once the travel has been started. The mobile inside the car reads the GPS values, posts them into the Google spreadsheet, and gets stored in the database. Here two spreadsheet values are considered, namely latitude and longitude from the static paths and dynamic values which are taken from the mobile device. The dynamic path is compared against the static path for major deviation. The major deviation values are statically stored in the database. These values will be compared with the fixed values which are stored in the other Google spreadsheet, and if the value

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exceeds the major deviation value during the path comparison, an alert is passed to the owner through SMS, saying that the car is going in a wrong way and the message contains the latitude, longitude value with a corresponding address where the vehicle is exactly located. This information can be passed on to the nearby police station too.

D. Billing

Calculating the distance of the vehicle using the HAVERSINE formula gives us the exact distance traveled by the vehicle. This helps with billing, in which for 1 km (Kilometre) cost can be fixed; finally, the cost is calculated for the total distance traveled by the vehicle. Giving SMS to the Customer and Owner regarding how much kilometer is traveled and the total cost.

E. Predict the Current Location

This module deals with predicting the location of the vehicle if our Mobile GPS is switched off. In our project the latitude and longitude values are received from the device and calculated for potential deviation from the path, unfortunately, if our device GPS is switched off, we need an alternate solution to predict the path in which the vehicle is traveling. For our purpose, we are using a prediction algorithm called the Time series prediction algorithm. There are several machine learning algorithms that can be used for time series data prediction [26], [27]. The latitude and longitude values are retrieved from the spreadsheet. The values are downloaded into a file to create a prediction model. A prediction model is created depending on the columns and format of the file. Data have to be normalized on every column. Then a regression model is created along with the timestamp data. Some data is held back for testing and some data for final validation so that we will get more consistent results. From the whole dataset, some percentage of data will be taken as a training dataset. Based on the training dataset we have analyzed and validated the remaining dataset.

Table-I shows the prediction accuracy.

Input features	Predict	Cross-validation	Total number of instances	Correlation coefficient	Mean Absolute Error	Root Mean squared error	Relative Absolute Error	Root relative squared error
Lat, Long, Timestamp	Lat, Long	5 folds	33803	1	0.0029	0.0038	0.52%	0.60%

3. RESULTS AND DISCUSSION

Here we have integrated all our modules and tested our application, and the results are shown in the form of screenshots. Figure 1 shows the Architecture diagram of the proposed system. Figure 2 shows how the latitude and longitude values of the moving vehicles are obtained. Figure 3 shows how dynamically the GPS values are pushed intothe Google Spreadsheet. Figure 4 tells us the value which is posted from the device and is pushed into our database as shown below. Here we have latitude, longitude, and address values that we received from the mobile device.

fx Address

	B	C	D	F	G
1	Latitude	Longtitude	Address		
2	10.88953	76.91214	Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
3	10.88953	76.91214	Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
4	10.90061	76.90258	Ettimadai Rd,Ettimadai,Ettimadai R.F., Tamil Nadu 641112,India		
5	10.9006	76.90261	No address available		
6	10.9006	76.90261	No address available		
7	10.9006	76.90259	Ettimadai Rd,Ettimadai,Ettimadai R.F., Tamil Nadu 641112,India		
8	10.9006	76.90261	No address available		
9	10.90586	76.89855	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
10	10.90586	76.89855	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
11	10.90586	76.89855	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
12	10.90598	76.89831	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
13	10.90598	76.89831	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		
14	10.90592	76.89839	Academic Block 3 Rd,Ettimadai,Boluvampatti, Tamil Nadu 641112,India		

Fig. 4. Values getting posted into Google Spreadsheet

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Figure 5 shows the blocks for mapping the current path. Figure 6 shows us the current paths where the vehicle is, andthe arrow indicates the vehicle's location. The spreadsheet consists of latitude, longitude, distance, and address values but only latitude and longitude values are taken to show on the map. Here the dynamically posted values are marked on the map. If the owner of the vehicle wants to check where his vehicle is, then he can view it by clicking the button.
Figure 7 shows us what the values present in a spreadsheet, which is retrieved using PHP are. Figure 8 shows us the total distance of the vehicle traveled and we calculate the distance using the Haversine formula. Once we get the whole values, we split values using explode () function to get latitude and longitude values, because we need only those values to calculate the distance using the Haversine formula. Finally, it gives us the total distancetraveled by the vehicle. Figure 9 represents the SMS module,where at the end of the trip the SMS notification is given both to the customer and the admin. Figure 10 shows the final automatic message received by the owner and the customer.

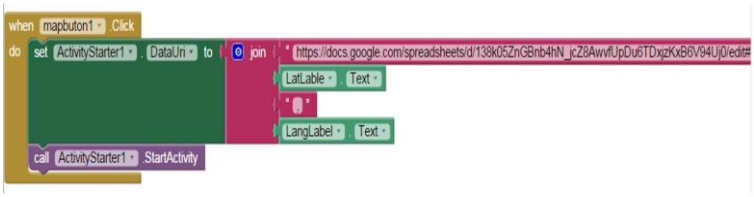

Fig. 5. Blocks for Map Button to know the current path

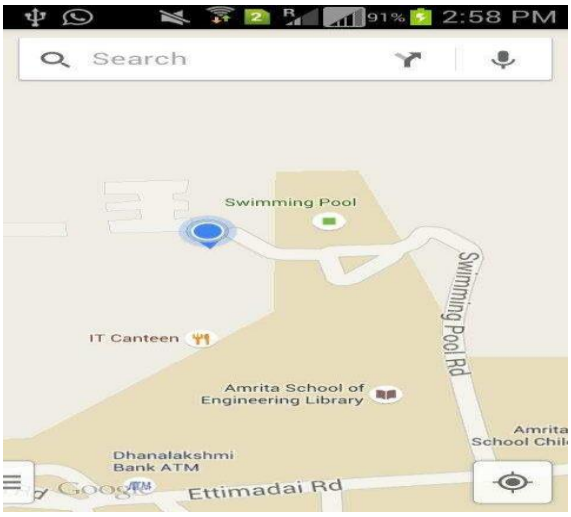

Fig. 6. Current path Map

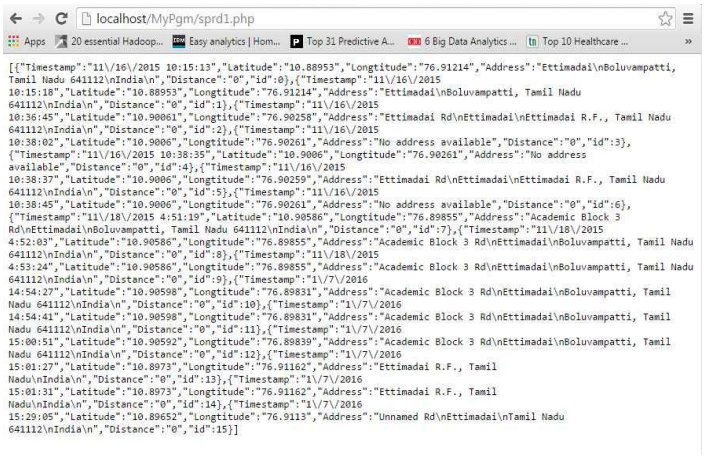

Fig. 7. The Whole Spreadsheet values retrieved by PHP

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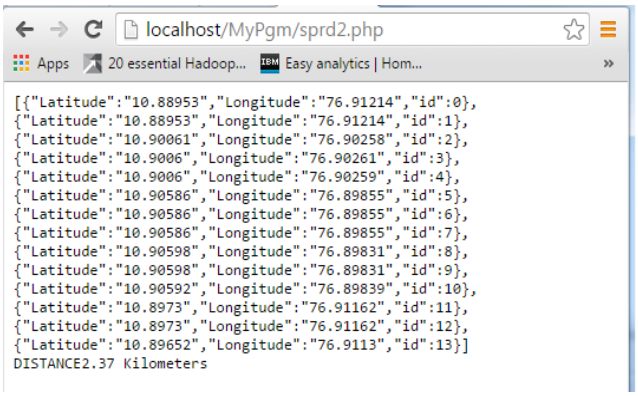

Fig. 8. Latitude and Longitude values along with exact distance.

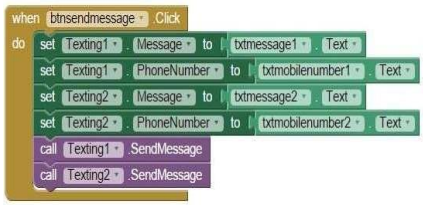

Fig. 9. Blocks for the SMS module

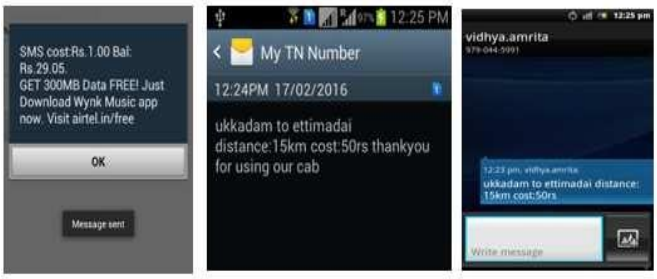

Fig. 10. Message received to owner and customerTABLE II
PRICE COMPARISON CHART

Arduino System			**Proposed System**		
Equipment	**No of set**	**Price (USD)**	Equipment	**No of set**	**Price (USD)**
Arduino Mega - 2500	1	12.67	Carbon K9 Smart Eco	1	37.27
SIM908	1	25.35			
GT-511CIR	1	38.02			
Antennas	2	5.07			
Wire & Misc	-	1.27	Charger	1	4.47
TOTAL		**82.38**			**41.74**

Table II shows the cost analysis table for the traditional Arduino-based approach and the proposed

DOI:10.46647/ijetms.2023.v07si01.004 ISSN: 2581-4621

mobile-based approach. The cost is almost reduced to half since there is nohardware requirement other than a Smartphone and a charger.

CONCLUSION

The existing system uses Arduino boards with microcontrollers to track the vehicle. However, this system proposes an application that tracks the vehicle path with the help of a mobile which is hidden inside the car and continuously monitor the path of the vehicle and passes a message to the higher authority if any significant deviation occurs from the actual path. The billing module will generate thebill based on the distance traveled. The proposed method uses a prediction algorithm to predict the location if GPS is switched off. The prediction is done with the help of the existing data which is available in the cloud. This way of tracking is less expensive when compared with other tracking systems and once this application is installed the usercan check the live status of the vehicle with current updates. Hence live tracking and theft can be identified

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