

Automated Toll Collection per Kilometre in Toll Plaza

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Abstract— Today, due to the increase in the vehicles, there is a lot of gathering of the traffic at the toll booths. The main reason for this traffic at the toll booths is due to the manual working of the toll tax collection at the booths. Each vehicle in an average needs to stop at the toll booth for about a minute for the payment of the toll tax. In order to decrease this traffic, we decided to work on the construction of a project which reduces the manual work and hence increases the vehicle speed passing by the toll booth. Also, people pay taxes till next toll booth, but they will not travel till there they take a diversion in between, to avoid the loss of money which they had not travelled. We decide to pay for the kilometer the vehicle has been travelled.

Key words: Toll Plaza, Automated Toll Collection

I. INTRODUCTION

Our life is changing very fast and the role of automation in our day to day life is increasing at a very fast rate. This is the motive behind our project, i.e. “Automation”. Day by day the number of vehicles passing over the road is increasing due to which the road condition is decaying rapidly. The government sponsors the price of road construction and road maintenance. The government has some source of money to build and maintain these roads & this source is the Toll Station.

At the onset, the goal of our project group was to design an Automatic tolling system for collecting toll per kilometer travelled. After studying various techniques like weight-based systems, bar coding etc. we choose GPS, which is an emerging technology applied for tracking. GPS is an area of automatic identification that has quickly been gaining momentum in recent years and has now been seen as a radical means of enhancing data handling processes, complimentary in many ways to other data capture technologies such as bar coding.

The proposed GPS-based highway toll collection system exhibited great potential for commercialisation. The proposed toll collection system has low power requirements and operates at 5 V. This operating voltage allows easy integration into existing car electronic circuitry that runs on 12 V. Moreover, the hardware components adopted in this prototype are matured technologies and are at reasonable cost. This cost is anticipated to be even lower upon commercialisation due to economies of scale. Not least, the installation of the toll collection system will not affect the overall user driving experience. The miniature box design takes up minimum space and allows the system to be installed on the vehicle’s dashboard, preserving the driver’s line-of-sight and granting the best GPS signalling.

In addition, sudden breakdown of the GPS-based highway toll collection system which results in the failure to acquire internet and GPS signals should be taken into account. Future works may include a redundant distance measurement circuitry to ensure proper toll collection in case

the main system fails. Lastly, the reliability of the established cloud server should be improved prior to product commercialization. Based upon the small-scale cloud server in this paper, additional works should be done in expanding server capacity to support wide user pools. Apart from scaling, cloud server security should be tackled by introducing encryption measures which shield the server from hacking attempts and potential user information leaks. Adding to these, the establishment and maintenance of such a reliable cloud server should be ensured to be economically feasible.

In today’s era of technology, where machines are being extensively used in all the fields we are trying to emulate concept, which will be of great use in public transport systems. Today a person has to travel long distances into vastly unknown territories for job, business, or even for tourism. As the vehicles are increasing and roads are falling short, nowadays we see frequent traffic jams or long queues at the toll stations waiting for paying the toll. Paying the toll every-time through cash or checking the pass takes a lot of time.

Also, paying the full amount until the next toll plaza makes loss of people money so reduces these losses people must pay money for the distance they travelled. Their might be loss of money to government if authority organized to collect the toll tax may involve in mal practice while collecting the toll amount. A toll road, also known as a toll way, turnpike, pike or toll pike, is a road for which a driver pays a toll (that is a fee) for use. Similarly there are toll bridges and toll tunnels. Non-toll roads are financed using other sources of revenue, most typically gasoline tax or general tax funds. Tolls have been placed on roads at various times in history, often to generate funds for Automated Toll Tax Collection System .Repayment of toll revenue bonds used to finance constructions and operation. The building or facility where a toll is collected may be called a toll booth, toll plaza, toll station, or toll gate. Two variations of toll roads exist, barrier (mainline) toll plazas and entry/exit tolls. On a mainline toll system, all vehicles stop at various locations along the highway to pay a toll.

While this may save money from the lack of need to construct tolls at every exit, it can cause lots of traffic congestion, and drivers could evade tolls by going through them as the exits do not have gates. With entry/exit tolls, vehicles collect a ticket when entering the highway, which displays the fares it will pay when it exits, increasing in cost for distance travelled. Upon exit, the driver will pay the amount listed for the given exit. Should the ticket indicate a traveling violation or be lost, the driver would typically pay the maximum amount possible for traveling on that highway. Modern toll roads often use a combination of the two, with various entry and exit tolls supplemented by occasional mainline tolls.

II. LITERATURE SURVEY

The Literature review is a vital part of the research process. Literature reviews provide you with a handy guide to a particular topic. If you have limited time to conduct research, literature reviews can give you an overview or act as a stepping stone. The literature review aims to gather research on a specific topic and to show the points that need to develop. It is an essential part of the project because it covers all previous research done on the topic and sets the platform on which the current research is based.

A. Intelligent Toll Path System using GPS & GSM

Automation means to reduce the activities of human labour. This means the process handled by the humans will be carried out by the machines once it is programmed such a way that it reduces more amount of time and it decreases the possibility of risk factor. Overview of the toll booth system in late 90s is, around 90th century the toll plazas were controlled manually. That system requires two people for opening and closing of the gate and another two are for reception of the money also data keeping etc. Transportation has emerged as a dominant part of India. Toll plazas play a crucial role in maintaining the road transportation. At present, manual toll collection is most widely used collection method in India. It significantly requires a toll collector or attendant. Due to manual intervention, the processing time at toll plazas is highest. The project has been designed for the automation in toll tax payment using GPS and GSM Technology. Automation of toll plaza has been experimented using combination of PIC Microcontroller, IR transmitter and receiver, Global positioning system, Global system for Mobile. Implementation of automation in toll plaza enhances the monitoring of vehicles that are travelling in predestined routes. This project aims in designing a system, which automatically identifies the vehicle that advance towards the toll plazas and observes the vehicle number and the time of arrival. If matches exist between vehicle data and GPS data, then predetermined amount is automatically taken from the user account. It passes this information to avoid the Traffic congestion at toll plazas and helps in consuming less amount of fuel.

B. GPS-based Highway Toll Collection System

The requirement for vehicles to halt for toll fee payment results in traffic congestion and reduces fuel efficiency. In this paper, hardware and software designs were involved to develop a GPS-based highway toll collection system. The system utilised the Raspberry Pi 2 as the microcontroller. Additional electronic modules such as GPS module, LCD module, speaker, wireless Wi-Fi router modem and wireless Wi-Fi adapter were included to perform specific tasks. The system utilised GPS coordinates to track vehicle and toll fees were incurred at predefined points. The travel summary was recorded in the online database. Furthermore, an automatic delay time adjustment system was studied and was implemented to reduce the power consumption of the system without compromising the accuracy. A personal cloud server was configured to allow online access of travel logs. The developed system promises motorists a smooth travel journey and eliminates the construction of expensive toll booths.

C. Automated Toll Collection System using GPS & GPRS

Developing countries like India needs a significant improvement in infrastructure such as Roads or Highways. Construction of these highways is a costly affair, which can't be invested by the government alone. Normally Public private partnerships are made to construct such a huge project. The money spent on these projects can be regained by collecting toll from the passengers who use the roads. The toll collection system, especially in India faces some problems such as long queue lines, escaping from toll plazas, etc. These systems can service only 300 vehicles per hour, and if more than that number of vehicles arrives at that plaza, server traffic jams may occur. To solve this we are proposing to create geo fences using GPS by giving latitude and longitude of the corner of the toll plaza. By comparing the position of the vehicle and toll plaza, the owner of the vehicle can be charged from the account.

D. Novel Design & Operation of GPS Toll System

The functional concept of a manual toll system is simple the motorist takes a ticket at the entrance to the motorway and presents it at the tollbooth at the exit. Ticketing and toll barriers can also be placed on each section of motorway. With technological progress, these systems have evolved towards electronic toll collection, allowing traffic to flow more smoothly and improving service to both users and operators. System consists of Automatic Toll Collection Centre (ATCC), control gates and board units (OBU). The system is based on an innovative combination of mobile telecommunications technology (GSM) and GPS, the satellite G based Global Positioning System. The main element of the automatic log on system is the on Board Unit (OBU). With the aid of GPS satellite signals and other positioning sensors, the OBU automatically determines how many kilometres have already been driven on the toll route, calculates the toll based on the vehicle and toll rate information that has been entered, and transmits this information to the ATCS computer centre for further processing. Software will be support with electronic road maps and data of users registered in as well as data charges of highways and expressways. Charge counting will be started after highway entrance gate and finished after highway exit gate. Data on vehicle position will be additionally approved by GPS system and delivered to ATCC by GSM net. The toll amount is based on the truck's emission category and number of axles, as well as on the length of the toll route.

III. METHODOLOGY

In the project, a vehicle equipped with GPS, for locating its vehicle location and computer connected to transceiver positioned at the toll station. Whenever the vehicle enters into the coverage area the location assigned to that particular travelled distance. After receiving the location, it is forwarded to the computer situated at the toll station.

The computer then recognizes the location and automatically access the database and if the vehicle has its valid prepaid account at the toll station, the appropriate toll is deducted from that account and the gate is opened to allow the vehicle to pass. In between the two toll booths for every diversion of toll roads to normal road GPS will track the

location of the vehicle, it detects the vehicle where the vehicle gets out of the toll service road that information is sent to the two toll booths and check from where the vehicle gets entered into the toll road and calculate the amount for the vehicle travelled on the toll road and deduct the same amount in vehicle account. The amount deducted from the account will be sent through the message of vehicle owner registered mobile number.

A. Node MCU Connects to the Router

Devices that connect to WiFi network are called stations (STA). Connection to Wi-Fi is provided by an access point (AP) that acts as a hub for one or more stations. The access point on the other end is connected to a wired network. An access point is usually integrated with a router to provide access from Wi-Fi network to the internet. Each access point is recognized by a SSID (Service Set Identifier) that essentially is the name of network you select when connecting a device (station) to the WiFi.

Each ESP8266 module can operate as a station, so we can connect it to the WiFi network. It can also operate as a soft access point (soft-AP), to establish its own WiFi network. Therefore, we can connect other stations to such modules.

B. Data Transfer to XAMPP of First Point

Location is fetched from GPS module and it is checked in Google API if vehicle is in polygon. If the vehicle is outside the polygon it does not show the functionality. It shows functionality only when the vehicle is inside the polygon. If the vehicle is inside the polygon the starting point of latitude and longitude is inserted in the database.

In the above figure 1 shows that data is inserted in the database using the local host apache server. The data is stored into the data table where it require database name and table to which the data to be inserted. The inserted data is shown in the figure 2.

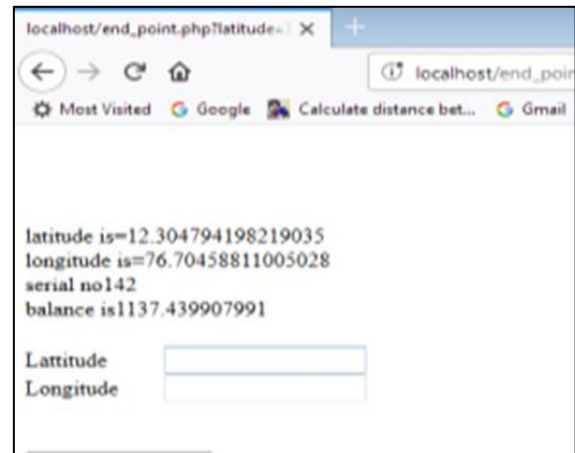
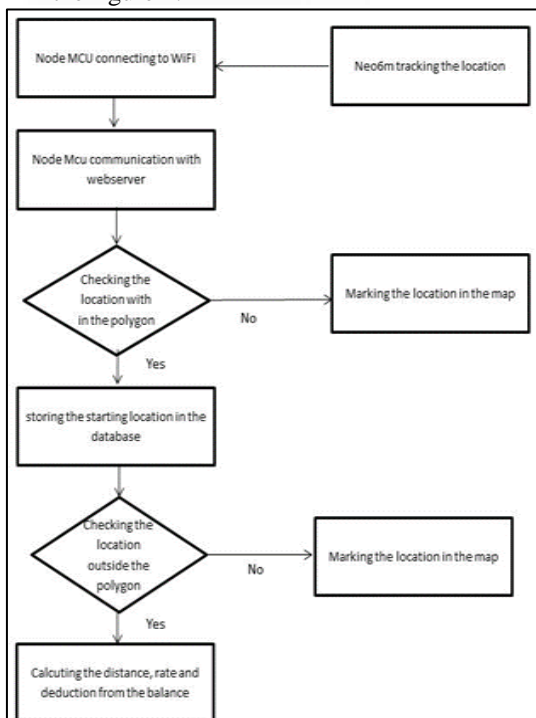


Fig. 1: Screen Shot Data Transfer to XAMPP of First Point

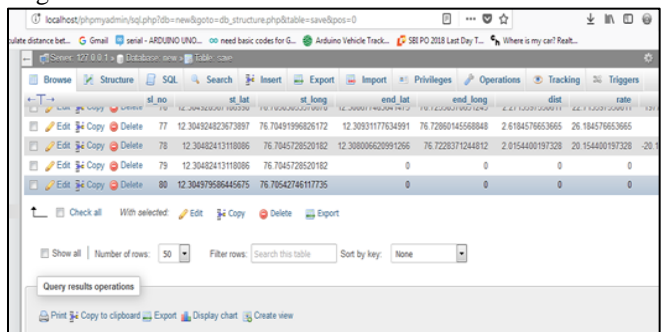


Fig. 2: Screen Shot Data Transfer to XAMPP of First Point is inserted

C. Data Transfer to XAMPP of End Point

Location is fetched from GPS module and it is checked in Google API if vehicle is in or not polygon. If the vehicle is inside the polygon it does not show the functionality. It shows functionality only when the vehicle is inside the polygon. If the vehicle is outside the polygon the end point of latitude and longitude is assigned to end point latitude.

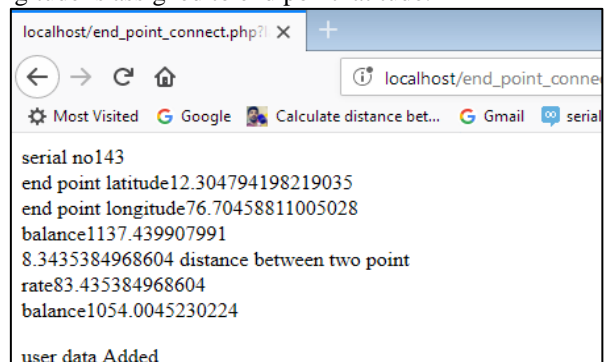


Fig. 3: Screenshot of Data transfer to XAMPP of end point

End point, distance, rate and balance inserted to database is as shown in figure 3. This figure shows the end point location rate calculated per kilometre 10rs and deducted from main balance

The first and end point latitude and longitude is fetched to the browser having code to calculate distance between two points.

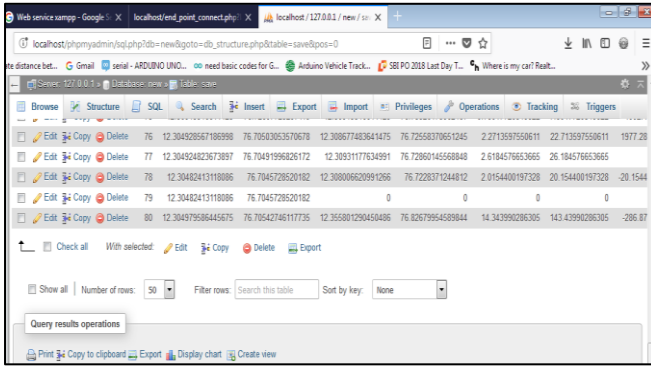


Fig. 4: Showing that Charges is Deducted from Balance & new Balance is updated

For the calculating distance the two point latitude is used and checks for the distance of those points and for the distance in kilometer the charges per kilometer is multiplied. The charges are deducted from his balance and new balance is updated. That is shown in figure 4.

D. Recharge Account

The recharge account is created for the purpose of prepaid deposition of amount initially. In this account the user or the vehicle owner has to personally recharge the sufficient balance to get the initializing into the automated toll system.

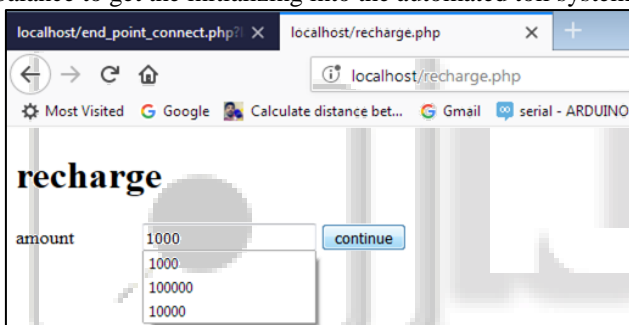


Fig. 5: View of recharging page

When the person travels using GPS the travelled distance is calculated using latitude and longitude of distance is travelled, by rating the cost for each type of vehicle amount is deducted by total travelled multiplied by the rate of cost and that amount is deducted from users account that is already created and remaining balance is also shown in the database page.

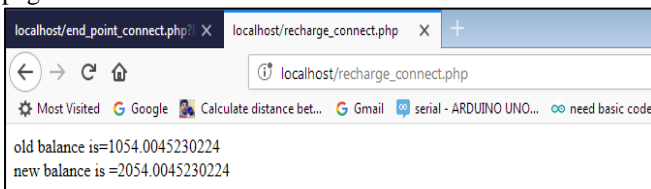


Figure 6 View of Old Balance & New Balance Page

In the above shown figure 5 and 6 recharge account of user is shown and new and old balance is shown with updated balance. This is also linked with user for recharge of their account in online and the toll collection agent can handle this form for recharge at toll gates if the account of a user is very low.

IV. RESULTS & DISCUSSION

The distance travelled by the vehicle is maintained in the database by getting start and ending or the diverted road from

where to where the person is travelled by getting the longitude and latitude for getting the travelled distance and amount from the account the person travelled is deducted by calculating the distance travelled multiplied by its rate per kilometer of vehicle.

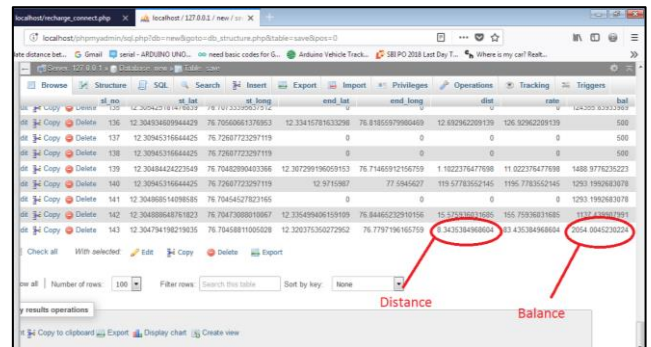


Fig. 7: Screenshot of Database

The above shown figure 7 is the database which works on local host to store data .In this database we are storing the data like serial number, latitude and longitude of starting and ending point, distance between those latitudes. For that distance of latitude rate is calculated and that rate of amount is deducted from the account balance.

Technology proposed can dramatically decrease vehicle queuing at automobile toll plazas, speed throughput, and significantly improve the quality of life for commuters and communities. Electronic toll collection transactions to be occurred under normal highway driving conditions. Open road tolling eliminates plaza barriers and creates a new toll road design that mitigates congestion is shown in figure 8.

The GPS used in automated toll collection system for detection of location where the person is travelling or diversion takes places helps for the security system purposes and also for detection or tracing of culprits using his details by making use of the GPS for tracking purposes.



Fig. 8: Picture of Open Toll System

V. CONCLUSION & FUTURE WORK

A. Conclusion

The GPS-based highway toll collection system was developed from a combination of electronic components such as node MCU, GPS module, GPS coordinates were used to trace vehicle travels and collect toll fees at predefined toll collection points. Toll-incurred travels were then recorded in the SQL database. The system was equipped with additional GPS connection availability detection as well as automatic delay time adjustment. An automatic time delay adjustment

in GPS coordinate acquisition was successfully implemented by carrying out a comprehensive investigation on the time delay and the changes in GPS coordinate. This feature would reduce the power consumption of the system significantly. This developed system is beneficial as it eliminates travel delays and the construction of expensive gantries or toll booths. In addition, the system may be utilised as a unique digital identity for each vehicle, promoting expansion into the area of car security and ownership.

B. Future Work

As if in future we are planning on making this system more accurate. Apart from these all the major modification that we are planning is to directly link the users' toll account with his bank account. Hence the toll tax will be directly deducted from the user's bank account instead of his toll account. Also in the future we are looking to add a feature that will allow the government cars to pass through without collecting their tax.

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