"DESIGN AN AUTOMATED TOLL CASH COLLECTION SYSTEM"

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Abstract:

The transportation system of expressway has become more important in modern transportation network and hence manual toll collection has become outdated because it has some drawbacks. The excellent technology for express way network is electronic toll cash collection. Currently DSRC (Dedicated short Range Communication) technology is used throughout the world. While, global positioning system is applied in recent years. In this paper working flow is described, discussed the components and design of the GPS based toll collection in details.

Keywords: e-toll, Global Position System, vehicle monitoring, Management center; Monitoring station.

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I. Introduction

Manual toll collection is based on classification of vehicle. Here toll is collected by collector also the processing time is very highest. Electronic toll collection (ETC) automatically identifies a vehicle with valid encoded data tag as it moves through toll lane or checkpoint.

ETC is used for authorization i.e. vehicle is registered or not and also for violation. It utilizes RFID (Radio Frequency Identification) using radio waves which identifies people or object. ETC designed for uninterrupted toll collection and it becomes important part of ITS (Intelligent Transportation system).

RFID contains transponder, reader-writer, antenna, computer host and also the microchips which contain memory and circuit transceiver widely used in Canada, Poland, Philippines, Japan, and Singapore.

ATCC (Automated Toll Cash Collection) is based on ACM (Automatic coin machine) accept both coins and token issued by operating agency. Depending on the toll rate use of automated coin or token collection instead of manual collection reduces transaction and processing time as well as operating cost.

Driver of the vehicle need not stop the vehicle at window of the toll road machine or toll station and waste time waiting in long queue to pay the toll payment. It reduces the consumption of the fuel as well as reduces road congestion, increase safety and hence traveler becomes pleased.

Our aim is to design an Automatic toll plaza which is based on GPS technology to save the time at toll plaza and having cash free operation. As the name suggests "Automatic Toll Plaza" the key theme of our project is the automation. So we can say that Automation means to replace the human being from the process with the machines.

Our project aim is to develop software for collection of toll by providing end user with a prepaid wireless cell phone may be android cell phone. The cell phone having GPS technology and according to the need of user he can recharge it.

If cell phones are with insufficient balance then it will be send through another path for recharge and to pay their undue amount.

II. Related work

Electronic toll collection (ETC), aims to eliminate the delay on toll roads by collecting tolls electronically.

Electronic toll collection determines whether the cars passing are enrolled or not and then alerts the enforcement system for those that are not enrolled, and electronically debits the accounts of registered car owners without requiring them to stop.

In 1959, Nobel Economics Prize winner William Vickrey was the first to propose a system of electronic toll collection for the Washington metro region. He proved that each car would be equipped with a transponder or tag. When the car passed through the toll area, personalized signal would be picked up and then relayed to a central computer i.e. monitoring station host which would calculate the charge according to the intersection and the time of day and add it to the car's bill" Electronic toll collection has facilitated the con- cession to the private sector of the construction and operation of urban free flow, as well as made feasible the generation and the practical implementation of road congestion pricing schemes in a limited number of urban areas to restrict auto travel in the most congested areas.

In the 1960s and 1970s, free flow toll system was tested with transponders or tag at the undersides of the vehicles and readers, which were located under the surface of the expressway.

Norway has been the world's pioneer in the widespread implementation of this technology. Electronic toll collection system (ETC) was first introduced in Bergen, in 1986, operates on electronic toll booth. In 1991, Trondheim introduced the world's first use of completely unaided full-speed electronic tolling. Norway has 25 toll roads operating with electronic fee collection (EFC) now days, as the Norwegian technology is called (see Auto PASS). In 1995, Portugal became the first country to apply a single and only universal system to all tolls in the country, used in parking lots and gas stations via Verde. The United States is another country with widespread use of ETC in several states, though many U.S. toll paths use another way for the manual toll collection.

The purpose of the project is to use transport system efficiently by reducing rate of acceleration and de-acceleration. As we know, in manual toll collection vehicles have to wait in the queue for a long duration and this result in high rate of acceleration and de-acceleration. Cash free operation and short interval of time can be achieved by designing a software system.

System architecture:

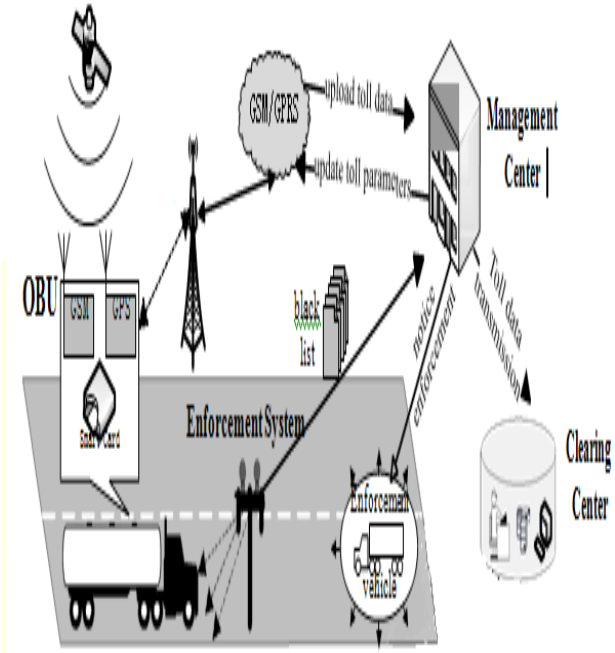

Fig. architecture of GPS based toll collection

Working:

As shown in fig. there are five main key components are as follows:

1) OBU

2) Enforcement system

3) Management center

4) Clearing center

5) Payment service center

- First, user of the vehicle acquire for OBU installation and for registration. For this he goes to the payment service center. The main working of OBU is to set wireless communication through GSM module and thus it compares current vehicle position coordinates from GPS. Main task of OBU is to display the transaction result as well as save transaction message to management center through GSM module. After receiving message at the management center it saves the toll and gives feedback to OBU. If error in

transaction result is found violation proceeds. To deal with this violation enforcement system is used.

- Two types of enforcement systems are used.
  1) Fixed enforcement and
  2) Moving enforcement

In fixed enforcement, there are monitoring stations built on express way. If the OBU doesn't detect the vehicle, it sends message to toll stations to collect the toll manually. DSRC system is used here to read the vehicles OBU status and registered information of vehicle user.

If vehicles actual information is not matched to the registered information then moving enforcement system orders the vehicle to park for violation process.

- Management center is the core part of system and its function is to track and monitoring the vehicle. It is also used for charging and guiding the vehicles.

- Main task of clearing center is to calculate the money and clears the toll data. For this process, it sends command to bank and after receiving command, the bank transfers the money from clearing center to all service providers.

- Payment service center is useful for registration and issuing the smart card. It also works as customer service center. It handles the client queries, account recharge and bill printing service.

III. Technologies used

Two types of system are there which currently in use. First is the single lane system and another one is free flow system. Single lane system is used in France and southern Europe countries like Italy, Spain, and Portugal. The free flow system simultaneously manages the several lanes. It improves traffic flow by significantly reducing delays at tool bath. In 1 hour electronic system

allow 500 vehicles per lane to pass. GUI is used to keep list of all users and its task is to remind users about low balance before they travel.

1. DSRC: (Distance Short Range Communication)

   It uses microwave or sometime infrared technology to transmit data over short distance between mobile system and the motorway. It uses RFID technology

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2. GPS: (Global Positioning System)

   It is the geo-location system which is developed by US and is first used in military applications. In 1993 USDD (United State Department of Defense) made this technology accessible to civilian user and then this can be used for positioning and navigation.

3. GSM: (Global System for Mobile applications)

   It is a digital mobile telephone system that has wireless telephone standard in Europe. It is used for positioning as well as navigation purpose.

4. Digital tachograph:

   This tachograph is installed in trucks weighing 3.5 or above tons as well as in vans or buses with more than 9 seats. It is similar to black boxes which are installed on aircrafts. It is used to verify only for the driver compliances with regulations. E.g. recording the distance driven in a given period of time

5. GNSS: (Global Navigation Satellite system)

   Same work as GPS and GSM. It allows some small receivers to determine the latitude and longitude.

6. W-MAX/ W-LAN and RFID (Radio Frequency Identification):

   For number plate recognition, this system also we can use in ETC.

Mathematical model

S= {{I},{O},{F}}

Where,

I= Input.

O= Output.

F= Function.

Input: Taking longitude and latitude through GPS.

I= {Longitude, Latitude}.

Output: Vehicle location.

O= {Tracking Vehicle Location}.

Function: Receiving message about deduction of balance.

F= {F1}.

Let, I= (v1, v2, v3….. vn). (Various vehicle types)

R= {c1, c2, c3…… cn}. (Cash Deduction)

If I is a set of different vehicles and R is a set of fixed amount for different vehicles

Then,

v1 j v1 then only pay c1 cash

v2 j v2 then only pay c2 cash

Similarly,

vn j vn then only pay cn cash.

Algorithms

In this project the GPS tracking algorithm is used.

GPS Tracking:

By using this algorithm vehicles location can be detected.

GPS tracking takes place in three phases.

- **Data logging:**

  In data logging phase first the vehicle position is detected and the coordinates are stored on the server.

- **Data Pushing**:

In the data pushing phase we used the distributed system. Here the main server collects all the data and provides it to the all different servers.

- **Data Pulling:**

If user wants to access the data then pulling phase allows access to user.

Characteristics

Data information can be easily exchanged between user of the vehicle and service provider. Thus it is more efficient toll collection because it reduces traffic as well as human errors.

- By using ETC accident rates can be reduced to improve safety
- ETC provides faster and more efficient road service
- Saves time by reducing waiting time also capital input is reduced
- By using ETC we achieve better environment than other techniques

IV. Conclusion

In this paper we studied, the development and improvement of GPS-based ATCC (Automated Toll Cash Collection) system, along charging zone and charging mode, better compatibility with other system. We believe that in the near future, GPS based of ATCC will be widely used in internal road charging. In this we described the working flow and frame composing of the system, discussed the design of GPS-based ATCC system components detailed.

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