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RESEARCH ARTICLE

Automated Toll Cash Collection System for Road Transportation

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Abstract:

The expressway transportation has become more and more important in today's road network and the manual toll collection system has become outdated due to its number of drawbacks. By employing automated toll collection system, driver of vehicles need not to stop at a window or and waste time for waiting in a long queue to pay their toll. This reduces the consumption of fuel; reduce congestion, increase road safety. An Automated Electronic Toll collection (ETC) system is basically designed for an uninterrupted toll collection, which has become an important part of intelligent transportation system. This paper presents the concept of Automated ETC using GPS system. This work eliminates the need for motorists and toll authorities to manually perform ticket payments and toll fee collections, respectively. Data information are also easily exchanged between the motorists and toll authorities, thereby it is able to eliminate possible human errors for efficient toll collection.

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

I. Introduction

As we all know that transportation is the backbone of any country's economy. Improvement in transportation systems result into the good lifestyle in which we achieve extraordinary freedom for movement, immense trade in manufactured goods and services, as well as higher rate of employment levels and social mobility. In fact, the economic condition of a nation has been closely related to efficient ways of transportation. Increasing number of vehicles on the road, result into number of problems such as congestion, accident rate, air pollution and many other. All economic activities for different tasks use different methods of transportation. For this reason, increasing transportation is an immediate impact on productivity of nation and the economy. Reducing the cost of transporting resource at production sites and transport completed goods to markets is one of the important key factors in economic competition. Electronic toll collection is a technology allows the automated electronic collection of toll costs. As it is studied by researchers and also applied in various expressways, bridges, and tunnels require such a process of electronic toll collection. ETC is capable of determining if the vehicle is registered or not, and then informing the management center about to process violations, debits, and participating accounts. The most excellent advantage of this ETC system is that it is capable of eliminate congestion in toll plaza, especially during those seasons when traffic seems to be higher than normal.

The benefits of this system are:

- Fewer or shorter queues of vehicles at toll plazas by increasing toll plaza service turnaround rates.
- Fast and more efficient service.
- Ability to make payments by keeping a balance on the card itself.
- Other general advantages include minimization of fuel wastage and reduced emissions by reducing deceleration rate, waiting time of vehicles in queue, and acceleration.

For the toll operators, the benefits include:

- Low toll collection costs;
- Better management by centralized user account

Thus, the ETC system is useful for both the motorists and toll operators, this is the reason of extended use of ETC system throughout the world.

II. Problem statement

“Design an Automatic toll plaza which is based on GPS system to save the time at toll plaza and having cash free operation”

As the name suggests “Automatic Toll Plaza” is the key theme of our project is the automation. So here we will just discuss about the over look of what is mean by Automation. So in very simple language the Automation means to replace the human being with the machines to reduce human work. Means the work done by the human is now performed by machines.

III. Objectives

Here are some objectives about the ETC based on GPS system which tells us about purpose behind selecting this topic & the requirement of this type of project in our day to day life.

- To avoid the fuel loss.
- To Save the time in collecting toll at toll plaza.
- To avoid financial loss.
- To control the traffic.

According to the survey of Karnataka Government, in Sept.2012 they have proposed to get the annual toll collection about 2500 crores/year .But in the present situation they are able to collect only 900 corers of the toll value. Means there is loss of 600 cores due to human errors. So, in this situation we have to control this leakage.

IV. Related Work

The ETC system is currently used throughout the world. Other countries that have applied the ETC system are Canada, Poland, Japan and Singapore, among many others.

The Electronic toll collection system used in Canada is based on the Optical Character Recognition (OCR). The means OCR cameras are used to photograph license plate numbers of vehicles that do not pay the bill. The toll bill will then be sent directly to the registered vehicle owners.

The ETC system used in the Philippines are based on the E-PASS system, which uses Transcore technology. The vehicle having the tag and when vehicle enters the toll that tag read by receiver, automatically balance deducted from account.

Many Electronic Toll collection system use transponder like one to electronically debit the account of registered cars without their stopping that system used in Singapore.

V. Structural Design

Database plays an important role in system. Database system is divided into three parts:

- Administrator
- Central database
- Integrated database.

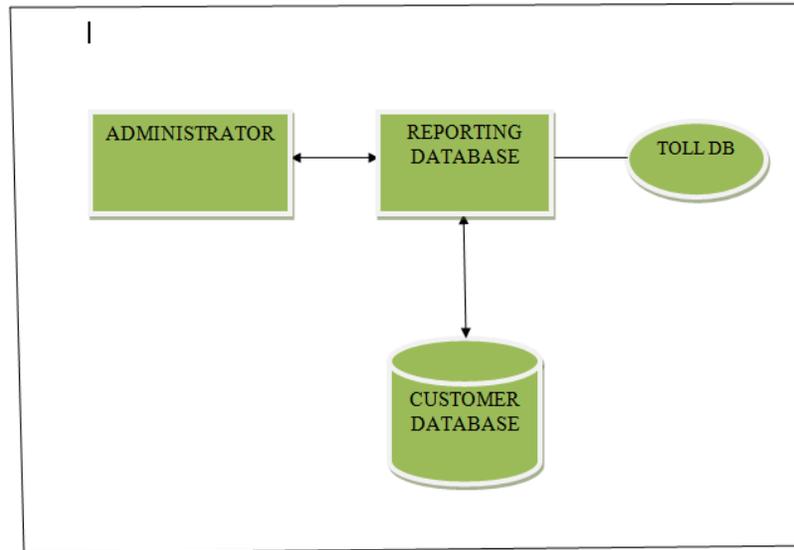


Figure 1: database Structure

1. Administrator:

Admin database contains all the details of central database and all toll plazas under Construction.

2. Central database:

Centralized system is heart of database. Central database consist records of all toll plazas under that construction. This central database managed by administrator. The customer must register into this account to use ETC system. This account information about is stored into the RTO database. When the registered customer passes through the particular toll plazas then, automatically toll will be deducted from customer's account. This deduction will be updated by central database

3. Integrated database:

Integrated database is connected to the central database. Integrated database consist of RTO database. This database will update automatically. RTO database includes all registered vehicles and the details of vehicle such as vehicle owner, vehicle number, license number, account ID, account balance, current charges, etc. All toll plazas records stored at central server and these records could be seen and printed by day, date, month, and year.

VI. Working Principle

The working principle of our project is based on the GPS track system that are to be used for the tracking the vehicle position and which type of vehicle that was to apply the charges on that vehicle. And also we are going to use the OBU unit which is placed in the vehicle. When the vehicle pass through charging zone then by using the OBU unit the balance was deducted from the account of registered user's account.

It's very easy to setup a new toll area and also we are going to remove the old one. DSRC-based Electronic toll system can only used in the district range with in that zone , if charge region need to change, it's difficult to change the whole environment of the system. By

altering the toll mode, toll rate and virtual toll node the GPS base ETC system can change toll area, carry out stretch and mutative toll mode.

GPS Toll Collection uses contact less automatic vehicle identification technology for identification of vehicle Owner passing through that particular toll Collection centers. So time required to take the toll manually can be reduced. Saving time for toll collection will save almost maximum time and also saves fuel. The project aims at developing software to collect toll by providing the end user a prepaid wireless cell phone. Users can take this cell phone having GPS technology and according to their need can recharge their cell phones. The user will be provided with prepaid wireless Android cell phone. And toll will be deducted at the end of the session.

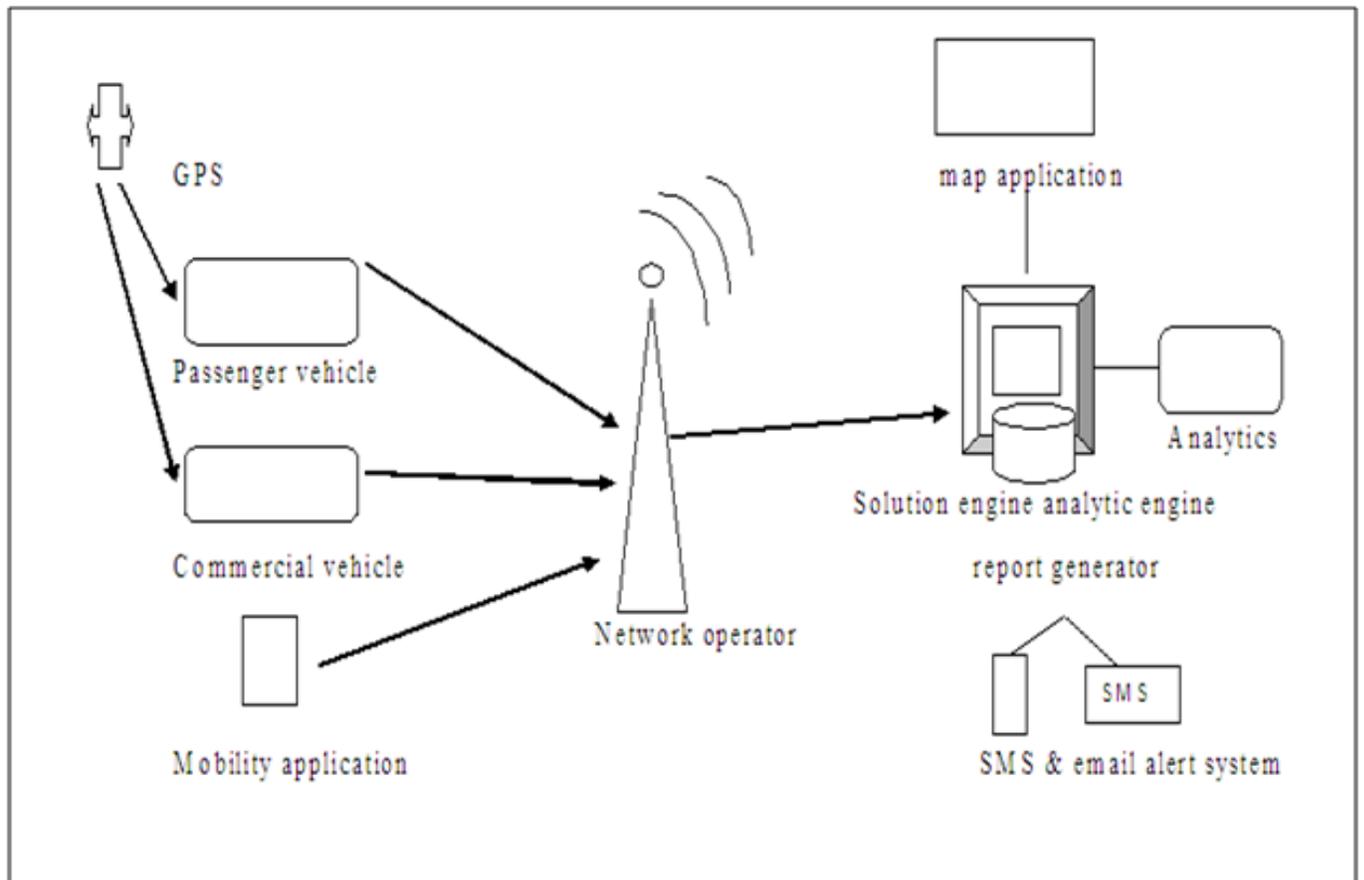


Figure 2: System Architecture

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.

UML Diagram:

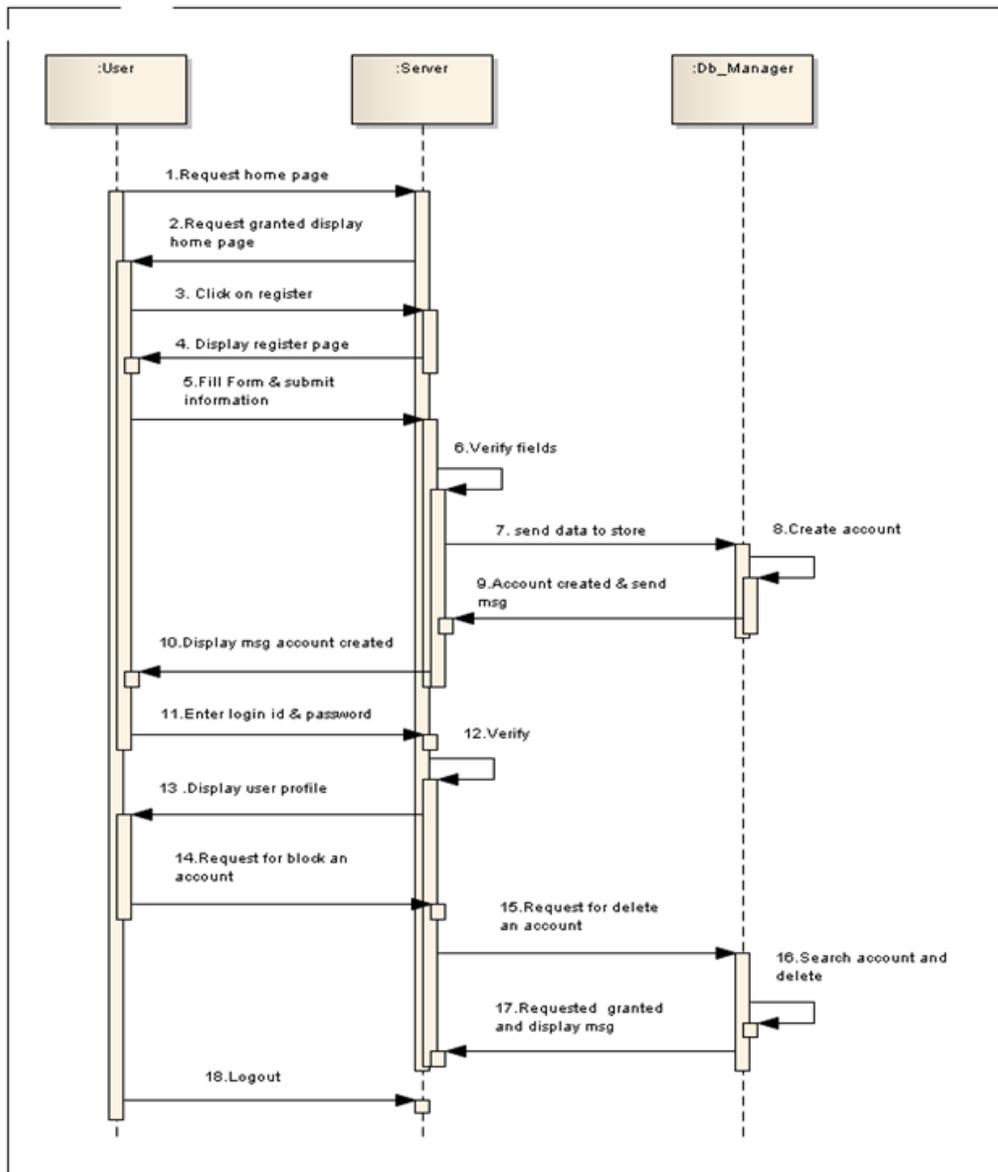


Figure 3: Sequence diagram

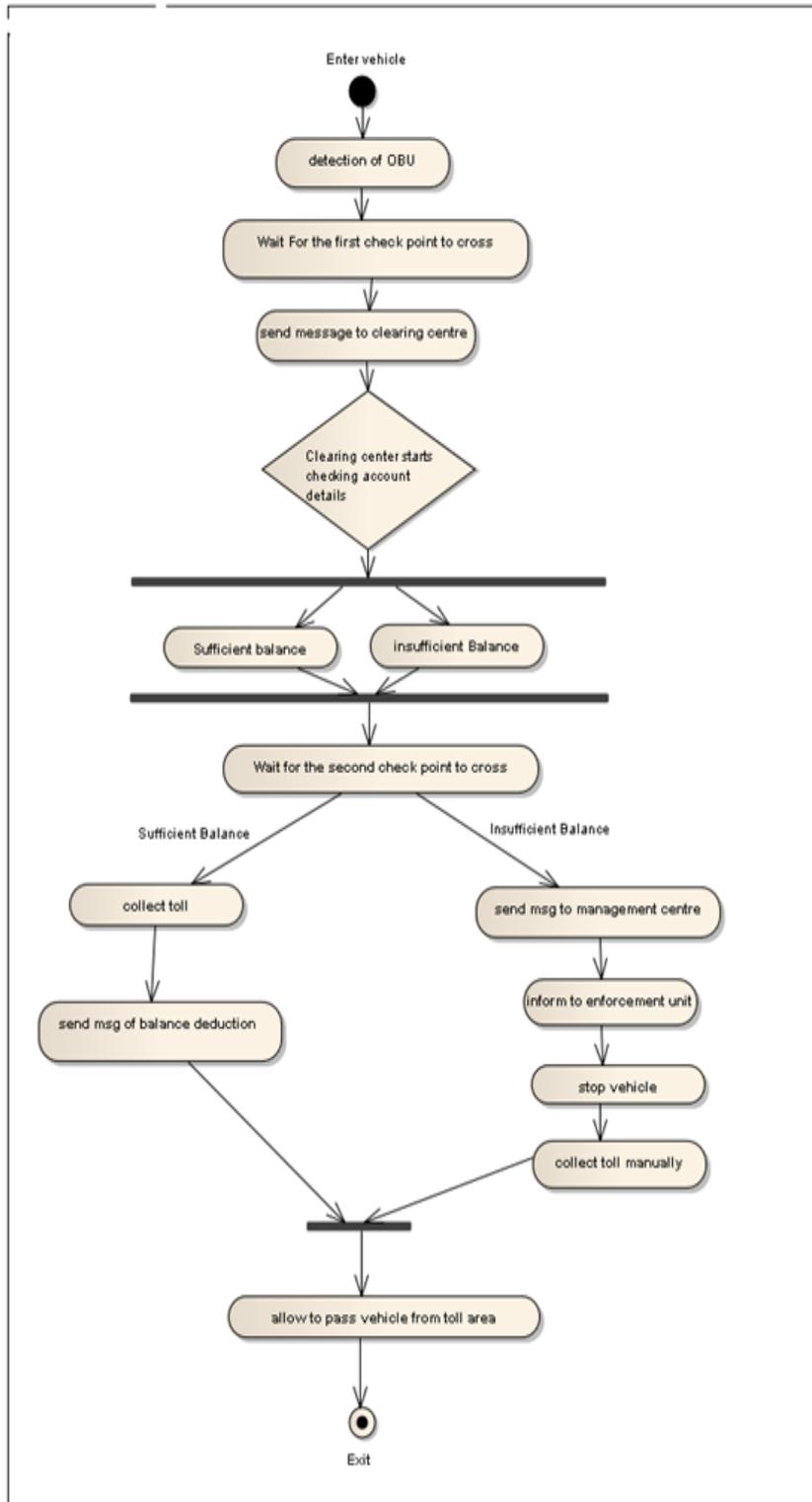


Figure 4: Activity Diagram

VII. Conclusion

One of the most important impacts of technology is the development of sustainable technologies that reduce the traffic conjunction and that need of future generation, save energy and time.

Our project mainly impact full in these aspects, by saving the time on the toll, and also for to save fuel and by regulating the pollution and usage of vehicle at toll gates; as shown it makes the toll collection payment easy by using automatic toll cash collection process.

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