A Comparative Study of Toll Collection Systems in India

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Abstract—**This paper is based on comparison of conventional toll collection and some existing automatic toll collection systems. Some Automatic toll collection systems discussed in this paper are FASTag which employs RFID (Radio-Frequency IDentification) technology. There is also a system called an Automated Toll Collection System (ATCS) for collecting tax automatically wherein a unique RFID tag is attached to the windshield of the vehicle. Here we also propose an automatic toll collection system using Image Processing. Automated Toll payment system is used to provide flexibility and reliability in paying toll amount at toll plaza.**

Index Terms—**Automated Toll Collection System, FASTag, Radio- frequency identification, Toll Collection System, Toll plaza.**

I. INTRODUCTION

In today world the transportation is important and backbone of any county's Economy. The amount of traffic in recent years is increasing due to the increasing number of vehicles. Every day, millions of people use their personal vehicles instead of public transport systems and due to this, there is increase in traffic in developing countries. Increasing number of vehicles on the roads, result into many problems such as congestion, air pollution and fuel wastage etc. There are certain types of roads where you have to pay money to travel on the road which are called Toll Roads. To travel on that road, you need to pay a tax called a toll tax. Toll tax is applied only to the users of the toll road. Sometimes there may also be more than one Toll Plaza on one particular toll road.

A toll road doesn't stay a toll road forever. Tolls may be removed, once the cost of construction has been recovered from the toll amount is collected. All highway toll plazas are manually operated, where an operator collects cash from the driver and provides a receipt. This procedure can be slow, which often results in traffic jams at the toll plazas on busy highways. Although, there are many lanes on toll booths to keep traffic moving as quickly as possible. On some lanes, you can pay with change or cash, while there are also other lanes called express lanes which are for the users who have an electronic pass attached to their vehicle. Special detectors senses vehicle's electronic pass and deducts amount directly from an account, such as a credit card or a bank account, whichever is connected to your electronic pass. Generally, these electronic passes are used by the commuters to travel the toll roads daily in order to avoid delay at toll roads to pay cash.

II. RELATED WORK

A) Electronic Toll Collection:

The Electronic Toll Collection (ETC) system is currently used throughout the world. Some countries that have the ETC system are Canada, Poland, Japan, Italy and Singapore, among many others [1]. Some Electronic Toll Collection Systems in India, owned by NHAI (National Highways Authority of India) operated by different toll management systems are NH-6 toll road at Kharagpur operated by Toll Tax Toll Collection System, Delhi Gurgaon Expressway at Delhi operated by Metro Electronic Toll Collection Systems, Lucknow, Sitapur Expressways Ltd at Uttar Pradesh operated by Rajdeep - Toll Management System, Madhurai, Rameshwaram Express ways Ltd and Cochin in Tamil Nadu operated by Technovaa - Toll Management System, GMR Ambala-Chandigarh Expressway in Haryana & Punjab operated by Rajdeep - Toll Management System etc.

B) FASTag:

It is easy to utilize, reloadable label which empowers programmed reasoning of toll charges and gives you a chance to go through the toll square without ceasing for the money exchange. FASTag is connected to a prepaid record from which the pertinent toll sum is deducted.

The tag utilizes Radio-Frequency Identification (RFID) innovation and is joined on the vehicle's windscreen after the label account is dynamic. FASTag is an ideal answer for a bother free stumble on national interstates.

Fig. 1. An example of automatic toll management and collection by Efcon India

FASTag is an electronic toll collection system in India, operated by the National Highway Authority of India. The system was initially set up as a pilot project in 2014 on the stretch of the Golden Quadrilateral between Ahmedabad and Mumbai. By April 2015, FASTag was rolled out to 247 toll plazas on national highways across India, representing 70% of all toll plazas in the country at the time. As on 23 November

2016, 347 fee plazas out of 366 on national highways across the country accept FASTag payments.

- Customer may recharge his tag account online through, Credit card/Debit Card/ or net banking, but we are also providing a facility of wallet.
- In FASTag, it is compulsory that every individual has his specific bank account. But we are providing it by E-Challan.
- In FASTag, every individual has to put a barcode on their vehicle so that it can be detect. But this barcode is made of paper, as a result there are the chances that the paper can tear of.
- So this will be done by image processing, which will capture the number plate of vehicle.

C) Electronic Tolling System:

Electronic Toll Collection is a system enabling collection of toll payments electronically allowing for near-nonstop toll collection and traffic monitoring. Under the system, a RFID chip-embedded sticker is put on the vehicles allowing deduction of money at toll plazas automatically. The first interoperable Radio Frequency Identification Device (RFID) technology based on Electronic Tolling System was launched at Charoti Toll Plaza, Dahanu in Thane District, Maharashtra.

RFID utilizes electromagnetic fields to consequently distinguish and track labels appended to objects. The labels contain electronically put away data. Detached labels gather vitality from a close-by

RFID peruser's examining radio waves. Dynamic labels have a nearby power source, for example, a battery and may work many meters from the RFID peruser. Dissimilar to a standardized identification, the label require not be inside the viewable pathway of the peruser, so it might be implanted in the followed question. RFID is one technique for Automatic Identification and Data Capture (AIDC).

The interoperable RFID based system would allow vehicles to sail through six toll plazas, operated by three different road developers Larsen and Toubro (L&T), IRB Infrastructure and NHAI. These include IRB toll plazas at Charoti, Bhagwada, Boriach and Choriyasi besides NHAI plaza at Narmada Bridge and L&T IDPL Plaza at Karjan, Vadodara. The pilot project for this has also been launched on Chandigarh-Parwanoo on NH-5.

D) Pay by Phone:

It is for parking system and toll payment system. For toll payment by this app the user need to download this app. After this register all the details of the approaching user to get started on the service. One account works everywhere for tolling system.

Enabling tolling by logging on to the website and editing 'Vehicle Details' in your profile. They can make auto payments, meaning worry-free driving. And they will send the SMS & email payment notifications, so they can keep of their usage.

Vehicle has to wait near toll plaza for the detection of the bar code. That bar code reader which is on the toll scan the barcode and the individual has to pay the amount. But, as we are design a wallet, the payment will be done automatically without waiting near toll.

On, going through various systems and its implementation, we find that, ETC system is installed at selected toll plaza in India which is owned by NHAI while Pay by phone system is currently under development. Moreover, on every toll plaza at least one lane of FASTag is being installed.

III. COMPARATIVE STUDY

A) Conventional Systems:

At present the conventional toll plazas are working manually. This method of toll collection is time consuming. The conventional way of collecting the toll from the vehicle owners or the drivers is to stop the car at the Toll Plaza and then pay the amount to the toll collector by the side of the toll booth, after which the gate is opened either mechanically or electronically for the driver to get through the toll station. These halts, on seemingly well laid roads, and sudden breaks, results in wastage of precious fuel. Another issue is that one needs to handle cash and even wait for getting the change.

After paying the toll tax, a receipt is provided which one needs to preserve when the ticket purchased is a two-way ticket. Possibility that one may escape the toll plaza without paying is also there. Suppose the manual toll collection system is very efficient, and time taken by one vehicle to stop and pay taxes is 50 seconds. Now if 200 vehicles cross the toll plaza, then time taken by 1 vehicle with 50 seconds average stop time in a month is: 50x30= 1500 seconds

Yearly total time taken = 1500x12 = 18000seconds = 5.0 hours

On an average each vehicle that passes through the toll plaza has to wait 5.0 hours, keeping their engines turned on. This figure is staggering, as if on an average we take 200 vehicles pass through the toll plaza each day, then yearly 72000 vehicles pass through the toll plaza, so each year 72000 vehicles waits for 5.0 hours keeping their engines on and thereby aiding pollution and wasting fuel and money.

B) RFID:

RFID chip is capable of carrying 2,000 bytes of data or less. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.

The advances in the technologies related to wireless communication has led to the emergence of several engineering designs to aid the human requirements. Today, on one side the importance for secured access is growing in several fields and on the other side with technology advancements the RFID cards and readers are becoming low cost. Both these aspects are the primary reasons for rapidly growing RFID based authentication system. Today, several wireless technologies are used for building wireless networks. Among them the 2.4GHz wireless network is most widely deployed and used.

As the data collected by the RFID readers is accurate and does not take more than few seconds to read all the products, it reduces the amount of time taken to count the stock and then store them at the designated location.

C) FASTag:

NHAI (National Highways Authority of India) has rolled out program for Electronic Toll Collection on Toll Plazas on National Highways to be called FASTag.

FASTag is a device that uses Radio Frequency Identification (RFID) technology for making toll payments directly from the prepaid account linked to it.

FASTag is a perfect solution for a hassle free trip on national highways and the convenience of cashless payment of toll fee.

Advantages:

- Saves Fuel and Time: FASTag is read by the tag reader at the plaza and the toll amount is deducted automatically, when the vehicle approaches the toll plaza. The vehicle with FASTag doesn't need to stop at the toll plaza for the cash transaction.
- SMS alerts for transactions: Customer will receive SMS alerts on his registered mobile numbers for all the transactions done in his tag account.
- Online recharge: Customer may recharge his tag account online through, Credit Card/ Debit Card/ NEFT/RTGS or Net Banking.
- No need to carry cash: Customer doesn't need to worry about carrying cash for the toll payments.
- Web portal for customers: Customers can access their statements by logging on the FASTag customer portal.

D) Pay by Phone:

Pay by phone is one such system which enables users to pay toll tax using the App. Pay by phone is currently implemented in Chennai Bye-pass Porur, Surapattu toll plazas and then in Nallur (Red Hills), Sriperumbdur (Nemili) toll plazas near Chennai.

In pay by phone, we just need to add Vehicles and the first added vehicle is selected as a default. Default vehicle means that the Mobile is mapped to that vehicle and the payment is done for that vehicle. For travelling with other vehicle you need to swap the default vehicle. Hence it provides the ease to travel with multiple vehicles, no need to always enter the vehicle number and type every time you want to travel. Before starting the journey, the user can choose the toll centre (to which pay by phone has made the agreement) through which he will be travelling and make the payment for it in advance. Thus, time is saved by pre-payment of the toll tax and reduce the congestion at toll booths. When the user approaches the toll centre with which pay by phone has made the agreement, a smart device installed before the Toll Centre will detect the Mobile Phone and initiates the payment through CCAvenue payment gateway. The payment is not done in advance i.e. the transaction is initiated when the user arrives near the toll centre. Hence the problem to handle cash is avoided. There are no chances of escaping the toll plaza. By the time the user reaches the Toll Plaza, toll tax is already paid. Pay by phone will even advise the Lane number of that Toll Centre through which the vehicle need to pass through. When the user approaches the toll centre for which he made the payment, the toll operator checks the vehicle number and if the payment is done, he will pass the vehicle. This system saves time and reduces traffic.

TABLE I
COMPARISONS OF VARIOUS SYSTEMS

	Conventional Systems	RFID	FASTag	Pay by phone (as per system description)
Time consumption	High	Avg.	Avg.	Avg.
Fuel wastage	High	Low	Low	Low
Traffic	High	Avg.	Avg.	Avg.
Payment Mode	Cash/Debit Card/Credit Card	Online	Online	Online
Processing	High	Avg.	Avg.	Avg.

IV. OBJECTIVES AND FUTURE SCOPE

- The main goal behind this project is to improve the efficiency and performance of the system.
- The objective is that it will detect the number plate of the vehicle and through that, it will grasp all the information of the owner such as owner name, owner card number, owner contact details, account no of a particular bank etc.
- It will also detect the type of vehicle i.e. light weighted or heavy weighted and according to it will send the message to that owner's phone number.
- The objective is to do the transaction process between the modules i.e. user and the admin.
- To do online payment, so there will no longer waiting time in toll queue.
- To reduce the manual work, so the time will be saved in paying toll at toll plaza.
- There will be no formation of queue as there is no manual work, as a result it will improve traffic strategy.

V. CONCLUSION

The problem in the existing system are more so to overcome the system, we created this system. The explained system will definitely overcome the problem. These system involves the use of high capacity cameras on toll plaza capable of capturing number plate of car. The image processing is performed on captured car number plate image. It helps in smooth and efficient payment at toll plaza without waiting in long queues on highways. These system is not only capable of reducing congestion of cars traffic but also prevent the loss of fuel .After success full payment the success full payment message is sent on registered mobile user. The whole system is very efficient and reduce the manual work on toll plaza. The amount of toll can be calculated very easily without any help of manual work.

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