

Secured Electronic toll collection using RFID and mobile application

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Abstract— The electronic toll collection using RFID & mobile application is a technology that will allow user to make the payment of highway tolls automatically. This terminology will in turn save the time as well as the money by decreasing the waiting time as well as the queues of vehicles at the tollbooth. The RFID tag will be deployed by the toll authority by embedding unique identification number (UIN) and customer's details into the tag. The deployed active RFID tag will be attached to the windshield of the vehicle. Whenever the vehicle passes through the tollbooth, tag data will be read by RFID reader & same will be sent to the server for verification. Server will check tag details & depending upon the type of the vehicle, the toll amount will be deducted from the user's account. The notification about the toll amount deduction will be sent to the customer via SMS and email as well. The developed android application will be used to recharge the customer's account.

Keywords: RFID, Active RFID tags, Electronic Toll Collection.

1 INTRODUCTION

Considering the current scenario, the numbers of vehicles passing through a specific tollbooth are substantially high. Hence there is a need for the alternate solution for the highway toll collection method which should be more opportune, cost effective and more efficient to the traditional toll collection method. The considered system will provide the better solutions to the toll collection and will deal with the problems coming due to the traditional toll collection system.

2 SCOPE OF ELECTRONIC TOLL COLLECTION IN INDIA

India has about 42.36 Lakh kilometers of road network, which is that the second largest within the world. [1] The length of varied categories of roads is as follows:-

1. National Highways - 70,934 km
2. State Highways - 1, 54, 522 km
3. Major district roads - 25, 77, 396 km
4. Rural roads - 14, 33, 577 km. [2]

According to the report given by National Highway Authority of India (NHAI) National Highways carry 40% of road traffic. Due to this traffic congestion is very high and to reduce it, Electronic Toll Collection must be implemented. And its major concern is to reduce the traffic density, provides road safety and also increases the Central Government's Economy. And National Highways Lane wise distribution can be classified as, 4-Lane - 22.3%
2-Lane - 52.3%
Single Lane - 25.4%

There is a possibility of maintaining ETC's on state highways as well as in busiest hours in cities. Hence for the effective traffic management during those hours ETC is needed.

Factors to be considered for a better system are:-

| Sr.No. | Name of the State /Union Territory | Length (Kms) | Sr.No. | Name of the State /Union Territory | Length (Kms) |
|--------|------------------------------------|--------------|--------|------------------------------------|--------------|
| 1) | Andhra Pradesh | 4,337 | 17) | Madhya Pradesh | 5,036 |
| 2) | Assam | 1,952 | 18) | Maharashtra | 4,176 |
| 3) | Arunachal Pradesh | 2,835 | 19) | Manipur | 959 |
| 4) | Bihar | 3,442 | 20) | Meghalaya | 810 |
| 5) | Chandigarh | 24 | 21) | Mizoram | 907 |
| 6) | Chhattisgarh | 2,184 | 22) | Nagaland | 404 |
| 7) | Dadra | 72 | 23) | Orissa | 3,704 |
| 8) | Daman | 269 | 24) | Pondicherry | 53 |
| 9) | Goa | 3,245 | 25) | Punjab | 1,157 |
| 10) | Haryana | 1,512 | 26) | Rajasthan | 5,585 |
| 11) | Himachal Pradesh | 1,439 | 27) | Sikkim | 62 |
| 12) | Jammu & Kashmir | 1,245 | 28) | Tamil Nadu | 4,832 |
| 13) | Jharkhand | 1,895 | 29) | Tripura | 400 |
| 14) | Karnataka | 4,396 | 30) | Uttar Pradesh | 6,774 |
| 15) | Kerala | 1,457 | 31) | West Bengal | 2,570 |
| 16) | Uttarakhand | 2,042 | 32) | Andaman & Nicobar | 300 |
| Total | | | | 70934 | |

1. The system must be interoperable nationwide, and affordable.
2. Technologies should be tried and tested.
3. Systems should be easy to use.
4. ETC should be scalable to other applications.
5. Payments should be possible through credit cards and mobile phones etc.

3 COMPONENTS OF ETC

An ETC system generally includes four parts [4]:
Automatic Vehicle Identification (AVI)
Automatic Vehicle Classification (AVC)
Dealing process
Violation social control

Automatic Vehicle Identification (AVI)



Figure 1. Ontario's road 407- use of automatic range plate recognition

Automated vehicle identification (AVI) is that the method of decisive the identity of a vehicle subject to tolls. The bulk of toll facilities record the passage of vehicles through a restricted range of toll gates. At such facilities, the task is then to spot the vehicle within the gate space. [4]

Some early AVI systems used barcodes glued to every vehicle, to be scan optically at the toll booth. Optical systems well-tried to possess poor reading responsibility, particularly once baby-faced with inclement weather and dirty vehicles. [4]

Most current AVI systems suppose radio-frequency identification; wherever associate degree antenna at the toll gate communicates with an electrical device on the vehicle via Dedicated Short range Communications (DSRC). RFID tags have well-tried to possess glorious accuracy, and might be scan at road speeds. The foremost disadvantage is that the price of militarisation every vehicle with an electrical device, which may be a serious start-up expense, if paid by the toll agency, or a robust client deterrent, if paid by the client. [4]

To avoid the requirement for transponders, some systems, notably the 407 ETR (Electronic Toll Route) close to provincial capital, use automatic range plate recognition. Here, a system of cameras captures pictures of vehicles passing through tolled areas, and also the image of the quantity plate is extracted and went to determine the vehicle. This permits customers to use the ability with none advance interaction with the toll agency. The disadvantage is that absolutely automatic recognition incorporates a important error rate, resulting in charge errors and also the price of dealing process (which needs locating and corresponding with the customer) is important. Systems that incorporate a manual review stage have abundant lower error rates, however need a seamless staffing expense. [4]

A few toll facilities cowl an awfully wide space, creating fastened toll gates impractical. The foremost notable of those could be a truck tolling system in Federal Republic of Germa-

ny. This method instead uses world Positioning System location info to spot once a vehicle is found on a tolled state highway. Implementation of this method clothed to be way lengthier and a lot of pricey than expected. [4]

Automatic Vehicle Classification (AVC)

Automated vehicle classification is closely associated with machine-controlled vehicle identification (AVI). Most toll facilities charge totally different rates for various sorts of vehicles, creating it necessary to differentiate the vehicles passing through the toll facility. [4]

The simplest technique is to store the vehicle category within the client record, and use the AVI knowledge to appear up the vehicle category. This is often inexpensive, however limits user flexibility, in such cases because the automobile owner World Health Organization often tows a trailer. [4]

More complicated systems use a spread of sensors. Inductive sensors embedded within the paved surface will confirm the gaps between vehicles, to produce basic info on the presence of a vehicle. Treadles allow tally the quantity of axles as a vehicle passes over them and, with offset-treadle installations, conjointly discover dual-tire vehicles. Light-curtain optical maser profilers record the form of the vehicle, which may facilitate distinguish trucks and trailers. [4]

Transaction process

Transaction process deals with maintaining client accounts, posting toll transactions and client payments to the accounts, and handling client inquiries. The dealing process element of some systems is said as a "customer service centre". In several respects, the dealing process operate resembles banking, and several other toll agencies have contractile out dealing process to a bank. [4]

Customer accounts could also be prepaid, wherever toll transactions area unit sporadically beaked to the client, or prepaid, wherever the client funds a balance within the account that is then depleted as toll transactions occur. The postpaid system is a lot of common, because the little amounts of most tolls makes pursuit of uncollected debts wasteful. Most prepaid accounts cope with this issue by requiring a deposit, effectively rendering the account a postpaid one. [4]

Violation social control

A violation social control system (VES) is helpful in reducing unpaid tolls, as associate degree unmanned toll gate otherwise represents a tempting target for toll evasion. Many strategies are wont to deter toll violators. [4]

Police patrols at toll gates are extremely effective, as being stopped by the police is kind of unforgettable for the violator. Additionally, in most jurisdictions, the legal framework is already in situ for backbreaking toll evasion as a traffic law-breaking. However, the expense of police patrols makes their use on a nonstop basis impractical, specified the chance of

being stopped is probably going to be low enough on be associate degree scarce deterrent. [4]

A physical barrier, like a gate arm, ensures that each one vehicles passing through the toll booth have paid a toll. Violators area unit known in real time, because the barrier won't allow the violator to proceed. However, barriers conjointly force licensed customers, that area unit the overwhelming majority of vehicles passing through, to slow to a near-stop at the toll gate, negating abundant of the speed and capability edges of electronic tolling. [4]

Automatic range plate recognition, whereas seldom used because the primary vehicle identification technique, is a lot of usually employed in violation social control. Within the VES context, the quantity of pictures collected is way smaller than within the AVI context. This makes manual review, with its larger accuracy over absolutely machine-controlled strategies, practical. However, several jurisdictions need legislative action to allow this kind of social control, because the range plate identifies solely the vehicle, not its operator, and lots of traffic social control laws need distinctive the operator so as to issue associate degree law-breaking. [4]

An example of this is often the vToll system on the Illinois Toll manner, which needs electrical device users to enter their car place info before victimization the system. If the electrical device fails to scan, the {license plate|car place|registration range plate|vehicle plate|registration code} number is matched to the electrical device account, and also the regular toll quantity is subtracted from the account instead of a violation being generated. If the car place cannot be found within the info, then it's processed as a violation. a remarkable side of Illinois' toll violation system could be a seven day grace amount, permitting toll manner users to pay lost tolls on-line with no penalty the seven days following the lost toll. [4]

4 SYSTEM ARCHITECTURE AND WORKING

The system mainly focuses on the following subjects who are required for the toll collection system in a cooperative task and time sharing environment.

It is assumed that:

1. Each vehicle has RFID tag attached to it.
2. All the users are registered to the Toll Collection Company.
3. RFID reader/writer circuit is installed at the toll booth center which will be connected to the server.

The communication of the RFID reader/writer interface with the server will be through the Java program and the mobile application will be developed using the android technology.

Figure 2 shows the working of the system. When the RFID tag which is installed in the vehicle comes in the range of RFID Reader/writer the data from the RFID tag will be read and sent to the server for further processing. A reader contains an antenna to transmit and receive data from the tag. The reader also contains a decoder and an RF module. The server acts as an interface platform for exchanging information between the RFID system and the end-user. This server system then con-

verts the information obtained from the RFID system into useful information for the end-user.

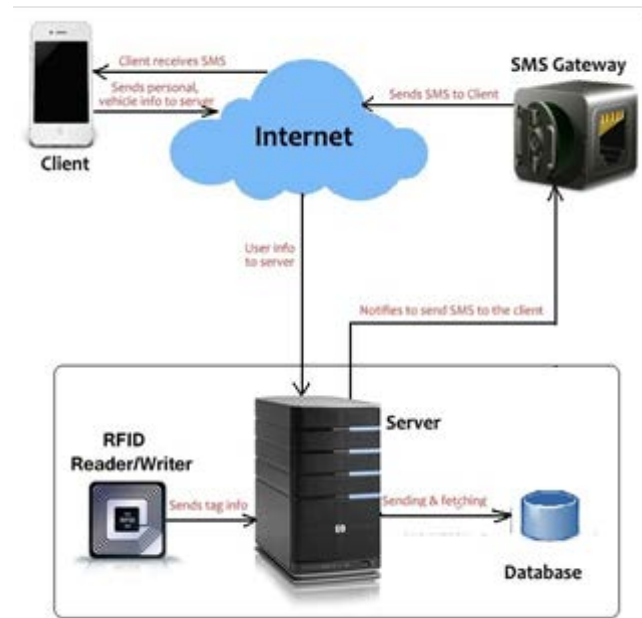


FIGURE 2. GENERAL OPERATION OF TOLL COLLECTION SYSTEM

The server checks if the registered user has sufficient balance in his account, if yes then by checking the vehicle type and toll location appropriate amount is debited from the users account. The system then notifies user by sending a SMS about the amount deducted.

This system will provide maximum benefits to the clients as well as to the Toll Collection Company by allowing them to collect the payment automatically and the processing of the data is in the real time to get their validity to notify every user about the toll paid at every toll booth.

SMS GATEWAY

The system provides a unique feature of sending SMS from a desktop machine using a mobile as a gateway. In this module, basically a hotspot is created by an android phone. Server PC is connected to the hotspot. And then using the hotspot connection server PC can send SMS to the users informing about deduction of toll amount from his/her account. In this module for sending SMS, server PC utilizes the service given by SIM card of android phone.

Security Aspect

Phase 1:- Deployment / Registration of tag

1. Vehicle no. given by the customer is first converted into ASCII format which is stored onto the RF tag.
2. Then it is XORed with the secret key maintained by the server.

3. One way hash function is applied and is XORed with password and one uniqueID is generated which is written on tag & is maintained on server as well.

Phase 2:- Login phase

1. When the card comes in contact with reader number is XORed with the secret key & hash function is applied to it.
2. The string so formed in step 1 is XORed with the password of particular customer & generated number is compared with the server. If the numbers are matched then the user is authorized else not.

- [2] http://www.pib.nic.in/archieve/eec/2010/eec_roadtransport.pdf
- [3] International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 1, January 2013 by Sachin Bhosale, Dnyaneshwar Natha Wavhal. .
- [4] http://en.wikipedia.org/wiki/Electronic_toll_collection.

5 ADVANTAGES AND DISADVANTAGES OF SYSTEM

ADVANTAGES

1. Reduction in manpower: The system reduces man power by making the toll collection method automated.
2. Specific detection: - Enables very specific detection of automobiles depending upon their tag id.
3. Saves time and money: - As vehicle doesn't need to wait at tollbooth, the system reduces waiting time and saves fuel as well. [3]

DISADVANTAGES

1. Low frequency results in lower maximum data rate, although it is fast enough to allow multiple transmissions to increase reliability.
2. Passive RFID tags are comparatively less proficient than active RFID tags, while active RFID tags are more expensive.
3 Speed of vehicle can be a bottleneck.
4. If at a particular tollbooth user loses his network coverage, may get SMS notification late. [3]

6 FUTURE SCOPE

The work may be further extended by adding image processing component into the system. Whenever the toll amount is deducted from the user's account at that moment using a camera,

The picture of number plate of a vehicle will be captured so that the defaulters (like if a customer doesn't have sufficient funds into his account or over speeders) can be identified and the corrective action may be taken.

7 CONCLUSION

Hence the considered system provides an intelligent solution to the traditional & toll collection method. RFID being non line of sight technology has an upper hand over the comparable technologies like barcode. Due to minimum human interference in the system operation, the operations will take place in less time and the system will be more efficient.

REFERENCES

- [1] India drives past china to No. 2 slot in road network, The Economic Times , July 8, 2005