International Journal of Emerging Trend in Engineering and Basic Sciences (IJEEBS)
*ISSN (Online)*2349-6967 *Volume 2 , Issue 1(Jan-Feb 2015), PP1-5*

Security Based Electronic Toll Collection Using NFC and Android 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: Active RFID tags, NFC, ETC, OCR, NATCS

I. INTRODUCTION

The modernization of transport has become one of the essential signs for the urban modernization level, the increase in the number of cars leads to serious problems concerning transport system. [4]Electronic Toll Collection facilities offer travellers the ability to pay toll electronically, most commonly via Radio Frequency Identification (RFID) transponders placed within the vehicle. Many toll authorities have searched for ways to improve the toll collection process. Over the last decade, a significant improvement in this process was implemented and dubbed Electronic Toll Collection (ETC).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 high- way 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.

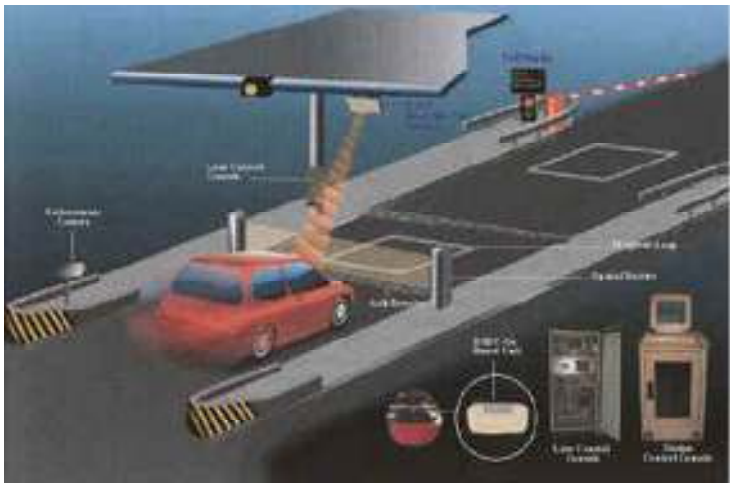

Fig1. Electronic Toll Collection System

II. RELATED WORKS

While compiling the information about different methods of toll collection, it's been observed that still the toll collection at most of the places takes place manually.The following issues and solutions to the proposed system are as follows:

2.1 Difficulties in the present Toll Payment System

Main difficulty faced by the user is wastage of precious time and fuel by waiting in longqueues for toll payment. Many vehicles don't turn of their engines while in queue, whichleads to fuel wastage and due to traffic congestion on the express way causes air pollution. Maintaining records of different type of vehicles and amount transaction is a hectic process. Employees which are assigned on every toll booth are paid in daily wages, which bythe survey is considered as useless man-power used.

2.1.1 The ETC system used in different countries.

The ETC system currently in usedin India [2][3] do not provide and external module that acknowledges the toll transaction to thevehicle owner. The system simply scans the vehicle tag and proceeds provided the vehicleis not under any sort of defaulter category.The electronic toll collection (ETC) system in India operating by radio frequency identification (RFID) equipment supplied by Mitsubishi Heavy Industries, Ltd. (MHI) began commercial operation on an expressway in India's Gujarat state [6]. The ETC system is managed by 3 road developers namely Larsen and Toubro (LT), IRB Infrastructures and National Highway Authority of India (NHAI). The Toll collection project is equipped with RF Scanners that detect the passive tags operating at frequency of 850MHz-950 MHz at a distance up to 90 feet with a response time of 10 milliseconds. Although the system is cost efficient (with tags available at Rs 150), but the motorist have to wait for the receipt. Also no external module can acknowledge the motorist about the successful transaction and pending balance.

The ETC system used in Canada is known as the Canada 407[2][3] Express toll route (ETR). It is one of the most sophisticatedtoll roads in the world. In Canada, the ETC system has deployed close barrier at each end of the stretch. The system is well equipped with optical cameras which record thelicense plate of the vehicle [4]. The camera specific to this type is called Optical CharacterRecognition (OCR).The OCRs are useful in capturing images and recognizing the license plates of the vehiclewithout transponders (tags). Laser beams are placed at the top the solid infrastructurewhich detects the vehicle type. In all the projects developed so far, it is not cost effective and the expense of the built infrastructure is recovered from the motorists by increasingthe toll bill.

The ETC system used in Poland [2] has been proposed by the Motor Transport Institute along with the University of Technology in Warsaw and Dublin. This system is called the National Automatic Toll Collection System (NATCS), and consists of the National Automatic Toll Collection Center(NATCC), control gates, and on-board units (OBU). The NATCS uses a combination of mobile telecommunication technology (GSM) with satellite-based Global Positioning System (GPS). Using GPS technology, the OBUs determine the kilometers that have been driven, calculate the toll fees and rates, and then transmit the information to the NATCS computer center. Each vehicle will be charged from the highway entrance up until the end of the highway. In order to identify the plate numbers of trucks, the system has control gates equipped with digital short range communication (DSRC) detection equipment and high resolution cameras. Due to the technical specifications, this system incurs a high cost for motorists.

2.2 Security

Security is considered as the major problem in the present system. As the payment is cash it becomes difficult for collection, transferring and managing purpose Fraud and blunder are also serious scenarios in this type of systems which were marked during survey.

III. SYSTEM ARCHITECTURE AND WORKING

This system is providing 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. This system is used to get and collaborate end user allowing them edit their information in the application and provide more automated details about toll amount and toll location. It also provides many facilities such as editing personal and vehicle details, top up the account that is being registered with the Toll Collection Company etc.This section mainly focuses on the following subjects that are required for a Toll Collection System in a cooperative task and time sharing environment. It is assumed that:

- Every vehicle has a Mifare tag attached to it.
- All the users are registered to the Toll Collection Company.
- NFC reader circuit is installed at the toll booth center which will be connected to theserver.

Fig 2. System Architecture

When the Mifare tag which is installed in the vehicle comes in the range of NFC Reader thedata from the Mifare tag will be read and send to the server for further processing. The server checks if the registered user has sufficient balance in his account. The NFC reader is capable of reading many Mifare tags at a time, but the mainissue arises is that the server application must be fast enough to accept the tag data and processthem in real time [5]. After reading the tag data, the tag ID must be searched from the databaseand retrieve the information of the user to whom the Mifare tag is registered. Then appropriateamount w.r.t toll location and vehicle type is deducted from the users account and SMSregarding amount deduction along with toll location and time is send to the user withinno time. As the records in the database are increasing it becomes difficult for maintaining thedata and also searching issues arises. For deducting the amount from the users account that userhas to be searched, which may be a serious problem. Because of this situation increased spaceof server and time requirements are key requirements. The above problems can be overcome by:

- Provision should be made that only one vehicle at a time should pass through toll boothwhere NFC reader is installed.
- Server should be fast enough for processing the tag data and at the same time retrievingthe information from the database.

ANDROID APPLICATION

Android application is developed for making the system user friendly. The application is used by the user to register him / her to the toll collection system and get the unique ID the application can also calculate the number of tolls in the route by setting the source and destination of the journey. This will help to calculate the toll amount and enable the user to have sufficient amount in his account. The customer can recharge his account through this application; he can check his available balance before beginning the journey.

IV. SECURITY ASPECT

Generation of unique ID:
1. Vehicle number given by the customer is first converted into ASCII format which is stored onto the Mifare tag.

2. This ASCII number is then converted into binary.

3. Then the hexadecimal conversion takes place where the binary number is converted into hexadecimal value.

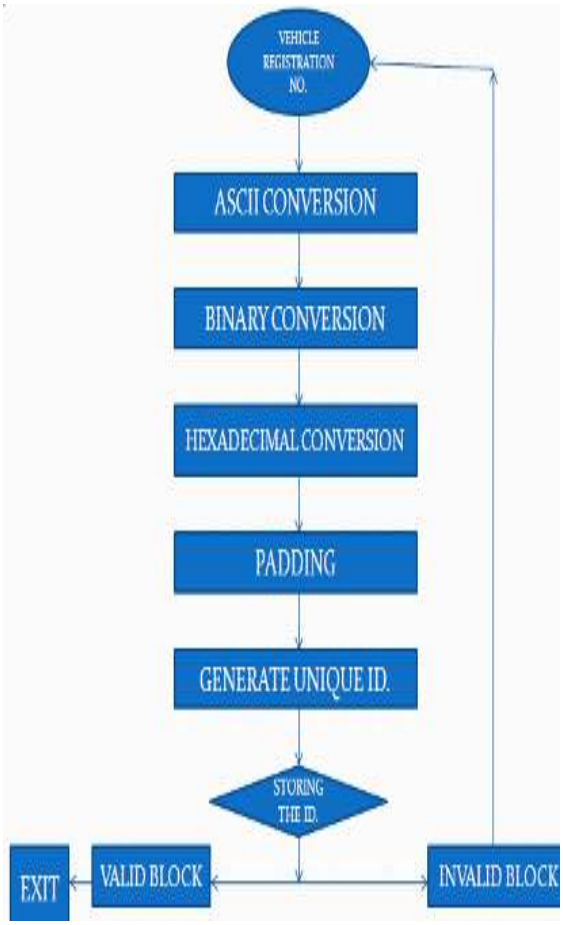

Fig 3. Unique ID generation

4. The tag has sectors and every sector is again divided into blocks[5]. The hexadecimal number generated is always less than 16 and there are 16 blocks of the tag. The blocks are arranged in 4x4 matrix form. Each hexadecimal number is placed in each block sequentially

5. Padding: We use padding technique or the remaining blocks except the last block. The last block stores the hexadecimal number of the total number generated through hexadecimal conversion.

6. Now the characters or numbers in matrix form are placed sequentially and thus we get the unique ID

7. This number is written in one of the sectors of the tag. The sector number for the same is given manually.

8. If the ID gets generated successfully then he tag is deployed or else again the above procedure for new ID generation is followed.

V. CONCLUSION AND FUTURE SCOPE

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 [1]. Due to technological interference in the system operation, the operations will take place in less time and the system will be more efficient.The RFID readers could be more sophisticatedly used along the road so that they can determine the traffic at any road and guide the users to use a separate path for efficient traffic handling.

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