Automated Toll Tax Collection System using Cloud Database

Etqad Khan[1], Dipesh Garg[2], Rajeev Tiwari[3] and Shuchi Upadhyay[4]

[1]Department of Virtualization and Cloud,
School of Computer Science Engineering,UPES
Dehradun,India
[1]khanetqad@gmail.com
[2]dipeshgarg017@gmail.com
[4]Uttranchal University, Dehradun, India

Abstract-- In today's era vehicles are large in number, the tollbooth seems to become bottleneck to pass through the gates due to their manual operations. This process may take few minutes to pass the toll system. In order to decrease this passing time, we decided to automate the process of toll system by doing technology enablement of Internet of Things (IoT). This work would reduce the manual work and hence would make the passing of the vehicles much faster as compared to traditional toll system.Every vehicle is tagged with a RFID tag, which has vehicle's registration number in it, which can be sensed by RFID reader present at tollbooth.RFID reader will send this information to IoT controller (Arduino). Sensed registration number can looked in to cloud database for getting wallet balance and if sufficient balance is there, and then toll charges can be deducted automatically. While rider can enjoy pause free ride and will be intimated about his trip deduction charges. For interaction of client a mobile app will also be designed with which client can track all logs of payments and can add money in wallet using the app. The sole purpose of this paper is to reduce the hardships caused by manual toll collection system and it assures time saving, fuel conservation andcontributing in saving of money by making process automatic.

Keywords—Toll Booth, RFID, Arduino, IoT,Cloud Computing,WiFiModule, Firebase database.

I.INTRODUCTION

Automation has made its way into our lives and is slowly seeping to our lifestyle. We see wide spectra of places where this can be used for the betterment of the society. The number of vehicles on the road are increasing at an alarming rate because of which the condition of the roads is worsening quickly. Then major roads have manual toll systems, where every vehicle has to stop and pay for toll tax and then leave the lane. With enormous increase in number of vehicles on road, the process of traditional toll system has become worst and at times on popular routes the waiting times of vehicles is significantly high. So the objective was to give a solution of this delayed manual toll system by designing and implementing an automatic tolling framework for gathering toll. Thesystem, which is better in terms of accuracy,efficiency and cost effectiveness with lesser delay for vehicles. So such systems are the need of society now a days to speed up the toll passage process.

II. PRELIMINARY AND RELATED WORK

Aniruddha Kumawat et.al. an Automated Toll Collection System using RFID used for collecting tax automatically[1]. Radio frequency is used for identification. A vehicle will hold an RFID tag. All the basic information of the vehicle will be stored in this, along with the amount paid by the vehicle at the toll booth. Whenever a vehicle will pass the toll booth, the readers which will be placed will read the vehicle and also deduct the necessary amount of cash. The new balance would be updated after the transaction gets over. If the balance is insufficient, the net total amount I the card goes to negative. This may lead to some financial loss to the system. So negative balance can be an escape for anunauthentic vehicle.

According to Khadijah Kamarulazizi and Widad Ismail, this paper focuses on an electronic toll collection (ETC) system using radio frequency identification (RFID) technology[2][4]. This method automated the system and eradicated the need and hassle of manually paying the toll. Data information are also easily exchanged between the vehicle and the authority that is collecting the tax, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors. But this was limited to the local servers, so scalability and reach upto all tolls was not possible.

According to S.Nandhini, P.Premkumar, most Electronic Toll Collection (ETC) systems around the world are implemented by DSRC (Dedicated Short Range Communication) technology[3]. This system talks of an automated toll gate system where transaction details are sent on the mobile phone of the motorist using a GSM module. It is a revolutionary idea for a speedy toll collection and verification as well. In this paper, the frame composing and working flow of the system is described and data information

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE

is also easily exchanged between the motorists and toll authorities, thereby making it a more efficient process.

III. DESIGN OF SYSTEM

A. Radio Frequency Identification (RFID):

RFID, is used for identification and uses electromagnetic field in the process. RFID system consist of two components,RFID tag and RFID reader.

The RFID tags that are available in the market electronically store information. RFID tags are of two types- a) Active RFID tags b) Passive RFID tags. Passive RFID tags do not have a battery of their own and extract all its powers from the radio waves of the RFID reader. Here is where an active RFID tag differs from a Passive one, because an active RFID tag has its own battery and can be detected by a reader from hundreds of metres away. RFID is one method for Automatic Identification and Data Capture.RFID reader is used to reading the tags,collecting the stored information and then communicating the result to a IoT controller or to database.Reader communicate with tag using its own antenna.

This Radio Frequency Identification has found widespread use in the recent times and has been the centre of development when talking about the Internet of Things. RFID tag used for this work is as shown below in Figure no 1.

Figure1: RFID Tag Used

B. Arduino Microprocessor

Arduino is an Open Source enterprise that aims at making this world a better place by producing single board microcontrollers and microcontroller kits that can be programmed to develop devices that are endowed with abilities to interact with objects from the non-digital world. Various microprocessors and controllers are part of different Arduino designs. The board provided has numerous Input/output pins that can be used to interface with different devices and boards. It consist of programmable circuit board and integrated development environment which is used to write the code and then feed the code to circuit board.Arduino can be coded for a designed function or a specific task.The Arduino has USB port that lets us connect it with the computer and in turn is used to upload programs on it. The language used for coding is generally C and C++ and all the embedded libraries are also available. Arduino also provides a dedicated integrated development environment (IDE) based on the Processing language project for compilation and upload of our Sketch (Program) on the board.It has 6 analogue input pins and 14 digital I/O pins.

C. Wi-Fi Module ESP 8266

Wi-Fi is the phenomenon in which computer or other devices communicate with one another. The ESP8266 is a Microcontroller unit capability. It is a low cost Wi-Fi and it comes with the TCP/IP stack fully embedded.It has a micro USB port for power, programming and debugging operations. This module is connected with Arduino kit as shown in Figure 2.

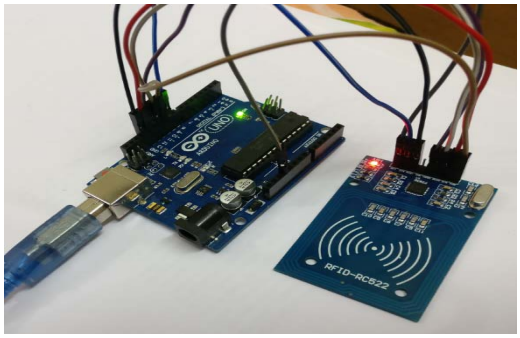

Figure 2: Arduino connected with WiFi Module for sending data to cloud database server

D. Mobile App

A mobile app is developed in this system, which can conncet every user with toll database. User can see the tolls on his way and can check the balance in his wallet. As his vehicle passes from toll gate, automatic his vehicle registration number is read and payment from his wallet balace is deducted. Recipt of toll charges is generated and can be downloaded from his mobile application user login controls. Then using app user can add balance into wallet.

E. Use of Sensors

We are using Radio Frequency Identification as a means to see which vehicles are registered and which are not. RFID tags are installed on each vehicle and when the vehicles close-in on the gate, the RFID reader strategically placed, does read the tag and checks on the basis of the initiation made. RFID uses Electromagnetic field in the process of Identification. The

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE

cards used in this process can either be Read-only or Read-write depending upon the cost structure. The Read-only RFID tags cannot hold any data but the Read-write tags can hold up to 128B of data. The RFID card have a unique Identification number which are used for checking whether a given vehicle is registered or not. This section holds major significance because it decides that whether the vehicle entering is valid or not and then proceeds for the pay.

F. Data Acquisitions

Every RFID tag has a unique Identification number and it is unique for all the cards. As we will recognise the vehicle by the tag/card embedded in the vehicle so at the time of vehicle's registration,it is must that every vehicle must be associated with a RFID tag.In this way,every vehicle will have a unique identity that can be easily identified by the RFID reader. The RFID reader in turn, reads all the RFID tags to fetch their unique ID numbers, and the Arduino is programmed to only accept certain RFID tags, thus allowing only the vehicles with the registered tags on them.The moment the tag comes within magnetic field of RFID reader,current is induced in it and it get energised.

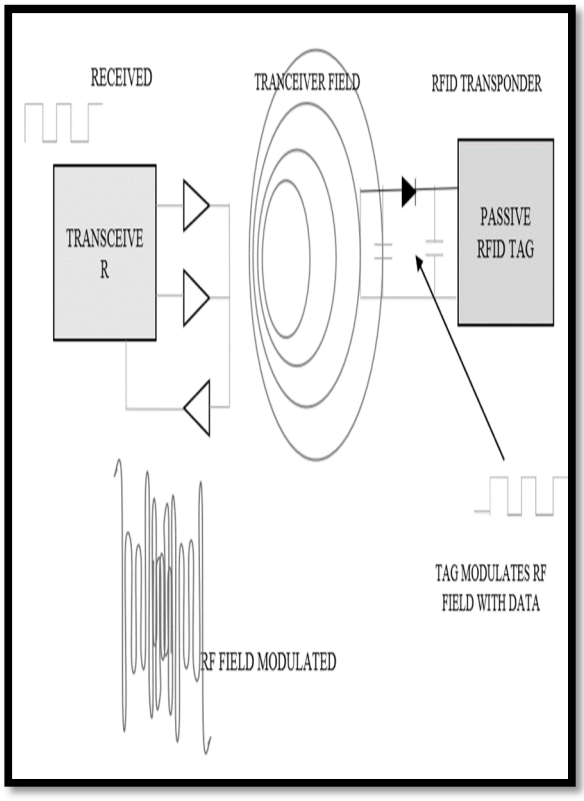

Figure 3: Valid RFID Identification framework

Thus stored information in tag is sent to reader.Then the designed system authenticates the user and allow the person to pass through the toll after deducting a fixed amount. All information of user is stored in cloud.The database containing all the details of the vehicles is set up on Firebase cloud service. With every unique Identification number, is associated three other fields, namely, Name of the owner, Registration number of the car and the account balance for the toll payment. From here on, this data is fetched and further analysis on the data is performed.

G. Flowchart

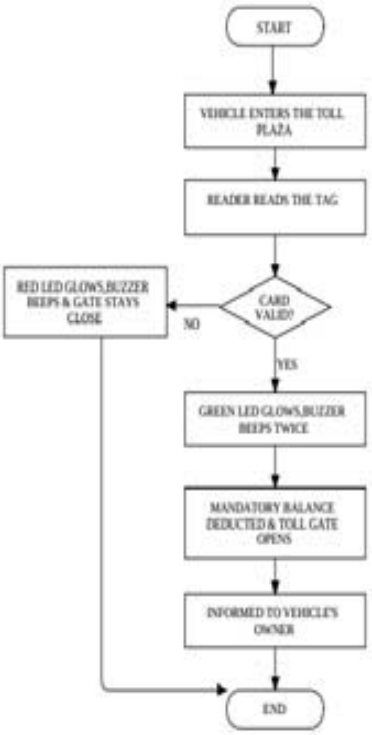

Figure 4: Working Flow Chart of Toll Automated System

The process start as soon as the vehicle comes at toll plaza.As shown in Figure 4. The RFID reader present there will sense the RFID tag embedded in the vehicle.As the magnetic field will energise the tag which results the sending of stored data to RFID reader.Now the system will authenticates the card.If the card is invalid then buzzer will beep and gate stays close.If the case is valid,then green led glows and a mandatory balance will be deducted from user wallet.Thus,user can enjoy pause free ride.

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE

H. Cloud Framework Used

The complete procedure of automating the toll gates creates data at runtime and this dynamic data needs to be stored. So, for creating a dynamic database, Firebase is used. Cloud framework used is shown in Figure 5 given below.

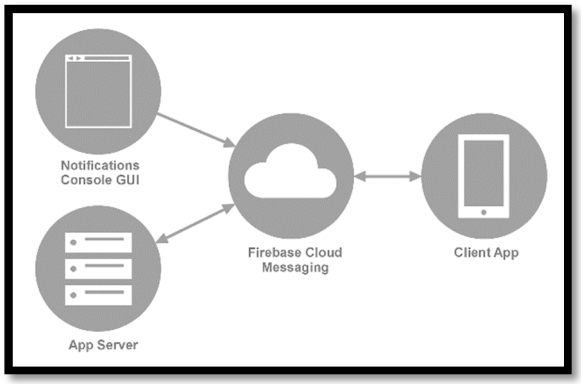

Figure 5: Firebase and Application Connectivity

Firebase, powered by google, provides numerous services, with Dynamic Database and Backend as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored on Firebase's cloud. Android, iOS, JavaScript, Java. In Firebase, a database is created that has the details of each of the vehicles registered and every time the RFID reader returns an identification number, the number is dynamically checked in the database and if the elements in the field array match with that of the identification number of the vehicle that is passing, then we can proceed to seeing if that particular vehicle has sufficient balance. If the balance turns out to be sufficient, a balance pay is initiated and the new balance is dynamically stored on the database.

The database is maintained and is dynamically updated with the balance after each subsequent turn of passage of the vehicle. The data from the RFID reader is the only data that is used for identification of the vehicle and thus maintains the uniqueness and low error margin in the process. The process enhances the existing traditional methods in every way possible and paves way for a better future. It also offers the usage of system in all geographical areas.

V. SYSTEM IMPLEMENTATION

5.1.System Model

The illustration aforementioned gives us a clear idea of how the physical framework of the system would look like shown in Figure 6. The vehicle, upon its arrival would be sensed by the RFID reader that would read the number provided on the car, the system upon verifying the valid entities deducts the balance and updates the same on the cloud service that is in use. The complete model is based on the utilisation of the Radio Frequency Identification which can sense data from a distance and thus becomes handy in such situations where we have to retrieve data from a moving object in the vicinity.

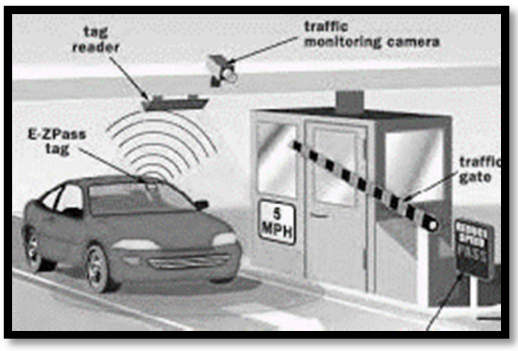

Figure 6. - Toll gate Activity Module

The vehicle and the mobile application both will hold relevance while connection with the tollgate. A fairly simple yet robust depiction of the problem hereby follows. The vehicle upon being sensed will be verified from the data that is fetched from the Cloud database by the virtue of the World Wide Web, the vehicle is then prompted into the toll booth and the amount is deducted from the application. While this happens, the new value of the balance is pushed back into the cloud database all over again.

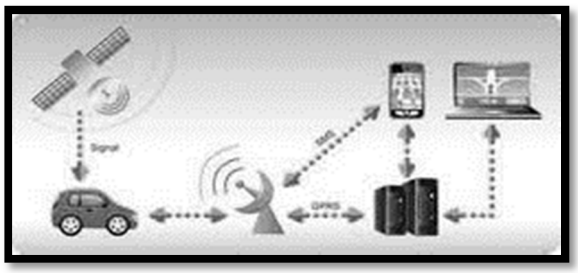

Fig 7. - Model for the System

5.2.Mobile App and its working

User can use the app for easy monitoring.Each card will be given a unique username and password. After successful login,user can see all the details related to this process involved.User can see the remaining balance in the wallet and can monitor the previous transactions.With every transaction, the new balance would be updated.In case of insufficient balance,user can add the money using e-mode by the app.

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE

The application serves its purpose good becomes it comes in as a handy piece of digitalisation while we enjoy a pause free ride. The app also serves its purpose when we try to backtrack all the transactions that have been initiated at the toll gates.

The application receives a push notification every time some transaction takes place. This can be helpful in cases of theft too, because we can actually track down or car on the basis of this very system. The basic model of the application is provided herein.

VI CONCLUSION

Automatic Toll Gate System using RFID is to automate the process of toll tax collection. This is implemented using an Arduino, RFID reader and an RFID tag for automating the process. User is provided with an android app for registering for his vehicle registration number. A wallet is linked with vehicles registration number. Driver can add money in advance in wallet. Vehicle is embedded with a RFID tag for identification of vehicle at tool booth. RFID tag is sensed from distance of 500 meters and linked wallet is deducted for chargeable amount. Driver can experience smooth pass at tool without a pause for passing process. The digital receipt is sent to registered mobile number into application for log keeping. This system which is a low maintenance method that would make the model an economical solution.An advantage of using this system is the simplicity of the setup and how each element is interlinked with the other.

REFERENCES

[1] Aniruddha Kumawat, Kshitija Chandramore, "AUTOMATIC TOLL COLLECTION SYSTEM USING RFID",International Journal of Electrical and Electronics Research ISSN 2348-6988 (online)

[2] Kamarulazizi K., Ismail W., "Electronic Toll Collection System Using Passive RFID Technology". Journal of Theoretical and Applied Information Technology.

[3] S.Nandhini, P.Premkumar,"Automatic Toll Gate System Using Advanced RFID and GSM Technology," IEEE Transactions on Signal Processing, Vol.3, Issue 11, November-2014.

[4] K. Senthil, Choudhury R., Basavaraju S., *"Automated Toll Collection System using NFC*", SSRG International Journal of Computer Science and Engineering, Vol 4, Issue 3, March-2017.

978-1-5090-6785-5/18/$31.00 © 2018 by IEEE