International Journal of Computer Engineering & Technology (IJCET)
Volume 9, Issue 3, May-June 2018, pp. 132–139, Article IJCET_09_03_015
Available online at http://www.iaeme.com/ijcet/issues.asp?JType=IJCET&VType=9&IType=3
Journal Impact Factor (2016): 9.3590(Calculated by GISI) www.jifactor.com
ISSN Print: 0976-6367 and ISSN Online: 0976–6375

IOT BASED TOLL COLLECTION SYSTEM USING IMAGE PROCESSING

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ABSTRACT

The conventional toll collection system is time consuming, results in traffic jams and is inefficient. This paper provides solution to this problem by automating the process of toll collection. The system provides fast toll collection and automatically controls the vehicle movements at toll plaza through Image Processing. There are RFID and FASTag which requires a smart device or smart tag to be attached with the car. Here we propose such a system, so that neither anything needs to be installed at toll plaza nor anything needs to be attached with car, as the processing can be done from the video received through CCTV installed at toll plaza. In this system we eliminate waiting time at toll plazas and make the entire process automated.

Key words: IOT, Image Processing, OpenALPR, Toll Plaza, Automation.

Cite this Article: IOT Based Toll Collection System Using Image Processing, Malvik Patel, Bharavi Joshi, Kajal Bhagat and Hetakshi Desai and Jekishan K. Parmara. *International Journal of Computer Engineering & Technology*, 9(3), 2018, pp. 132–139.
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1. INTRODUCTION

Due to the increasing number of vehicles, the traffic is increasing at the toll plazas. There are long queues on busy highways. Nowadays people prefer to use their personal vehicles instead of public transports which results in increase of traffic. Increasing number of vehicles on the roads, result into many problems such as congestion, air pollution and fuel wastage etc.

Most of the toll plazas are operated manually, where there is an operator on each lane for collecting the toll amount i.e. for every lane there are two operators one for operating the system and the other for interacting with the driver. So huge manpower is required. One more thing

which results in congestion is the drivers sometimes start chitchatting with the toll operator, hence the vehicles waiting in the queue gets irritated and may result in chaos.

Conventional Toll Collection Systems includes manual as well as automatic collection which is based on reliable technologies like LCD monitor, touch screen monitor, industrial computers, fast toll barriers, different sensors etc. They use various sensors for vehicle classification like axle, height, length etc. This cost of the sensors can be reduced by implementing the proposed system.

2. LITERATURE SURVEY

Today, there are some automated systems developed at the toll plazas like the RFID based FASTag Systems, Electronic toll collection systems.

2.1. 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, results in wastage of fuel and time. Another issue is that one needs to handle cash and even wait for getting the change [1].

After paying the toll tax, a receipt is provided which one needs to preserve when the ticket purchased is a return ticket. In the manual toll collection system, let us assume that 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 [2]. The approximate CO2 emission per litre of diesel fuel is 2.68kg, and for petrol it is approximately 2.31kg. LPG produces around 1.51kg per litre [11] which results in pollution.

2.2. Electronic Toll Collection System

Electronic Toll Collection System utilizes Radio Frequency Identification (RFID) [5] technology. A RFID tag is mounted on each vehicle with unique ID. This ID is invisible on tag, it contains all the information about the vehicle and owner. When vehicle reaches at toll plaza tag will emit the radio wave signal. RFID reader receives the signal from tag, decode that signal and send to the ARM controller [6]. The controller will display the vehicle number and amount on LCD. Microcontroller is interfaced with computer to collect the vehicle data through serial port for future use. When accessed form database, it shows all the vehicle details on computer screen such as ID, vehicle number, date and time. Microcontroller checks the balance, if sufficient balance is there, it deducts predefined amount from prepaid account and update the balance in that account [5].

2.3. FASTag

FASTag is an electronic toll collection system in India, operated by the National Highway Authority of India [7]. The system was initially set up as a pilot project in 2014 on the stretch

of the Golden Quadrilateral between Ahmedabad and Mumbai. The system was implemented on the Delhi - Mumbai arm of the Quadrilateral on 4 November 2014.

FASTag is a simple to use, reloadable tag which enables automatic deduction of toll charges and enables one to drive through toll plazas without stopping for the cash transaction. FASTag is linked to a prepaid account from which the applicable toll amount is deducted. The tag employs Radio-frequency Identification (RFID) technology and is fixed on the vehicle's windshield. FASTag can be recharged by making payment through cheque or online through Credit Card/ Debit Card/ NEFT/ RTGS or through Net Banking. FASTag account can be recharged up to a maximum of Rs 1 lakh and a minimum of Rs 100. Toll Plazas may have a dedicated FASTag lane or provision for validating FASTag through a handheld reader [1]. You need to have some balance in FASTag in advance whenever you travel.

3. ISSUES/CHALLENGES IN EXISTING SYSTEMS

3.1. Existing system

Today, there are two types of toll collection system. Either all the vehicles have to stop at toll plaza on the highway to pay the toll tax, where one person collects the money and provides a receipt, after which barrier is opened either mechanically or electronically or the other is smart card system i.e. RFID based FASTag systems, in which FASTag is attached to the windshield of the car and when the car reaches near the toll plaza, the hardware sensors installed at the toll plaza detects the tag and specific amount is deducted from the user's card. User needs to recharge the tag with appropriate amount.

3.2. Drawback of existing system

The existing system for toll collection is time consuming and also you need to stand in queues, wait for the attendant to provide change and when the ticket is return ticket then you need to preserve the receipt. This process results in traffic jams. For RFID/FASTag systems, the user and the toll plaza needs to install RFID/FASTag readers.

4. PROPOSED WORK AND RESULTS

4.1. Proposed Solution

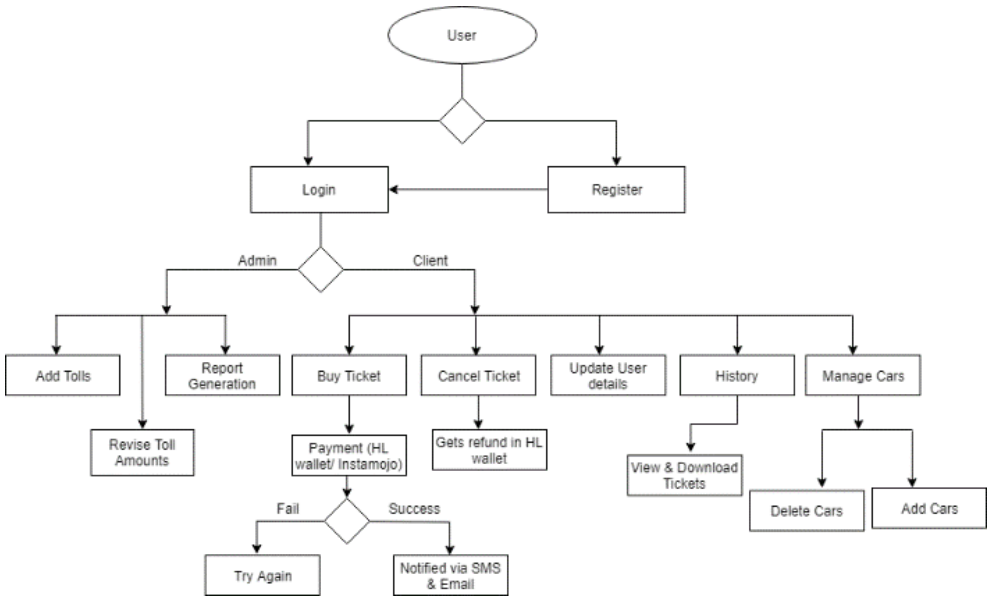

Figure 1 Flow of the System

The system designed is very simple and provides automatic toll collection using Image Processing. For the user, there is web app as well as android app. The user needs to register and then after the person can buy tickets for different toll plazas with different cars. Purchasing of tickets is done sitting at home. One can easily cancel the ticket, if he doesn't wish to travel. User's account also maintains the history for the previously bought tickets. The user can even download the ticket from it.

For the users, ticket can be booked using web app or android application. User has the feasibility to even add multiple cars.

The Admin side of the system contains a webapp in which admin can manage toll plazas. Managing Toll plazas include adding new tolls when new toll plaza are installed on any highways, revising the toll amounts if any and report generation.

When the User books the ticket for any toll plaza, payment is done by Instamojo Payment Gateway [8]. There is a wallet for each user so that the amount will be saved in it and will be deducted only when the user reaches the toll. So the user can even use wallet amount for buying any other ticket. After the successful payment, the user will get an SMS stating his ticket id. After having bought the ticket, when vehicle reaches near the toll plaza, the camera fixed there detects the car's number plate and checks for its ticket in database. If the user has purchased the ticket, barrier will be opened using IR sensors [9] placed near to the toll plaza. The camera installed at the toll plaza will detect the car and then extract the car's number through Raspberry Pi using Image Processing algorithms. On successful completion of verifying the ticket, the barrier will be opened and after crossing the toll, another IR sensor will detect the car and the barrier will be closed.

4.2. Implementation

The basic block diagram in Figure 1 shows the concept of Automatic Toll Tax collection using Image Processing.

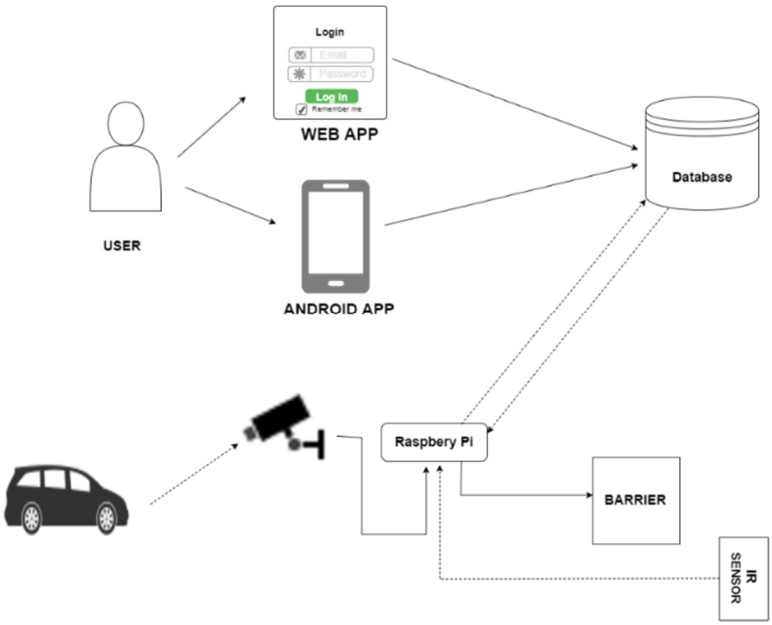

Figure 2 Block Diagram of the System

The use of raspberry pi in the project to capture image and to verify the vehicle with python based GUI (tkinter), apart from this it is used for controlling various sensors, LEDs, servo motor etc.

- First of all, raspberry pi is booted, python program is initiated, where the GUI will be displayed for camera and the current ongoing process of the program will be displayed.
- As soon as, the Infrared Sensor (IR-Sensor) get input, it captures the image and with help of Cloud API of OpenALPR [3] number plate is recognised and JSON [10] string is returned, which is further processed by raspberry pi.
- After processing of JSON string the number plate is verified with centralised database, to check whether ticket is booked or not, again the JSON string is returned for server.
- If the ticket is booked, then with help raspberry pi servo motor is controlled and gate is opened. At the end of lane there is another IR-sensor which detects the vehicle.
- Once the vehicle is detected, raspberry send signal to servo motor to close the gate.

If captured image fails to recognise the number or faulty number is recognised a dialog box will inflate so that operator can enter the correct Licence plate.

The prime purpose of using raspberry pi is to make light weight, cost efficient and user friendly system. As it operates on raspbian OS [4] which is an open source Linux OS. It is easy to integrate with the current system. No additional cost is required for integration. Maintenance for system is also easy.

4.3. Features

- User can cancel the ticket without any transaction cost.
- If user buys multiple ticket, and travels only once in 24hrs, then fare for single trip will be charged.
- Easy maintenance of tickets.
- The main feature of our project is that the openALPR module detects a wide range of fonts and not just a predefined set of templates. This makes the number plate recognition more efficient.
- Admin panel is there for report generation, revising toll amounts and adding new Toll plazas.

4.3. Comparison with old system

	Conventional System	Proposed System
Time Consumption	High	Low
Fuel wastage	High	Low
Traffic	High	Low
Processing	High	Low
Payment Mode	Cash/Debit Card/Credit Card	All types of Online Payment Modes

5. SCREENSHOTS

- User can Buy Ticket by selecting specific car and the toll name and the app provides feature to cancel the ticket which is previously bought.

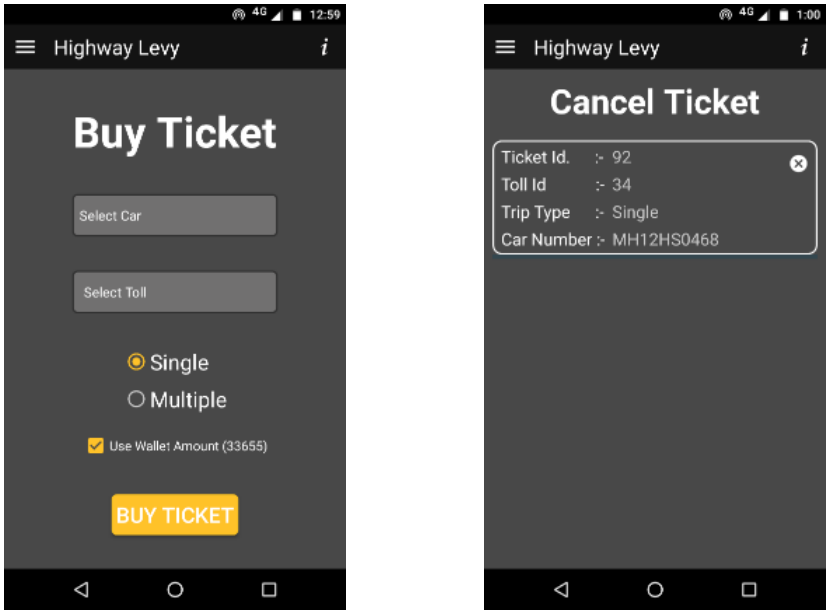

Figure 3 Screenshot of Android Application

- Toll amounts received by specific Toll plaza in specific time period and All Tickets generated for particular tolls with the ticket id, car no., time and amount will be displayed and report can be downloaded by the Admin.

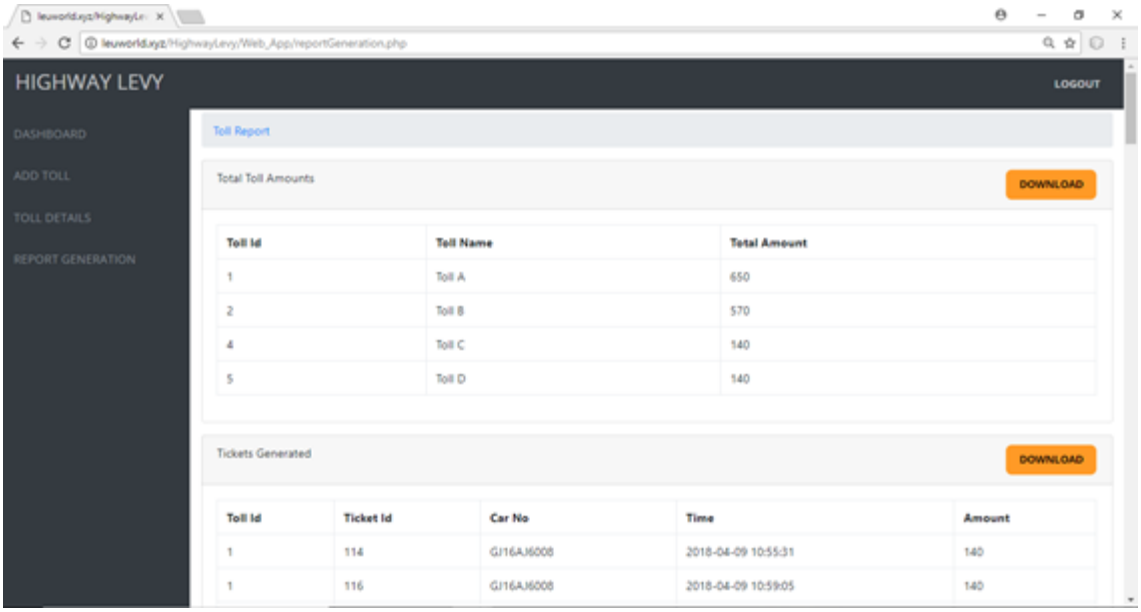

Figure 4 Screenshot of Web Application(Admin Panel)

- This is home page for the user. User can Buy Ticket by selecting Toll and specific car.

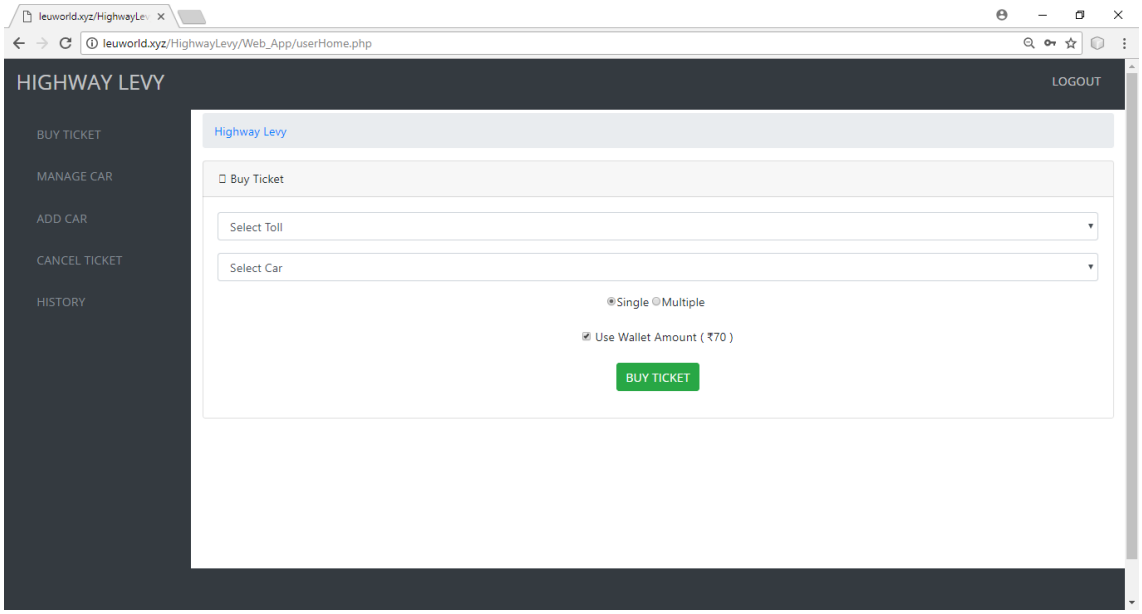

Figure 5 Screenshot of Web Application (User Side)

- This is the GUI for raspberry pi which shows the detected Number plate when car reaches near the Toll plaza.

Figure 6 Screenshot of GUI of Raspberry Pi

6. CONCLUSION

The automated toll collection system will help in greatly reduce the time required to complete the process of issuing toll receipts and enable the whole system to be swifter. The system also eliminates possibility of any kind of human error that might be possible with the conventional toll collection systems. There will be also great reduction in carbon emissions as well as fuel consumption as the car needs not to stop at the toll plazas. This system in this way paves way to a cleaner, greener and swifter process as compared to the current system.

REFERENCES

[1] A Comparative Study of Toll Collection Systems in India <http://www.ijerd.com/paper/vol13-issue11/Version-1/I131116871.pdf >

[2] Omarhommadi1, Hussain Asiri, Mamdoohalzahrani, Comparison of Different toll collections system's and RFID tool collection system, American Journal of Engineering Research (AJER) Volume-6, Issue-1, pp-118-121 <http://www.ajer.org/papers/v6(01)/R0601118121.pdf>

[3] openALPR <https://www.openalpr.com/cloud-api.html>

[4] Raspbian <https://www.raspberrypi.org/downloads/raspbian>

[5] Amol A. Chapate, D.D. Nawgaje, Electronic Toll Collection System Based on ARM, International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 1, January 2015 <http://ijsetr.org/wp-content/uploads/2015/ 01/IJSETR-VOL-4-ISSUE-1-46-49.pdf>

[6] ARM Processor <https://whatis.techtarget.com/definition/ARM-processor>

[7] FASTag <http://www.fastag.org/>

[8] Instamojo <https://www.instamojo.com/>

[9] Vehicle Detection Sensors <https://www.bannerengineering.com/ in/en/products/capabilities/vehicle-detection.html#all>

[10] JSON <https://www.json.org/>

[11] Fuel CO2 calculator <https://www.drivingtests.co.nz/resources/ fuel-co2-calculator-carbon-dioxide-emissions-in-kg/>