

User Authenticated Electronic Toll Collection System using Image Processing

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Abstract: *Now a day there is a huge rush at the toll plazas in order to pay the toll tax. On any toll plaza the vehicle has to stop for paying the toll amount. Hence we are trying to develop a system that would pay the toll amount automatically and reduce the rush at the toll plaza. In our system user registration is done with information like name, address, mobile number, vehicle plate number, vehicle type, etc. Camera is used to capture number plate of vehicle. System will check the database, if match is found then toll amount will be deducted from the user's account and then gate will be open. Notification will be sent to the user via message. Our system is able to count the total number of vehicles that are passing through the toll plazas. By doing automation of toll plaza we can have the solution over money loss at toll plaza by reducing the man power required for collection of money and also can reduce the traffic at toll plazas which indirectly resulting in the reduction of time at toll plaza.*

Keywords: Image Processing, Toll Collection, Automation, Unique Identification, Raspberry Pi

I. 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. Today's most important problem is the number of hours a person spends traveling on roads. The next is the increasing number of vehicles and thus the traffic congestion. This causes the vehicles to wait for several minutes in the toll booth queues and thus waste precious time. There are toll collections systems, which have implemented are used in India and these systems have disadvantages that lead to some errors in the corresponding system. The technologies are developed to support better toll collection like RFID, Barcode readers. But they are not meeting factors like feasibility, reliability and cost. The proposed system is feasible, efficient and more practical for toll collection. The proposed system solves all these issues as the transaction process is done within seconds and payment is in digital form which keeps no scope of manual operation. This system will also lead to less air pollution and faster traveling. This proposed system is based on image processing. The system is implemented using OpenCV method and Optical Character Recognition. Automatic Toll Collection systems are designed and developed to cooperate in the operations of toll

management through the use of technology. These systems collect data through the vehicle number and collect the amount according to the type of vehicles passing through the booth. Now a day the Automatic Toll Collection system is becoming more and more popular. Unlike manual toll collecting system which requires collector or attender they do not require manual collector for their working. There are some toll collection systems which are existing from very long duration still they are perform the operation of collecting toll tax from vehicles. From these systems transparency is not provided. Transparent systems play an important role in toll collection such that there will be no corruption regarding toll. The proposed system in this paper is transparent to appropriate toll collection.

II. LITERATURE REVIEW

After that many electronic toll collection systems are implemented with different techniques. Some of them are as follows:

System proposed in [1] uses Wi-Fi for communication with the Smartphone of user. This phone contains all necessary data related to the user registration. User is registered at toll booth automatically as he passes through. But in countries with less Smartphone penetration, system may not work effectively. System proposed in [2] uses overhead camera to detect number plate and uses it as the account number of the user. Database is stored in central server. But deterioration of number plates or duplicate numbers may introduce false positives in the system. System proposed in [3] uses NFC chips for detection of vehicle identity. The NFC chips are designed to work in the close vicinity of reader. If the distance between reader and chip is more than critical limit, system will not detect the vehicle. RFID tags needs no battery as they can work perfectly with the power transmitted by RFID reader [4]. Unlike number plate physical wear and tear has no harm. Distance of tag from reader is no issue as high power radio waves can detect the tag up to sufficient distance. Unlike Wi-Fi it does not require any authentication hence faster than system proposed in [5] more to this the raspberry pi based toll collection system provides a cost effective implementation as components are fairly inexpensive[6]. In earlier stages, toll collection systems are manual toll collection system. They do not create digitally printed receipt for people who are passing through the booth. Inside they require a collector, the toll collector classifies the vehicles [7], collects the toll, dispense the change and provide receipt. This method is not easy to perform. This method of payment was used to stop the vehicles at toll station and wait for relatively long time for their turn to come [8], more consumption of fuel and also pollution level get increased in that region. This was also causing congestion of traffic. Because of congestion and inefficiency, the Automatic Toll Collection system [9] which will solve the problem of congestion, inefficiency and facilitate convenience for all who involved in the process of toll collection directly or indirectly.

III. SYSTEM OVERVIEW

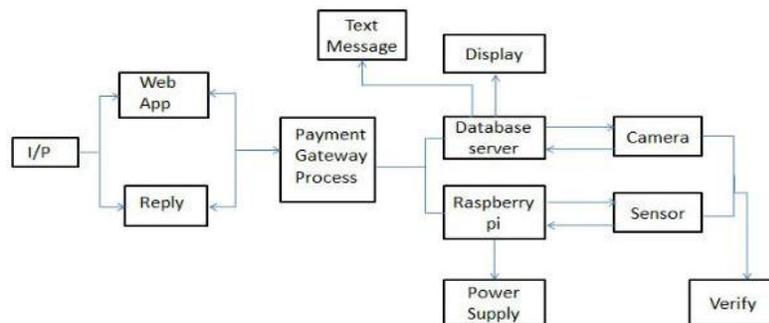


Fig.1 Block diagram of system

The system designed is very simple and provides user authentic 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 select the trip and root of travel. After selection root android app will give information about number of toll plazas will cross toward his trip. App will also give number of Rs. He needs to pay for all toll plaza according to his vehicle type with different cars. Payment processing is done sitting at home. User can also book return trip if he is coming from the same root. One can easily cancel the trip, if he doesn't wish to travel. User's account also maintains the history for the previously travelled

trips. This trip can be booked using web app or android application. The Admin side of the system contains a webapp/android app in which admin can manage toll plazas. Managing Toll plazas include adding new tolls when new toll plaza is installed on any highways, revising the toll amounts if any and report generation. When the User books the trip for toll plaza, payment is done by Payment Gateway. After the successful payment, the user will get an SMS stating his trip id. After having booked trip, when vehicle reaches near the toll plaza, the camera fixed there detects the car's number plate and checks for its trip in database. If the user has done payment through android app, barrier will be opened using IR sensors 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 car no in database and will check payment have done or not for this user, the barrier will be opened and after crossing the toll, another IR sensor will detect the car and the barrier will be closed. After crossing the vehicle. Data from the payment done for this car will be vanish for the single trip.

3.1 Raspberry Pi

Raspberry Pi is a small single board computer. By connecting peripherals like Keyboard, mouse, display to the Raspberry Pi, it will act as a mini personal computer.

Raspberry Pi is popularly used for real time Image/Video Processing; IoT based applications and Robotics applications. Raspberry Pi is slower than laptop or desktop but is still a computer which can provide all the expected features or abilities, at low power consumption.

Raspberry Pi Foundation officially provides Debian based Raspbian OS. Also, they provide NOOBS OS for Raspberry Pi. We can install several Third-Party versions of OS like Ubuntu, Archlinux, RISC OS, Windows 10 IOT Core, etc.

Raspbian OS is official Operating System available for free to use. This OS is efficiently optimized to use with Raspberry Pi. Raspbian have GUI which includes tools for Browsing, Python programming, office, games, etc. We should use SD card (minimum 8 GB recommended) to store the OS (operating System). Raspberry Pi is more than computer as it provides access to the on-chip hardware i.e. GPIOs for developing an application. By accessing GPIO, we can connect devices like LED, motors, sensors, etc and can control them too.

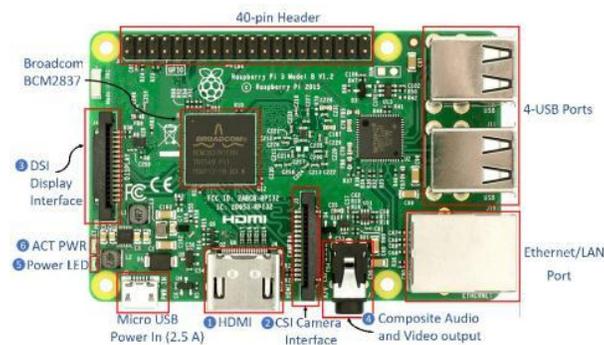


Fig.2 Raspberry Pi

3.2 Raspberry Pi Camera

The Raspberry Pi Camera Board plugs directly into the CSI connector on the Raspberry Pi. It's able to deliver a crystal clear 5MP resolution image, or 1080p HD video recording at 30fps! Latest Version 1.3! Custom designed and manufactured by the Raspberry Pi Foundation in the UK, the Raspberry Pi Camera Board features a 5MP (2592x1944 pixels) Omni vision 5647 sensor in a fixed focus module.

The module attaches to Raspberry Pi, by way of a 15 Pin Ribbon Cable, to the dedicated 15-pin MIPI Camera Serial Interface (CSI), which was designed especially for interfacing to cameras. The CSI bus is capable of extremely high data rates, and it exclusively carries pixel data to the BCM2835 processor. The board itself is tiny, at around 25mm x 20mm x 9mm, and weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. The sensor itself has a native resolution of 5 megapixel, and has a fixed focus lens onboard.

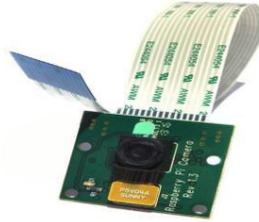


Fig.2 Raspberry Pi Camera

3.3 Methodology

Once the image is captured, the raspberry pi process the image and extract the vehicle number from that captured image. The following steps are followed to detect and extract the vehicle number from the image:

- Step 1: Capture the image
- Step 2: Convert the color image into grey image
- Step 3: Smoothing the image by filter
- Step 4: Finding the edges using canny edge detection
- Step 5: Drawing the edges using the contour line method
- Step 6: Finding the number plate shaped rectangle using find contours method.
- Step 7: Crops the image of the number plate
- Step 8: Number extraction from Optical Character Recognition

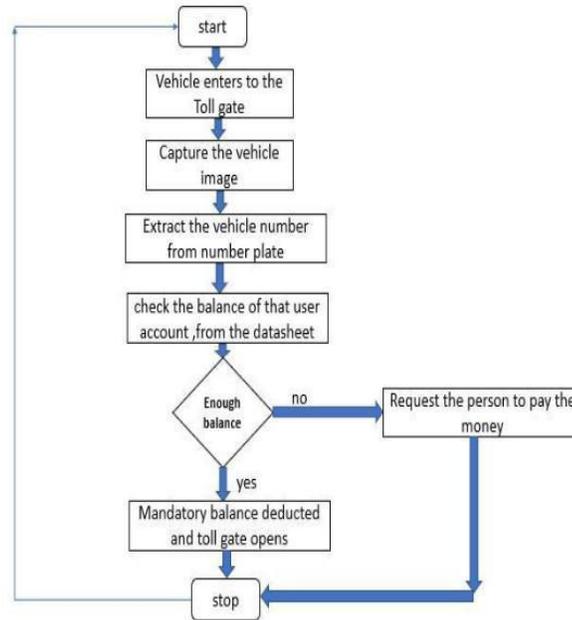
The resulting vehicle number is then compared with the available database of all the vehicles so as to come up with information about the vehicle type & to charge toll tax accordingly. The Automatic toll system is interfaced with hardware model & database to make an automated toll tax collection system. The hardware model consists of proximity sensor to detect the presence of vehicle, a web camera to capture the image, motors to open/close the road barriers of toll plaza on which this algorithm is executed, LCD & seven segments display & a Raspberry pi for controlling all the components of hardware model. As the vehicle arrives at toll plaza, the inductive proximity sensor detects the vehicle and gives a signal to the Raspberry pi. The camera connected to the Raspberry pi captures the image of front view of the vehicle & applies number recognition algorithm on the image to recognize the vehicle's license number. This number is then used to charge toll tax & generate receipt containing all the information of vehicle. Also, all the information such as time, date, plate number & toll amount is stored in database to maintain the record. PC then sends the signal to Raspberry pi. This system is connected online; this system will check the balance of that specific vehicle owner. If the balance is enough as per the toll booth fee, then the Raspberry pi will give the logic signal to the motor drive circuit the motor will clear the path to pass the vehicle. Similarly, if the vehicle owner balance is not enough as per toll both fee then the microcontroller will not give the logic signal to the motor drive circuit will not drive the motor to clear path to pass the vehicle. Continually this condition, the Raspberry pi will send the logic signal to then it will display that the amount is not enough in your account kindly pay the Toll charges.

3.4 Flow Chart

OCR (optical character recognition) is the use to distinguish printed or handwritten text characters inside digital images of physical documents, such as a scanned paper document. The basic process of OCR involves examining the text of a document and translating the characters into code that can be used for data processing. The resulting vehicle number is then compared with the available database of all the vehicles so as to come up with information about the vehicle type & to charge toll tax accordingly. The Automatic toll system is interfaced with hardware model & database to make an automated toll tax collection system. In order to control the toll gate, different cases of money debiting will be used depends on the amount in that account of the user in the database of the vehicles. Different cases are

1. Sufficient money is present in the account
2. Insufficient money in the account

3. Account not exist
4. Already paid the toll due on that day.



IV. CONCLUSION

In a populated country like India implementing new techniques is extremely difficult and this technique can be easily implemented without much change to the current toll system and also with least expense. Collect money from the vehicle owner at toll gate is very time taken process then automated the toll gate, it would take very less time and also no need of human interference. This paper concludes that if properly implemented, E-Toll system can help the society to achieve proper traffic and time management. This can also be extend to identifying the theft vehicles and inform that to nearest station.

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