

Electronic Toll Collection System Using ANPR

KVBL Deepthi¹, CH. Sandhya², CH. Samyuktha³, V. Sindhu⁴

¹Electronics and Communication, Assistant Professor, Maturi Venkata Subba Rao, Engineering College, Affiliated to Osmania University
deepthikvbl_ece[at]mvsrec.edu.in

²Electronics and Communication Engineering (B. E), Maturi Venkata Subba Rao, Engineering College, Affiliated to Osmania University
sandhya.chunchu26[at]gmail.com

³Electronics and Communication, Engineering (B. E), Maturi Venkata Subba Rao, Engineering College, Affiliated to Osmania University
samyukthaareddy26[at]gmail.com

⁴Electronics and Communication Engineering (B. E), Maturi Venkata Subba Rao, Engineering College, Affiliated to Osmania University
sindhureddyvelumala[at]gmail.com

Abstract: *This paper proposes the Raspberry pi based toll collection system for automatic toll tax collection. It implements an automatic electronic toll collection system using Raspberry Pi and the image processing technology which uses a vehicle's number plate to identify the vehicle and collect the respective tax. The system is implemented using the ANPR algorithm for the extraction of number plate characters from the image such that we would take images of the vehicle which is sensed from distance using IR sensor and give the images as input to image processing where the number plate will be extracted, segmented and it is simulated using python's OpenCV and other OCR libraries. The extracted number plate characteristics is again given as input to Raspberry pi and it verifies with the data present in the database and if it matches then the toll will be collected according to the vehicle's parameters. And after the toll is collected, the gate would automatically open. If the vehicle number plate is unauthorized or not available in the database then it will send a message to pay money manually.*

Keyword: Python, OpenCV Raspberry pi 3, IR Sensor, Toll collection, vehicle identification

1. Introduction

Electronic Toll collection system is a wireless system which can be implemented in our day to day life. Tolls are collected in order to pay the debt on the securitized bonds that paid for the construction of roads. Generally government invites the investments from private players under Build Operate and Transfer (BOT) scheme under which they will construct the roads, maintain them and collect the toll up to an agreed term. The amount of toll determined based on the length of the stretch of toll road (usually 60km). If this is less, you will be charged based on the actual length of the road. Other factors are infrastructure type and IR sensor to detect the unique ID and store it in a microcontroller. There is a delay in barcode reading and microcontroller (bridge, tunnel, bypass, etc....) and also the vehicle's axle count, load etc.

Automatic toll collection system is the smartest way to reduce human errors, reduce traffic delays which in turn reduces air pollution, keep track of any car that might not be correctly registered and also find the stolen vehicle. It is aimed at making toll taxation more efficient, reliable, and safe and environment friendly. It saves the time and reduces the traffic congestion.

The system uses Automatic Number plate Recognition (ANPR) which is fast and efficient.

2. Existing System & its Problems

There are different existing systems that are developed for toll collections. The most widely used system is RFID tag where there is an RFID tag reader present to read the tag. Every vehicle has a unique tag which contains user details

and vehicle information. But RFID tags require maintenance and there can be situations where the RFID tag would be torn and wouldn't work while reading the tag. And RFID tag readers won't work most of the time and the worker would come with a hand - held reader which would take more time. Another most widely used toll collection system is Barcode Scanner. It uses Capacitive Sensor to sense the vehicle size

3. Proposed System

The proposed system mainly aims to make a digital toll collection system which will be less time consuming and automated monitoring and control of vehicle entry - exit in highways using the Raspberry pi system. The proposed system requires only a number plate of the vehicle and camera which is already installed in the toll plazas. At the entrance of the toll gate, the camera captures an image of the vehicle and from that image the number plate is extracted then that extracted number is verified with the authorized registered plate number stored in the database. Raspberry Pi is connected with that database for verification of registered data with the image processing tool OCR.

If the verification is successfully done with the comparison of the registered database information, then it is processed by Raspberry Pi to authorize entry and exit of the vehicle. When the authorized vehicle was detected then the system operates the gate using DC motor. Automatic Number Plate Recognition (ANPR) system is very much useful in applications like, automated traffic surveillance and tracking system, automated highway/parking toll collection systems, automation of petrol stations, traveling time monitoring.

Rules for Indian Number Plate

The Indian number plates following the new format can be of lengths 8, 9 or 10. Format of the registration is as shown below.

AA 11 BB 1111

Where AA indicates two letter state code; 11 indicates two digit district code; 1111 indicates unique license plate number and BB are the optional alphabets if the 9999 numbers are used up.

4. Hardware Description

IR SENSOR is the first stage of this system which is placed at some distance from the toll plaza so that it generates the signal when it detects the vehicle. The IR sensor interfacing is shown as below.

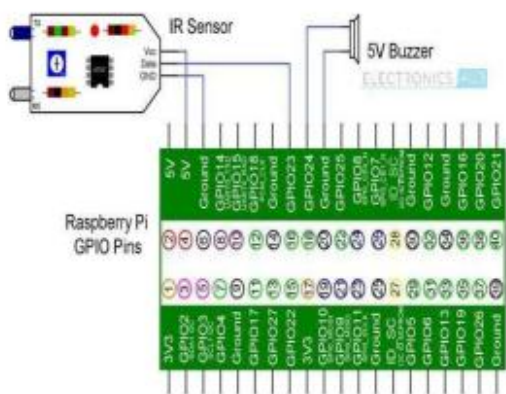


Figure 1

An infrared sensor is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detect the motion.

SERVOMOTOR is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback.



Figure 2

RASPBERRY PI is a low cost, credit - card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.

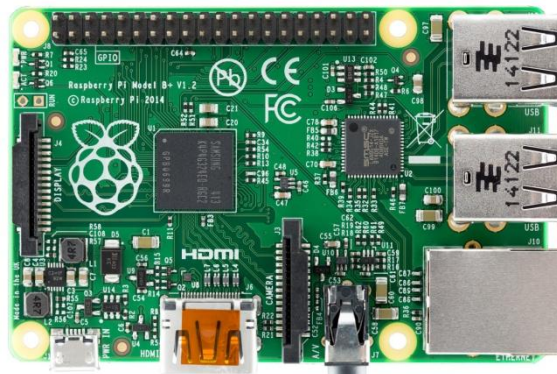


Figure 3

CAMERA - 16 MP Web Camera with 6 digit light is used



Figure 4

5. Design and Implementation

The block diagram of automatic toll system is shown below:

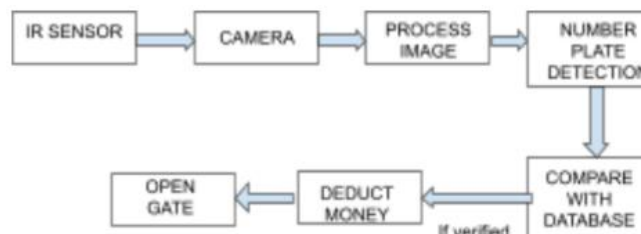


Figure 5

The first stage of this system is to detect the vehicle when it arrives at the tollgate. This detection can be done by using the sensors. Here the IR sensors are used to detect the vehicle. The IR sensor is connected to one of the GPIO pins of raspberry pi and if the vehicle is detected then it sends the signal to the controller. The IR sensor is placed at a distance from toll gate so that camera will take pictures and completes the process before vehicle reaches the toll gate. Camera takes the images of the vehicle's number plate and gives input to image processing. The system uses infrared lighting to take picture anytime of the day.

The next stage in the block diagram is image processing. Digital image processing is the use of computer algorithms to create, process, display digital images. Digital image processing algorithms can be used to:

- Convert signals from an image sensor into digital images
- Improve clarity, and remove noise
- Extract the size, scale, or number of objects in scene
- Prepare images for display or printing

- Compress images for communication across a network

The next stage is number plate detection in which the image is segmented and the useful information from the images is extracted. In this case, the characters in the vehicle number plate are extracted. This stage is followed by comparison with database contents. The database is created and all the valid user and vehicle details are stored. A local computer of every toll plaza is connected to a central server through the Internet. The extracted character from image segmentation is compared with characters from database and if it matches, the gate is automatically opens after deduction of toll. If it doesn't matches, the vehicle user has to manually pay the toll. Thereafter, the worker opens the gate by push button. The servo motor is used as gate to open and close after collecting tolls.

The process is shown in the form of flowchart given below:

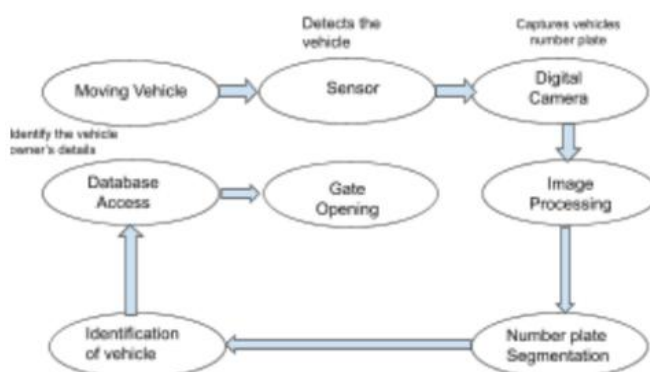


Figure 6

The whole setup of the system is shown in the figure in which a number plate image was taken and Raspberry Pi server was set up in another system along with a manual push button for manually allowing the vehicles which are not registered to be available in the database.



Figure 7



Figure 8

Case 1: The number plate image is captured, segmented and characters are recognized through OCR and displayed as shown in Fig: 10. Since the given number is available in database in this case corresponding number is validated from the database and the gate is opened (servomotor is rotated) as shown in the fig: 9.



Figure 9

```

sudo
File Edit Tabs Help
main()
File "/home/pi/automatictollgate/plate_recognition.py",
e 292, in main
stringplatenum = str(plate_values[0])
IndexError: list index out of range
Recognized LP Number:
TN57AD3604
True
---VALID NUMBER PLATE AVAILABLE IN DB ----
Input was LOW
-----
Traceback (most recent call last):
File "/home/pi/automatictollgate/plate_recognition.py",
e 302, in <module>
main()
File "/home/pi/automatictollgate/plate_recognition.py",
e 292, in main
stringplatenum = str(plate_values[0])
IndexError: list index out of range
Recognized LP Number:
TN57AD3604
True
---VALID NUMBER PLATE AVAILABLE IN DB ----

```

Figure 10

6. Results

A proposed system prototype is developed. This prototype model is implemented and stimulated in Python using OpenCV and other libraries. The performance is tested. The prototype model is as shown in the Fig:

Case 2: The number plate image is processed according to the ANPR algorithm and since the number is not available in the database, it is not validated from the database when checked. Hence, the gate is not opened (servomotor is not rotated) as shown in the fig: 11 and the same is displayed in the sudo terminal as shown in fig: 12

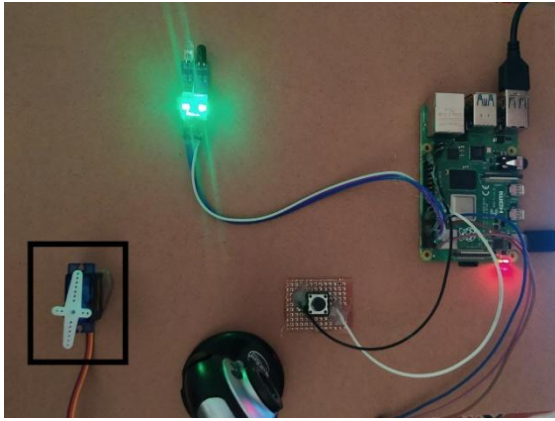


Figure 11

```

sudo
File Edit Tabs Help
File "/home/pi/automatictollgate/plate_recognition.py", line 75, in rec
n_api
    response = requests.post(
File "/usr/lib/python3/dist-packages/requests/api.py", line 119, in post
    return request('post', url, data=data, json=json, **kwargs)
File "/usr/lib/python3/dist-packages/requests/api.py", line 61, in requ
    return session.request(method=method, url=url, **kwargs)
File "/usr/lib/python3/dist-packages/requests/sessions.py", line 542, in
st
    resp = self.send(prepare, **send_kwargs)
File "/usr/lib/python3/dist-packages/requests/sessions.py", line 655, in
    r = adapter.send(request, **kwargs)
File "/usr/lib/python3/dist-packages/requests/adapters.py", line 516, in
    raise ConnectionError(e, request=request)
requests.exceptions.ConnectionError: HTTPSConnectionPool(host='api.plater
er.com', port=443): Max retries exceeded with url: /v1/plate-reader/ (Caus
NewConnectionError('<urllib3.connection.HTTPSConnection object at 0x7f8a2
Failed to establish a new connection: [Errno -3] Temporary failure in nam
lution'))
Recognized LP Number:
TN117
False
***** NUMBER PLATE NOT AVAILABLE IN DB PAY MANUALLY *****

```

Figure 12

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7. Conclusion

The performances of this automated electronic system make it an efficient choice among its competitors especially in those situations when the cost of the application has to be maintained at reasonable levels. This paper is helpful for the identification as well as detection of vehicle number plates. . There are several approaches taken to achieve this concept. In the future, cloud computing can be used, which will be very helpful for storing the data permanently.

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