

ANPR Implementation in Toll Tax Collection

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Abstract— Today, due to the increase in vehicles, there is a lot of gathering of the traffic at toll booths. The main reason for this traffic at toll booths is due to the manual intervention working of the toll tax collection at the booth. Our product will automatically collect toll taxes. Our Product is designed to automatically keep track of the vehicle's movement, record the time and details like the Owner's name, address, contact details, vehicle model, etc. This will help to improve the Tracking & monitoring of vehicles, traveling in predetermined routes. There is an immediate need for such kind of ANPR systems in India as there are problems of traffic, stealing vehicles. Toll collection automation can have the better solution over money and time loss at toll plaza by reducing the manpower required for collection of money and also can reduce the traffic indirectly resulting in a reduction of time at the toll plaza.

Keywords: RFID: Radio-Frequency-Identification, ML: Machine Learning, IOT: Internet of Things ANPR: Automatic Number Plate Recognition, OCR: Optical Character Recognition

I. INTRODUCTION

The automatic toll collection using ANPR is a technology that will allow the user to make the payment of highway tolls automatically. This system also allows authorities to keep track of blacklisted vehicles that pass through tolls. This terminology will, in turn, save time as well as the money by decreasing the waiting time as well as the queues of vehicles at the tollbooth. ANPR is a mass traffic surveillance method that uses OCR on images to read the license plates on vehicles. ANPR uses a special type of CCTV camera that is software assisted to help identify and capture license plate on still and moving vehicles.

There is a certain category of roads where you have to pay tax to travel on the road which is called Toll Roads. Toll tax is applied to the users of the toll road and its services. A tolled road doesn't stay a toll road forever, it collects tax until it gets an investment equilibrium. Most of the highway toll plazas are manually operated where an operator collects cash from the driver and provides a receipt. This procedure is slow, which often results in traffic jams at the toll plazas on busy highways. Although, there are some lanes where you can pay with change or cash, while there are also other lanes called express lanes where Special detectors sense vehicle's number plate and deduct amount directly from an account, such as a credit card or a bank account, whichever is connected to your vehicle database

II. PROBLEM STATEMENT:

Time and fuel wastage while waiting in long queues at collection points is a great problem. So, a preferred solution to this problem can be "Design an Automatic toll plaza which is based on the ANPR system to save time at the toll plaza and having cash free operation". Automation on the

process of the toll collection in order to gain the time and cost efficiency at toll collection booth is our main aim.

III. OBJECTIVE:

Here are some objectives about the ANPR based on OCR system which tells us about the purpose behind selecting this topic & the requirement of this type of project in our day to day life.

- To Save the time in collecting toll at the toll plaza.
- To avoid fuel loss.
- To reduce traffic congestion on highways.
- To avoid financial loss.
- To control the traffic.

According to the survey conducted by Karnataka Government in Sept. 2012, they proposed to get the annual toll collection of about 2500 crores/year, but in the present situation, they are able to collect only 900 crores of the total toll value. This indicates there is a loss of 600 crores due to human errors. So, this situation needs a proper solution to the financial leakage problem.

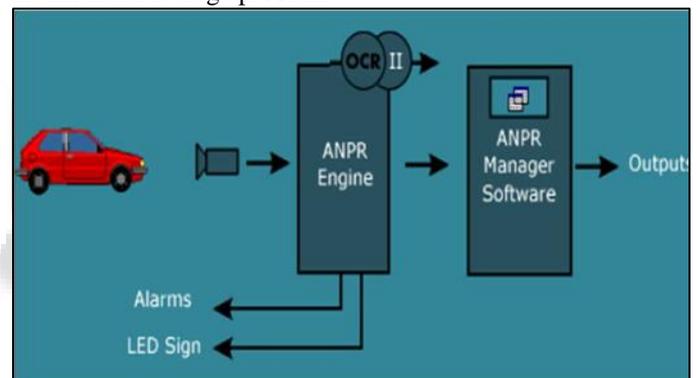


Fig. 1: ANPR [9]

Hence, automation can be a good solution to this problem. It will be a 4 stage process including image capture, processing, database searching, and final payment.

IV. ANPR SYSTEM:

ANPR is an image-processing technique which is used to track vehicle-les by their registered license plates. This expertise is an upcoming revolution in security and traffic installation. PC vision is a technique for using a PC to extract abnormal state information from a digital image. The ANPR system consists of the following steps:-

- 1) Vehicle image capture.
- 2) Preprocessing.
- 3) Number plate extraction.
- 4) Character segmentation.
- 5) Character recognition.

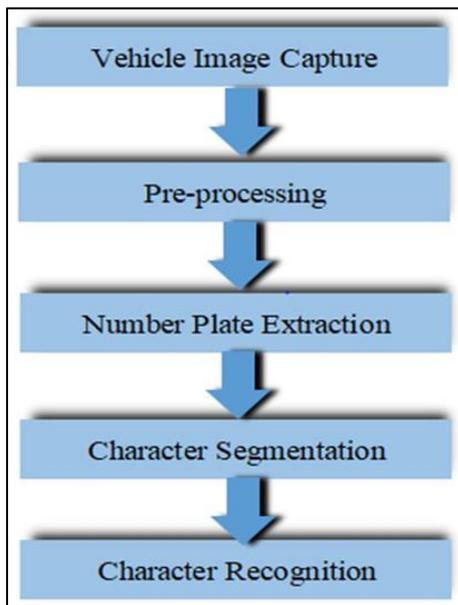


Fig. 2: Block Diagram of ANPR

The initial step in ANPR is the location of the vehicle and capturing a vehicle image of front or back perspective of the vehicle capturing the vehicle number plate, the second step is the localization of Number Plate and then extraction of vehicle Number Plate from an image. The final step use image segmentation strategy. For the segmentation, a few techniques such as neural network, mathematical morphology, color analysis, and histogram analysis are used. Segmentation is for individual character recognition. OCR is one of the strategies to perceive every character with the assistance of a database stored for the separate alphanumeric character.

V. ANPR SYSTEM MODEL:

ANPR system consists of four steps these are Image Capturing, License Plate extraction, character segmentation, and character recognition. ANPR takes into consideration the machine learning algorithms to execute the steps involved in ANPR.

A. Image Capturing

The initial step is capturing an image using the digital camera associated with the PC. These captured images are in RGB format so it can be the further process for the number extraction. The training database contains the information of the vehicle proprietor and a few plate vehicle images, abbreviations and acronyms to serves as the comparison dataset for further processing.



Fig. 3: Captured (RGB) image by digital camera[9]

B. Image Processing

The captured image is influenced by many elements like Optical system distortion, system commotion, lack of presentation, the inappropriate relative motion of camera or vehicle, etc. and thus the result is the degradation of a captured vehicle image and the unfriendly influence to the further image processing. Therefore before the main image processing, pre-processing of the captured image ought to be taken out which include converting RGB to gray in fig 3, clamor evacuation, and border enhancement for brightness.



Fig. 4.1: Preprocessed Image[9]



Fig. 4.2: Pre-Processed Image[9]

C. Plate Localization

The Basic start to the recognition of vehicle Number Plate is to identify the plate size. By python tensorflow arrays, the image matrix is analyzed to detect the plate location and availability in the current frame and binds it in a rectangle. It satisfies a set of properties for each marked region in the matrix. We used the bounding rectangular box to gauge the properties of the image region. In the wake of labeling the associated components, the region will be extracted from the input image. Number plate localization is shown in the figure.



Fig 5. Vehicle Plate Localization[9]

D. Plate Segmentation:

Number plate segmentation assumes an imperative role in the ANPR system. The essential thought after region growing is to remember one or more criteria that are qualified for the wanted region. The image is looked for pixels that satisfy the necessary criteria. At any point where such a pixel is experienced, its neighbors are checked, and if any of the neighbors likewise parallel the criteria, both the pixels are measured as have a place with the same region. We obtain individual character and number image by using vertical and horizontal scanning techniques.

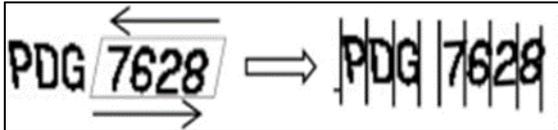


Fig 6. Plate Segmentation[9]

E. Character Recognition

This is the most important and basic phase of the ANPR system. It takes into consideration the techniques that were used to order and then perceive the individual characters. The classification is based on the extracted features. These features are then arranged using either the statistical, syntactic or neural methodologies. For the comparable characters, second identification is made with the technique for highlight point matching. Another method is that once the lines in an extracted vehicle number plate are separated, the line separation procedure is presently connected segment savvy so an individual character can be separated. The separated unique characters are then stored in separate variables. The extracted characters are taken from the number plate and the characters on the database which were stored are presently coordinated.

The next phase is template matching. Template matching is a proficiently trained algorithm for character recognition. The character's image is match up to the given dataset and the best resembling is considered. Another technique for character recognition is the optical character recognition (OCR) which is used to look at every individual character against the complete alphanumeric database. The OCR uses relationship strategy to match the individual character and finally, the number is recognized and stored in string format in a variable. The character is then contrasted and the database for the vehicle authorization is traversed for corresponding details. The resultant characters are analyzed according to the consequence of comparison. Templates exist for every one of the characters i.e. A-Z and 0-9 in the database as appeared in the figure.

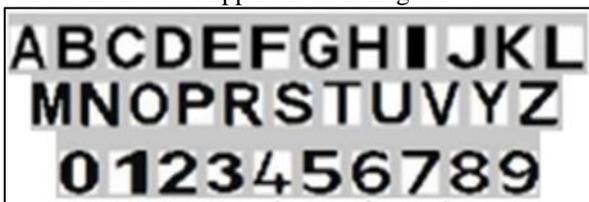


Fig 7. Database of templates[9]

VI. METHOD AND MATERIAL:

The hardware and software needs of the system were identified based on the data collected. The main hardware devices are the Arduino-Mega- board and two WebCam devices. The program codes are written in the Python programming language using the Arduino Integrated Development Environment (IDE), which is open source. PHP is used in the implementation of the backend that provides services for logging monitored data. Database content was created, accessed, and managed using MySQL, an open source Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). The web dashboard was designed using HTML and Flask. An object-oriented programming language was used to add more user interactivity to the web dashboard for toll administrators. The identity of the vehicle can be easily verified for appropriate toll fee deduction for the subscription of the vehicle owner. The central database was hosted and operated as a cloud-based service. This cloud platform allows easy and efficient communication between the ANPR and the highway users by providing the facility to view the history of transactions performed with real-time notification options. One of the major advantages of the cloud platform is in its ability to offer on-demand self-service. It also provides location-independent resource pool. In addition, it allows users to pay per use, and it offers required elasticity. In the developed ANPR system, data transmission between the WebCam and the central processing unit was achieved through the web application that was hosted on the cloud platform. Vehicle owners can easily interact with the ANPR system by using a mobile application designed for that purpose. This Internet-enabled facility allows road users to conveniently renew their subscriptions and receive prompt notifications on transactions in real-time. Toll payment history can equally be tracked on the mobile Application. Android platform to exploit its popularity, simplicity, cost-effective, and user-friendliness. An enhanced web application was designed for city managers to effectively maintain, manage, and control toll evasion in a bid to uphold strict compliance. This platform also provides a good means for the electronic audit of the toll fees collected over a particular period of time, in a particular area.

VII. STRUCTURAL DESIGN:

Database plays an important role in the system. The database system is divided into three parts: Administrator, Central database Integrated database.

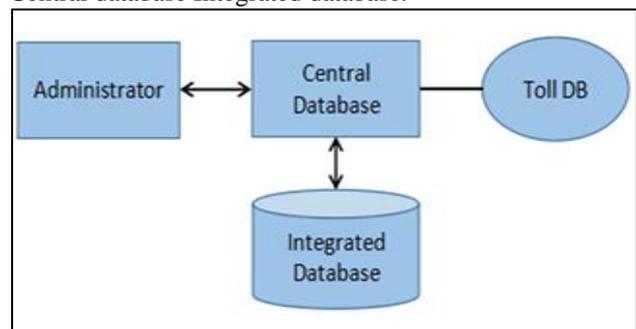


Figure 8. Database Structure

VIII. ADMINISTRATOR:

Admin database contains all the details of the central database and toll plazas under construction.

IX. CENTRAL DATABASE:

The central database consists of records of all toll plazas under that construction. This central database managed by the administrator. The customer must register into this account to use ANPR system. This account information is stored in the database. When the registered customer passes through the toll plazas, the recognition takes place and automatically toll will be deducted from customer's account. This deduction will be updated by the central database by sending notification of payment link for toll tax.

X. INTEGRATED DATABASE:

Integrated database is connected to the central database. The database includes all registered vehicles and the details of the vehicle such as vehicle owner, vehicle number, license number, account ID, account balance, current charges, etc. All toll plazas record stored at the central server and these records could be seen and printed by day, date, month, and year.

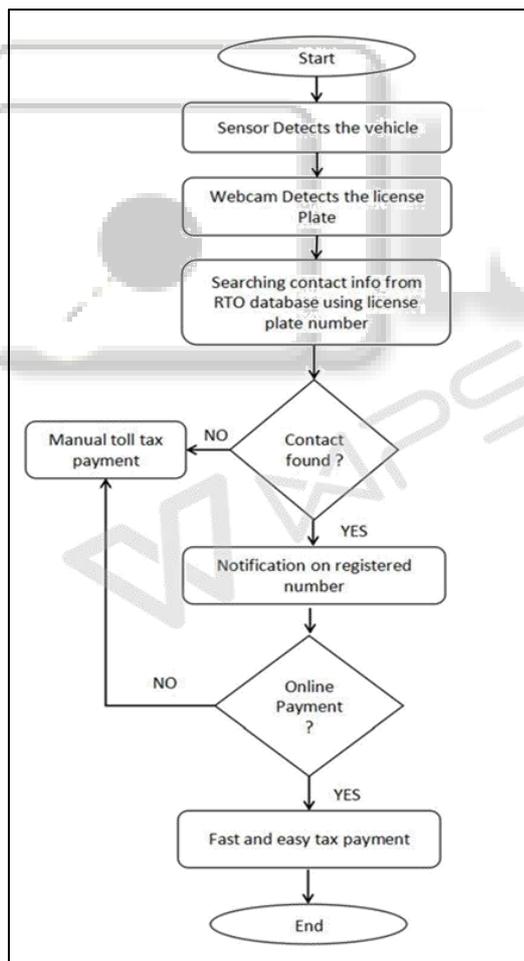


Fig 9: Activity Diagram

XI. SYSTEM IMPLEMENTATION:

The toll tax automation system uses the ANPR technology which uses OCR algorithms in vehicle detection in order to

get the user details and vehicle details through the user registered database. The IoT serves as the interface between the vehicle (webcam) and the system (ANPR algorithms), the Web Services are included to serve the database connection, Desktop applications and Android applications are used for client-server communication and Payment Wallets are used for the online transaction of the toll collection.

The system is a 2 scan system based on dual recognition of a vehicle where first recognition is performed pre-appearance of the vehicle at the toll and The user scan is done at the toll point. The user will register on the app prior to payment and the details of the user and vehicle will be stored in the database. The application, hardware devices, and the processing unit will serve as a whole system implementing automation of toll collection system which replaces the veteran human intervention system.

XII. SCOPE AND APPLICATIONS:

The scope and application of the system are as follows:

- 1) Automated Vehicle Identification.
- 2) Automated Vehicle Classification.
- 3) Transaction Processing (Toll Calculation).
- 4) Vehicle tracking for security purposes.
- 5) Parking system.

XIII. CONCLUSION:

In this article, we have discussed toll tax automation using ANPR technology. ANPR is a highly stable and reliable technology. The ANPR automatically detect the identities of the vehicles, reading items in motion and tracking of the vehicles can be done accurately. With the elimination of human interaction in the entire toll collection process and also reduction of time at the toll plaza, we can create a better toll tax automation system to be implemented. It can also significantly improve the efficiency of toll stations and the traffic solution of the toll road. ANPR technology can provide new capabilities as well as an efficient method to collect, manage, disseminate, store, and analyze information. It also eliminates manual data entry, the system improves better management, leading to lower operational costs and increased revenue generation.

ACKNOWLEDGEMENT:

We would like to thank Prof. Shaifali Shrivastava for providing necessary guidance in conducting this research.

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