

Research Paper

TOLL SYSTEM USING AUTOMATIC NUMBER PLATE DETECTION

NAMPELLY PRANAYA CHARY
SCHOLAR. DEPARTMENT OF MCA
VAAGESWARI COLLEGE OF
ENGINEERING (S4), KARIMNAGAR

MRS.T. MOUNIKA
ASST. PROFESSOR DEPT OF MCA
VAAGESWARI COLLEGE OF
ENGINEERING (S4), KARIMNAGAR

DR. P. VENKATESHWARLU

Professor & Head, Department of MCA

Vaageswari College of Engineering(S4), Karimnagar

(Affiliated to JNTUH, Approved by AICTE, New Delhi & Accredited by NAAC with 'A+' Grade)

Karimnagar, Telangana, India – 505 527

Abstract

The **Toll System Using Automatic Number Plate Detection (ANPR)** is an intelligent transportation system designed to automate toll collection by identifying vehicle number plates using image processing and machine learning techniques. Traditional toll collection systems require vehicles to stop and make manual or electronic payments, which can result in traffic congestion, waiting time, and human errors.

The proposed system uses a camera to capture the vehicle image as it approaches the toll plaza. The captured image is processed to detect the vehicle's number plate. Optical Character Recognition (OCR) is then used to extract the registration number from the detected plate. The extracted vehicle number is verified with the registered vehicle database, and the corresponding toll amount is automatically calculated and recorded.

The system can maintain vehicle details, toll transactions, payment status, and entry/exit information. It can also provide an administrator dashboard for monitoring vehicles and transactions. The proposed approach reduces manual intervention, improves toll collection efficiency, minimizes waiting time, and provides a digital record of toll transactions.

Keywords: Automatic Number Plate Recognition, ANPR, Toll Collection, OCR, Image Processing, Vehicle Detection, Intelligent Transportation System, Machine Learning.

Introduction

Traditional toll collection systems generally require vehicles to stop at toll booths for manual or electronic payment. During peak hours, a large

number of vehicles may arrive simultaneously, resulting in queues and increased waiting time.

Automatic Number Plate Detection provides an efficient solution by identifying vehicles automatically through their registration numbers. A

camera installed at the toll plaza captures the vehicle image. Image processing techniques are used to locate the number plate, and OCR technology extracts the characters from the plate.

The extracted registration number can be compared with a database containing vehicle and user information. Once the vehicle is identified, the system can calculate the applicable toll amount and record the transaction.

The system therefore combines vehicle detection, number plate recognition, database management, and automated toll processing into a single platform.

Problem Statement

Toll plazas handle a large number of vehicles every day. Conventional toll collection methods may require manual verification, physical payment, or vehicle-specific identification devices.

These processes can cause:

- Traffic congestion
- Increased waiting time
- Manual errors
- Delayed toll collection
- Additional operational effort
- Difficulty maintaining accurate transaction records

Therefore, there is a need for an automated toll system capable of identifying vehicles without requiring extensive manual intervention.

The proposed system aims to develop a camera-based automatic number plate detection and recognition system that can identify vehicles, retrieve their registered information, calculate toll charges, and maintain transaction records.

The system should achieve:

- Accurate number plate detection
- Reliable character recognition
- Automated vehicle identification
- Faster toll processing
- Secure transaction storage
- Reduced manual intervention

- Easy monitoring by administrators

Existing System

The conventional toll collection system mainly depends on manual operators or separate electronic toll-payment mechanisms.

In a manual toll system, the vehicle approaches the toll booth and the operator identifies the vehicle and collects the required toll amount. The transaction is then recorded manually or through a separate system.

Some existing electronic toll systems use RFID or other identification technologies. These systems require a compatible tag or device to be associated with the vehicle.

Although these systems can reduce some manual work, they may still have limitations such as dependence on physical tags, maintenance requirements, equipment availability, and difficulty handling vehicles without registered electronic identification.

The existing toll infrastructure can therefore be improved by using camera-based automatic number plate recognition for vehicle identification.

Disadvantages of Existing System

The major disadvantages of conventional toll collection systems include:

1. Manual Intervention

Traditional systems may require an operator to collect payment and record vehicle information.

2. Traffic Congestion

Vehicles may need to slow down or stop at the toll booth, especially during busy periods.

3. Increased Waiting Time

Manual verification and payment processing can increase the time required for each vehicle.

4. Human Errors

Incorrect vehicle details or transaction information may be recorded during manual processing.

5. Cash Handling

Cash-based toll collection requires additional handling and management.

6. Limited Automation

Traditional systems may not provide complete automatic vehicle identification and transaction processing.

7. Maintenance of Physical Tags

Electronic systems based on RFID or similar technologies require tags to be issued, maintained, and properly associated with vehicles.

Proposed System

The proposed **Toll System Using Automatic Number Plate Detection** uses a camera to automatically identify vehicles at a toll plaza.

When a vehicle approaches the toll point, the camera captures its image. The system processes the image and identifies the vehicle's number plate. The detected plate is then passed to an OCR module to extract the registration number.

The extracted number is compared with the vehicle database. If the vehicle is registered, the system retrieves the associated information and determines the applicable toll amount.

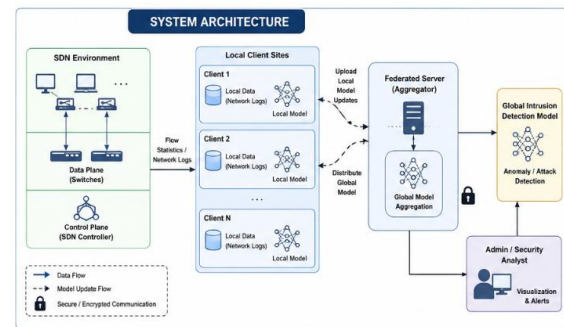
The transaction details are stored in the database and the toll status is updated.

Main steps:

Vehicle → Camera → Image Processing → Number Plate Detection → OCR → Vehicle Database → Toll Calculation → Transaction Record

The system can also provide an administrator interface for managing vehicle information, viewing toll transactions, and monitoring system activities.

System Architecture



Proposed Methodology

The proposed methodology consists of the following sequential stages:

Step 1: Vehicle Detection

The camera continuously monitors the toll lane. When a vehicle approaches the toll point, an image of the vehicle is captured.

The captured image acts as the input to the number plate recognition process.

Step 2: Image Preprocessing

The captured image may contain noise, shadows, different lighting conditions, or background objects. The preprocessing stage improves the image before number plate detection.

Common operations include:

- Image resizing
- Noise removal
- Grayscale conversion
- Contrast enhancement
- Image thresholding

Step 3: Number Plate Detection

The system identifies the region containing the vehicle's registration number.

The detected number plate is cropped from the original vehicle image.

The plate detection stage should handle variations in:

- Vehicle size
- Camera distance
- Lighting
- Plate position
- Background conditions

Step 4: Character Recognition

The detected number plate image is passed to the OCR module.

OCR identifies the individual characters and converts them into a text-based vehicle registration number.

For example:

Input: Number plate image

Output: Vehicle Registration Number

The extracted number is then forwarded to the database verification module.

Step 5: Vehicle Database Verification

The extracted registration number is searched in the vehicle database.

The database may contain:

- Vehicle Number
- Owner Information
- Vehicle Type
- Registration Details
- Account/Payment Information
- Toll History

If the vehicle is registered, the system retrieves the corresponding details.

Step 6: Toll Calculation

After identifying the vehicle, the system determines the toll amount according to the configured vehicle category or toll rules.

For example:

- Car
- Bus
- Truck
- Other vehicle categories

The calculated amount is associated with the current toll transaction.

System Implementation

The proposed system can be implemented using a combination of **Python, computer vision, OCR, database technologies, and a web-based interface.**

Python can be used for image processing, number plate detection, OCR integration, and backend processing.

A computer vision library can process the vehicle images and identify the number plate region.

An OCR engine can be used to convert the characters from the number plate into text.

A database such as MySQL can store:

- Vehicle details
- Owner information
- Toll details
- Transaction history
- Payment status

A web-based dashboard can provide administrative functionality.

The implementation can contain the following modules:

1. **Admin Login**
2. **Vehicle Registration**
3. **Vehicle Image Capture**
4. **Number Plate Detection**
5. **OCR Recognition**
6. **Vehicle Verification**
7. **Toll Calculation**
8. **Transaction Management**
9. **Payment Status**
10. **Reports and Dashboard**

Experimental Setup

The system can be tested using a collection of vehicle images captured under different conditions.

The dataset may contain:

- Different vehicle types
- Different number plate formats
- Different viewing angles
- Different lighting conditions
- Day and night images
- Different vehicle distances

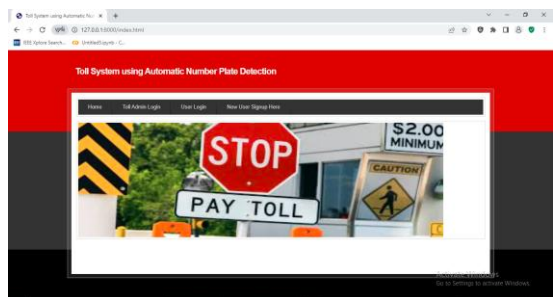
The system can be evaluated using the following parameters:

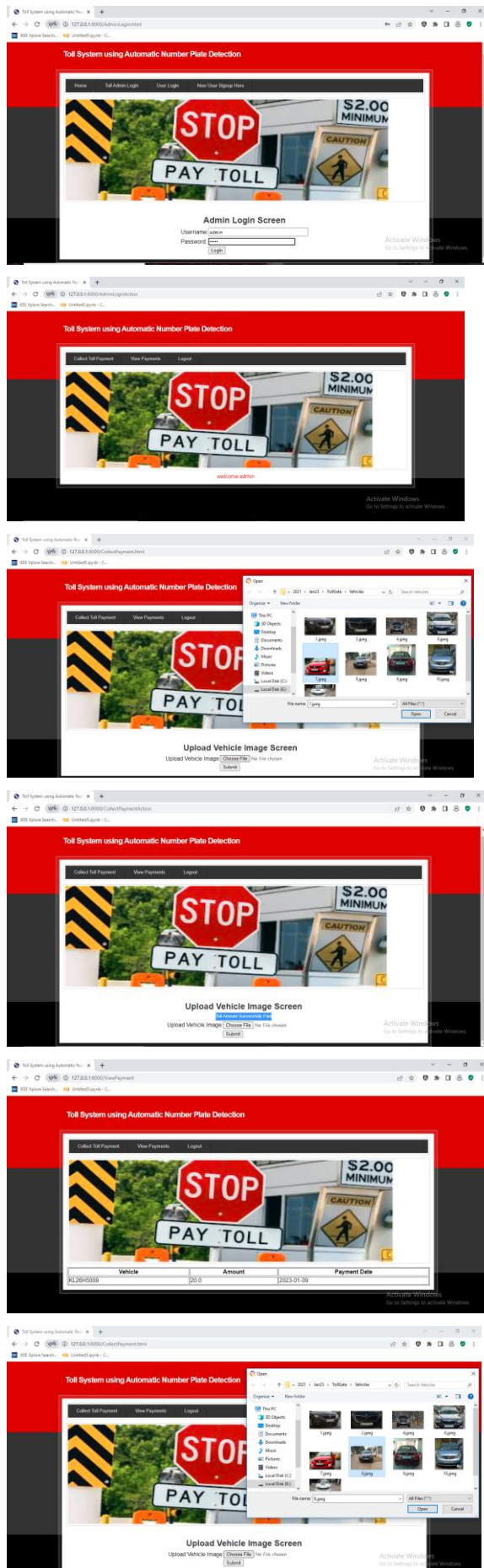
Parameter	Description
Plate Detection Accuracy	Correctly detected number plates
OCR Accuracy	Correctly recognized characters
Vehicle Recognition Rate	Correctly identified vehicles
Processing Time	Time required to process one vehicle
False Detection Rate	Incorrectly detected plates
Transaction Accuracy	Correct toll transaction generation

```
C:\Windows\system32\cmd.exe
E:\venkat\2021\Jan23\Tollgate>python manage.py runserver
C:\Users\Adelin\AppData\Local\Programs\Python\Python37\lib\site-packages\django\__init__.py
C:\Users\Adelin\AppData\Local\Programs\Python\Python37\lib\site-packages\django\__init__.py
Performing system checks...

System check identified no issues (0 silenced).

You have 5 unapplied migration(s). Your project may not work properly until you apply the migrations for app(s): admin,
auth, contenttypes, sessions.
Run 'python manage.py migrate' to apply them.
January 08, 2021 - 12:12:03
Django version 3.1.7, using settings 'Tollgate.settings'
Starting development server at http://127.0.0.1:8000/
Quit the server with CTRL-C.
```





Future Work

Future improvements can enhance the proposed toll system in several directions.

1. Improved Number Plate Recognition

Advanced deep-learning-based detection models can be used to improve recognition under difficult lighting and weather conditions.

2. Real-Time Video Processing

Instead of processing individual images, the system can analyze real-time video streams to detect vehicles continuously.

3. Multi-Lane Toll Processing

The system can be extended to support multiple toll lanes simultaneously.

4. Mobile Application

A mobile application can be developed for vehicle owners to view toll transactions and payment history.

5. Cloud Integration

Cloud-based infrastructure can be used to store and manage toll transaction data across multiple toll plazas.

6. Fraud Detection

Machine-learning techniques can be integrated to identify suspicious or abnormal toll transactions.

7. Advanced Security

Encryption, stronger authentication, and secure access-control mechanisms can be incorporated to protect vehicle and transaction information.

Conclusion

The Toll System Using Automatic Number Plate Detection provides an automated approach for identifying vehicles and processing toll transactions.

Instead of depending completely on manual vehicle verification, the proposed system uses camera-based number plate detection and OCR to recognize vehicle registration numbers.

The recognized vehicle number can be verified against a database, followed by toll calculation and transaction recording. This approach can reduce manual intervention, improve transaction management, and reduce vehicle waiting time.

Overall, the proposed system combines **computer vision, OCR, database management, and automated toll processing** to provide an intelligent toll-management solution.

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