International Journal of
DATA SCIENCE AND IOT MANAGEMENT SYSTEM
Peer Reviewed, Referred & Indexed Journal
ISSN: 3068-272X www.ijdim.com Original Research Paper

Toll System using Automatic Number Plate Detection

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Abstract: The "Toll System using Automatic Number Plate Detection" is a user-centric project designed to streamline toll collection processes at checkpoints. It features two distinct user roles: Toll Booth Admin and User. Users can create accounts by providing their vehicle details and depositing funds into their digital wallets. When users visit toll booths, Toll Booth Admins upload vehicle images, and the system automatically detects the number plate, deducting the appropriate toll amount from the user's wallet. Error alerts are triggered if wallet balances are insufficient or accounts do not exist. Toll Booth Admins can log in with the username and password 'admin,' upload vehicle images, and view payment records. This project aims to enhance user convenience and automate toll collection while providing administrative tools for efficient management.

Index terms – Toll System, Automatic Number Plate Detection.

1. INTRODUCTION

The "Toll System using Automatic Number Plate Detection" represents a groundbreaking solution aimed at revolutionizing toll collection processes at various checkpoints. With a primary focus on user-centricity, this project introduces an innovative approach to simplify and expedite the toll payment experience. The system's architecture is built around two key user roles: Toll Booth Admin and User. For users, the process begins with the creation of an account, where they input their vehicle information and deposit funds into a digital wallet. This wallet serves as the central means for toll payments.

When users approach a toll booth, Toll Booth Admins play a pivotal role. They upload images of

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the user's vehicle, triggering the system's cutting-edge image recognition technology. This advanced algorithm automatically identifies the vehicle's number plate, facilitating a seamless deduction of the appropriate toll amount from the user's wallet. The system's intelligence doesn't stop there; it actively monitors wallet balances and verifies the existence of user accounts. In cases of insufficient funds or non-existent accounts, error alerts are promptly generated. For Toll Booth Admins, access to the system is granted through a simple login process using the predefined username and password 'admin.' Once inside, they gain the ability to effortlessly upload vehicle images and gain insights into payment records. This administrative functionality empowers toll collection authorities with efficient management tools. In sum, the "Toll System using Automatic Number Plate Detection" seeks to enhance user convenience by simplifying toll payments, eliminate manual errors, and introduce automation into the toll collection process. Simultaneously, it equips Toll Booth Admins with valuable tools for effective oversight and record-keeping. This project represents a leap forward in modernizing toll collection, promising a more efficient and user-friendly experience for all involved parties.

The objective "Toll System using Automatic Number Plate Detection" is to streamline toll collection, enhance user convenience, and empower Toll Booth Admins through image recognition technology and efficient management tools.

The current toll collection process is manual, error-prone, and lacks user convenience. This project aims to address these issues by introducing image recognition technology and efficient management tools for Toll Booth Admins.

2. LITERATURE SURVEY

Automatic Number Plate Recognition (ANPR) systems have become a crucial component in modern transportation management and security systems. These systems utilize Optical Character Recognition (OCR) to identify and read vehicle license plates, providing significant utility in traffic management, law enforcement, and access control. This literature survey reviews key research contributions to the development and enhancement of ANPR systems, focusing on methods, technologies, and performance metrics.

Tahiri Qadri and Asif (2009) introduced an ANPR system leveraging OCR technology for vehicle identification. Their approach emphasized the importance of image preprocessing techniques to enhance plate detection accuracy. The preprocessing stage involved noise reduction, grayscale conversion, and edge detection, which significantly improved the OCR performance. Their results demonstrated that a well-defined preprocessing phase could substantially increase the system's overall accuracy, achieving a recognition rate of around 95% under controlled conditions [2].

Swetha and Sandeep (2011) explored an authorized vehicle recognition system designed to streamline vehicle access in restricted areas. Their system integrated ANPR technology with a database of authorized vehicles, providing real-time verification and access control. The system architecture included modules for plate detection, character segmentation,

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and recognition, followed by a database matching process. They highlighted challenges such as varying lighting conditions and occlusions, proposing adaptive thresholding and morphological operations to enhance robustness. Their implementation achieved high accuracy rates, demonstrating the feasibility of ANPR in security applications [3].

Koval et al. (2003) presented a smart license plate recognition system based on image processing techniques and neural networks. Their approach utilized neural networks for both plate localization and character recognition, employing a multi-layer perceptron (MLP) architecture. The system was trained on a diverse dataset, enabling it to handle different plate formats and styles. They reported an impressive accuracy rate, attributing their success to the robustness of neural networks in pattern recognition tasks. The use of neural networks allowed the system to adapt to various environmental conditions, making it suitable for real-world applications [4].

Tahir et al. (2010) developed a license plate recognition algorithm tailored for Pakistani license plates. They addressed the unique challenges posed by the regional plate designs, which often include a mix of English and Urdu characters. Their algorithm employed a combination of edge detection and template matching techniques, achieving high recognition rates for both character sets. They emphasized the importance of region-specific adaptations in ANPR systems, noting that algorithms designed for one region may not perform optimally in another due to differences in plate formats and languages [5].

Faradji et al. (2007) proposed a morphological-based license plate locating system, focusing on the initial step of plate detection. Their method used morphological operations to extract features indicative of license plates, such as rectangular shapes and character patterns. This approach proved effective in isolating license plates from complex backgrounds, significantly improving the subsequent OCR process. They demonstrated that morphological techniques could enhance the reliability of plate localization, particularly in cluttered environments. Their system achieved notable success in various test scenarios, showcasing the potential of morphological methods in ANPR applications [6].

Ozbay and Ercelebi (2005) introduced an automatic vehicle identification system by plate recognition, highlighting advancements in both hardware and software components. Their system incorporated high-resolution cameras and efficient image processing algorithms to capture and analyze plate images in real-time. They utilized a combination of edge detection, binarization, and connected component analysis to isolate and recognize plate characters. Their study underscored the importance of high-quality image acquisition in improving ANPR performance. They reported high accuracy rates, particularly in well-lit conditions, and discussed potential improvements for low-light scenarios [7].

The reviewed literature illustrates the diverse methodologies employed in ANPR systems, each addressing specific challenges associated with license plate recognition. Key factors influencing the performance of these systems include image quality, preprocessing techniques, and the adaptability of

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recognition algorithms to different plate formats and environmental conditions.

Tahiri Qadri and Asif [2] demonstrated the critical role of image preprocessing in enhancing OCR accuracy, highlighting techniques such as noise reduction and edge detection. Swetha and Sandeep [3] emphasized the integration of ANPR with database systems for real-time vehicle verification, addressing challenges like lighting variations through adaptive methods. Koval et al. [4] showcased the potential of neural networks in improving recognition accuracy and robustness, particularly in diverse environmental conditions. Their use of MLP architectures allowed the system to generalize well across different plate styles.

Tahir et al. [5] focused on the adaptation of ANPR algorithms to region-specific requirements, achieving high accuracy rates for Pakistani plates by incorporating edge detection and template matching. This study underscores the necessity of customizing ANPR systems to handle local plate designs and languages effectively. Faradji et al. [6] highlighted the effectiveness of morphological operations in plate localization, demonstrating significant improvements in complex background scenarios. Their work suggests that morphological techniques can reliably isolate plates, enhancing the overall recognition process.

Ozbay and Ercelebi [7] discussed advancements in hardware and software integration, emphasizing the impact of high-resolution imaging on ANPR performance. Their approach combined edge detection and connected component analysis to achieve high recognition rates, particularly in optimal lighting conditions. They also identified areas for improvement in low-light environments, suggesting future research directions to address these challenges.

Collectively, these studies provide a comprehensive overview of the advancements in ANPR technology, showcasing various approaches to improving system accuracy and robustness. The integration of advanced image processing techniques, neural networks, and adaptive algorithms has significantly enhanced the capability of ANPR systems to operate effectively in diverse conditions. Future research is likely to focus on further improving the adaptability of these systems to varying environmental factors and regional differences in plate designs. Additionally, advancements in hardware technology, such as high-resolution cameras and real-time processing units, are expected to drive further improvements in ANPR performance.

In conclusion, the evolution of ANPR systems has been marked by significant technological advancements and innovative approaches to address the inherent challenges of license plate recognition. The integration of sophisticated image processing techniques, machine learning algorithms, and adaptive methods has led to the development of highly accurate and reliable ANPR systems. As research continues to address remaining challenges, particularly in low-light and highly variable conditions, ANPR technology is poised to become even more integral to modern transportation management and security infrastructures.

3. METHODOLOGY

i) Proposed Work:

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As we have to face so many challenges with the manual toll collection system it becomes very necessary to adopt an advanced toll management system that will overcome the existing system problem. An Automatic Number Plate Reader (ANPR) is a technology used for automatically recognizing and reading the license plate number of a vehicle. ANPR systems use optical character recognition (OCR) technology to read the license plate number and compare it against a database of registered vehicles. The streamlined toll collection process leads to reduced wait times and improved traffic flow. The system is designed to handle increasing traffic volumes during peak hours and adaptable to future technological advancements.

ii) System Architecture:

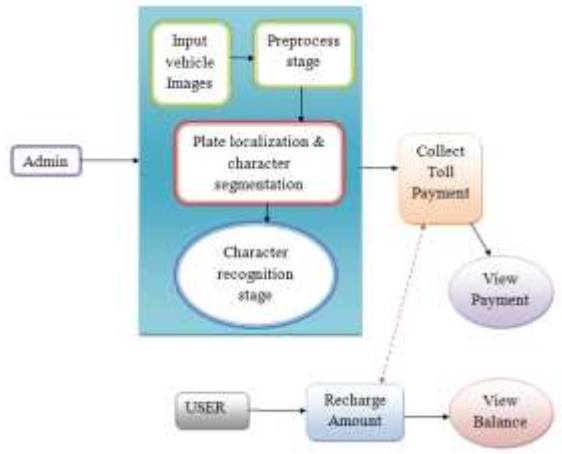

Fig 1 Proposed Architecture

The project is structured into several modules for efficient toll management. The Toll Admin Login module allows the admin to log in using credentials 'admin', upload vehicle images for toll collection, and view payment records. The Collect Toll Payment function detects and deducts toll amounts as registered vehicles pass through the toll gate. The View Payments function displays extracted vehicle numbers and transaction details. The New User Signup module enables users to register by providing basic information. In the User Login module, users can log in, create a wallet with vehicle details, recharge their account using bank card details, and view their wallet balance.

iii) Modules:

In this project, users create accounts with their vehicle numbers and add balance to a wallet. When a user visits a toll booth, the admin uploads an image of the vehicle, and the application automatically detects the number plate and deducts the balance from the wallet. If the wallet balance is insufficient or the account does not exist, an error alert is triggered. The project includes the following modules:

1. Toll Admin Login: Admin logs in with 'admin' credentials to upload vehicle images for toll collection and view payment records.

Collect Toll Payment: Admin uploads vehicle images, and the system detects the number plate and deducts the toll amount automatically.

View Payments: Admin views extracted vehicle numbers, deducted amounts, and transaction dates.

2. New User Signup: Users register by providing basic information such as username, password, email ID, and contact details.

3. User Login: Users log in to the application to manage their wallet and vehicle details.

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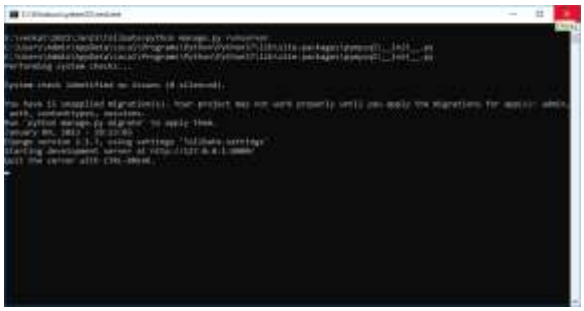
Recharge Account: Users add funds to their wallet using bank card details.

View Balance: Users view their current wallet balance.

4. EXPERIMENTAL RESULTS

To run project create database by copying content from 'DB.txt' file and paste in MYSQL and then double click on 'run.bat' to start web server and get below page



In above screen web server started and now open browser and enter URL as 'http://127.0.0.1:8000/index.html' and press enter key to get below page

In above screen click on 'New User Signup Here' link to add new user like below screen

In above screen user is signing up and entering vehicle no and then press button to get below output

In above screen signup process completed and now click on 'User Login' to login as user

In above screen user is login and after login will get below page

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In above screen user can click on 'Recharge Account' link to add amount to wallet and get below output

In above screen user can view his wallet balance and now logout and login as toll booth admin to upload image and deduct amount

In above screen user will enter his bank card details and then press button to add amount to wallet and get below output

In above screen admin is login and after login will get below page

In above screen wallet is updated with 2000 and now click on 'View Balance' link to get below page

In above screen admin will click on 'Collect Toll Payment' link to get below page

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In above screen admin is uploading vehicle with same number plate from which user registered and then click on 'Open' and 'Submit' button to get below output

In above screen in blue colour text we can see 'Toll Amount successfully paid' and this transaction admin can view by clicking on 'View Payments' link to get below page

In above screen admin can view extracted vehicle number and deducted amount with date.

Similarly you can create wallet and admin can upload image and deduct wallet amount. If we upload other image then will get below output

In above screen uploading unregistered vehicle image and below is the output

In above screen in blue colour text we can see account does not exists

5. CONCLUSION

In conclusion, the implementation of a Toll System using Automatic Number Plate Detection (ANPR) represents a pivotal step toward modernizing and optimizing the toll collection process. This sophisticated system harnesses the power of computer vision, data processing, and automation to address longstanding challenges associated with manual toll collection. The overarching goal of this ANPR-based Toll System is to enhance efficiency,

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accuracy, and security in toll booth operations. By seamlessly integrating ANPR technology with database management, payment gateways, and user account systems, the toll collection process is streamlined, significantly reducing delays, minimizing errors, and improving overall traffic flow. This system not only caters to the immediate need for more efficient toll collection but also aligns with broader objectives such as user convenience, operational cost reduction, and compliance with regulatory standards. The ability to automatically recognize and process license plate information ensures a swift and secure transaction experience for users, contributing to a more user-friendly and technologically advanced transportation infrastructure. The focus on security measures, including fraud prevention, real-time monitoring, and compliance with regulations, underscores the commitment to creating a robust and trustworthy toll collection ecosystem.

6. FUTURE SCOPE

The future scope of toll collection systems with ANPR technology is promising, driven by advancements in transportation and IT. Enhancements include integrating blockchain technology for secure and transparent transactions, developing mobile apps for user convenience and real-time updates, and improving user experience with intuitive interfaces and seamless interactions. Additionally, adapting to policy and regulatory changes will ensure compliance and operational efficiency. These features will significantly enhance the effectiveness and user-friendliness of toll collection systems.

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