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GateX – Automated Parking Authentication System

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Abstract: *GateX – Automated Parking Authentication System is an Automatic Number Plate Recognition (ANPR) based solution designed to control vehicle access in restricted parking areas. The system captures vehicle images and processes them using computer vision techniques to detect number plate regions. Image preprocessing methods such as grayscale conversion, noise reduction, edge detection, and contour filtering are used to identify plate-like structures. The extracted plate region is enhanced using thresholding techniques and processed using EasyOCR to obtain the vehicle number. The recognized plate text is validated using pattern matching and verified against a SQLite database of authorized vehicles. A Flask-based server processes incoming images and returns an ALLOW or DENY response. The system improves parking security, reduces manual effort, and demonstrates real-time application of computer vision and machine learning for automated vehicle authentication.*

Keywords: Automatic Number Plate Recognition, Computer Vision, OpenCV, EasyOCR, Flask Server, Smart Parking

I. INTRODUCTION

Parking security and vehicle authentication are important concerns in residential societies, educational institutions, corporate offices, and commercial parking areas. Traditional parking systems rely on manual verification of vehicles, which is time-consuming and prone to human error. Unauthorized vehicles entering restricted parking spaces can lead to security issues and management difficulties.

With the advancement of computer vision and artificial intelligence, automated solutions can be developed to identify and authenticate vehicles efficiently. Automatic Number Plate Recognition (ANPR) systems use image processing techniques to detect vehicle number plates and extract text information for verification purposes.

GateX – Automated Parking Authentication System is designed to automate the vehicle verification process using image processing, Optical Character Recognition (OCR), and database validation. The system captures images of vehicles, extracts the license plate number, and verifies whether the vehicle is authorized to enter the parking area. This improves efficiency, enhances security, and reduces the need for manual supervision.

II. LITERATURE SURVEY

Automatic Number Plate Recognition (ANPR) systems have gained significant importance in recent years due to their applications in traffic monitoring, toll collection, law enforcement, and smart parking systems. Researchers have explored various computer vision and machine learning techniques to improve the accuracy and efficiency of vehicle identification systems.

Many early ANPR systems were based on traditional image processing techniques such as edge detection, morphological operations, and contour analysis. These methods were effective for detecting rectangular number plate regions under controlled lighting conditions. OpenCV-based approaches have been widely used due to their simplicity, cost-effectiveness, and real-time processing capability.

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Recent research has introduced Optical Character Recognition (OCR) techniques combined with machine learning algorithms to improve character recognition accuracy. EasyOCR and Tesseract OCR are commonly used tools for extracting alphanumeric text from vehicle number plates. These OCR systems improve recognition accuracy by using deep learning models trained on large datasets of characters and symbols.

Several studies have also explored deep learning-based object detection methods such as YOLO (You Only Look Once) and Convolutional Neural Networks (CNN) for detecting license plates more accurately. While these approaches provide higher accuracy, they require more computational resources and complex training procedures.

Smart parking systems have also been developed using RFID technology, QR codes, and IoT-based sensors. Although RFID-based systems provide reliable identification, they require additional hardware installation and maintenance costs. Image processing-based ANPR systems provide a contactless and cost-effective alternative without requiring modifications to vehicles.

The proposed system, GateX – Automated Parking Authentication System, combines traditional computer vision techniques with EasyOCR for real-time number plate recognition. The system integrates image processing, OCR, and database verification using a Flask-based server architecture. Compared to hardware-based solutions, the proposed approach provides a scalable and low-cost method for automated parking authentication while maintaining satisfactory accuracy under normal lighting conditions.

III. PROPOSED SYSTEM

The proposed system consists of a camera module connected to a processing unit that captures real-time images of incoming vehicles. The captured image is processed using OpenCV to detect edges and contours in order to identify rectangular regions corresponding to vehicle number plates. Image preprocessing techniques such as grayscale conversion, Gaussian blur, median filtering, and bilateral filtering are applied to improve image quality and reduce noise.

After detecting candidate plate regions, aspect ratio filtering is applied to ensure only plate-like rectangles are considered. The identified plate region is extracted and processed using thresholding techniques to enhance the visibility of characters. EasyOCR is used to recognize the alphanumeric characters present on the number plate.

The recognized text is refined using regular expression pattern matching based on standard Indian vehicle number formats. The validated plate number is compared with a SQLite database containing authorized vehicle records. The system then returns an ALLOW or DENY response using a Flask-based API server.

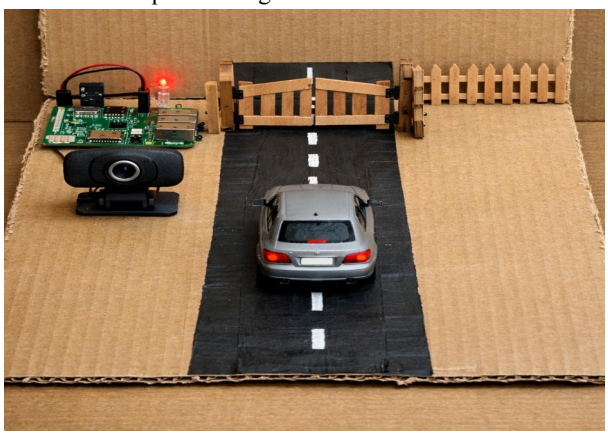

Fig 2. Working model of GateX System

IV. METHODOLOGY

The working methodology of the proposed system is divided into several steps:

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1. Image Acquisition
The camera captures real-time images of vehicles entering the parking area.
2. Image Preprocessing
The captured image is converted to grayscale and noise reduction techniques such as Gaussian blur, median filtering, and bilateral filtering are applied.
3. Edge Detection
Canny Edge Detection is used to identify edges in the image for contour detection.
4. Contour Detection
Contours are extracted from the edge-detected image to identify possible plate regions.
5. Rectangle Detection
Contours with four corners are considered as possible rectangular objects.
6. Aspect Ratio Filtering
Rectangular contours are filtered based on aspect ratio to select plate-like shapes.
7. Region of Interest Extraction
The number plate region is cropped from the original image.
8. Image Enhancement
Thresholding techniques are applied to enhance text visibility for OCR.
9. Optical Character Recognition
EasyOCR extracts text from the processed image.
10. Text Validation
Regular expressions are used to validate the extracted text according to Indian license plate formats.
11. Database Verification
The extracted plate number is checked against a SQLite database of authorized vehicles.
12. Result Generation
The system returns ALLOW or DENY response through the Flask API.

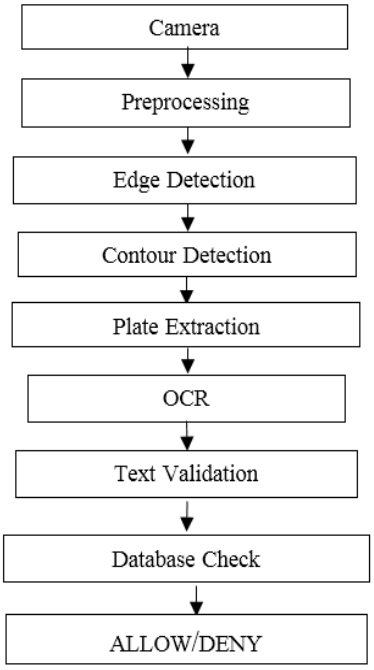

Fig 1. Methodology of GateX System

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V. TECHNOLOGIES USED

Software Tools:

- Python
- OpenCV
- EasyOCR
- Flask
- SQLite
- NumPy
- Regular Expressions

Hardware Components:

- Raspberry Pi
- Camera module or USB webcam
- LED indicator (for gate signal)
- Computer system

VI. ADVANTAGES

•Reduces manual verification effort
•Improves parking security
•Fast and automated authentication
•Cost-effective implementation
•Scalable system architecture
•Real-time vehicle authentication

VII. LIMITATIONS

•OCR accuracy depends on lighting conditions
•Dirty or damaged plates may reduce recognition accuracy
•Camera angle affects detection performance
•Processing speed depends on hardware capability
•Requires proper positioning of camera

VIII. FUTURE SCOPE

The system can be further improved by integrating advanced deep learning models such as YOLO for more accurate plate detection. Gate automation hardware such as boom barriers can be connected for automatic entry control. Cloud database integration can enable centralized vehicle monitoring. Mobile application integration can provide real-time notifications for vehicle entry logs.

Additional features such as parking slot detection, visitor vehicle logging, and multi-camera support can enhance system scalability and usability.

IX. CONCLUSION

GateX – Automated Parking Authentication System demonstrates the practical implementation of Automatic Number Plate Recognition using computer vision and machine learning techniques. The system successfully detects vehicle number plates, extracts text information using OCR, and verifies authorization using a structured database. The proposed system improves efficiency, enhances security, and reduces manual intervention in parking management systems. The proposed system demonstrates a practical and scalable approach for intelligent parking authentication using real-time image processing techniques.

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X. RESULTS

The proposed system was tested using multiple vehicle images under normal lighting conditions. The system successfully detected number plate regions and extracted vehicle numbers using EasyOCR. The extracted plate numbers were validated using regular expressions and verified using a SQLite database. The system produced correct ALLOW or DENY responses based on database records. Experimental results show that the system performs efficiently in real-time with satisfactory accuracy when the number plate is clearly visible.

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