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SecurePass: Intelligent Vehicle Access Management System

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Abstract
Vehicle Access Management is a important aspect of security, especially for any private Organization. The traditional manual methods can be inefficient and prone to human error. The handling of large data becomes difficult. Thus, as the organizations grow, the need for streamlined and automated solution is necessary. "SecurePass: Intelligent Vehicle Access Management System" is designed to address these challenges by using Machine Learning solution for real time vehicle monitoring, number plate detection and validation. The system is designed in such a way that it uses OpenCV, TensorFlow and OCR technologies to accurately detect and extract vehicle registration number. The extracted number plate is validated against a dataset maintained by organization. The SecurePass additionally checks the number plate on basis of the RTO norms and classifies them into personal (if black and white), transportation (if yellow) and electric (if green). It signals the suspicious plate for further inspection. SecurePass consist of 2 modules, first one is the admin itself, who manages the data and the other one is the Security Personnel who can verify the vehicle entries. The Security Personnel the can record the entry and exit of the Vehicle. SecurePass gurantees the security, data accuracy and operational efficiency in Vehicle Access Management.

Keywords: SecurePass, OpenCV, Tensorflow, OCR, Detection, Recognition, Private Organizations

1. Introduction

In today's fast paced world, secure and efficient Vehicle access management is a critical concern for private organization where traditional manual monitoring methods fail to be accurate and are inefficient. These approaches can be inefficient mostly for handling high Volume data of vehicle. To address this challenge "**SecurePass: Intelligent Vehicle Access Management System** "is an innovative solution which uses the advanced Machine Learning technologies.

The SecurePass detects and extract the vehicle registration number from a live camera feeds and upload images by using OpenCV, TensorFlow and OCR. It ensures the Number Plate against the organization database and crosschecks, validates on basis of RTO regulations. The system provides dashboards for two Primary users roles: Administrator, they are given access to manage, modify and update the vehicle data and Security Personnel only verifies the authorized Vehicle entry in real time. The details of vehic-

le's in/out times are recorded.
SecurePass offers an efficient solution that can be customized according to the organization needs. As it can handle a high data volume and has a user-friendly inference, a SecurePass becomes an ideal choice for modern access control and parking management.

2. Research Methodology

This section outlines the step-by-step methodology used to develop a machine learning-based system for vehicle number plate identification and validation. The project utilizes technologies like Python, OpenCV, TensorFlow, EasyOCR, Flask, and SQL-based database management.

A. Data Collection: Vehicle data, including the roll number, name of the owner, registration number, academic year, type of vehicle, and an image of the number plate, are collected from the college premises. The number plates are categorized based on the Regional Transport Office (RTO) standards: black and white for personal vehicles, yellow for transport, and green for electric vehicles.

B. System Architecture: The system architecture consists of two primary users: admin and security personnel. Admin users have access to modify stored vehicle records, while security personnel capture and process number plate images for validation. The website provides login/signup functionality, dashboards for both roles, and handles number plate detection and validation tasks. The data is stored in a secure MySQL database.

C. Number Plate Detection: The system leverages OpenCV to capture images either through live camera feeds or uploaded images. Preprocessing techniques, such as grayscale conversion, are applied to enhance image quality. TensorFlow is utilized for object detection to locate the number plate within the image.

D. Character Recognition: Once the number plate is detected, the Optical Character Recognition (OCR) tool EasyOCR is used to extract the alphanumeric characters from the number plate. The recognized text is compared against the stored vehicle records in the database.

E. Validation Process: The detected number plate is checked for validity according to RTO norms. Fancy or tampered plates that modify characters are flagged as invalid. If the number plate complies with the rules and matches the database, the vehicle is allowed to pass. In the absence of a valid match, manual entry is required.

F. Database Management: The MySQL database is structured to store employee and vehicle records. The in-time and out-time of each vehicle is recorded for future reference. Admin users can view and edit records, while security personnel can log entries based on the captured number plate images.

G. User Interface: The website's user interface is developed using HTML, CSS, and Flask to ensure a smooth and intuitive experience. The dashboards provide clear access to all functionalities for both admin and security personnel, including login/logout tracking.

3. Literature Survey

[1] License Plate detection using OCR (M.L.S.N.S Lakshmi, Prasad Jones Christydass, Sreevardhan Cheerla)(December 2020):This study focuses on using OCR technique for License Plate detection system. The YOLOv5 is employed for detecting the License plate. The model divides the image into square grids and applies bounding box regression to detect and highlight the plate within the grid. The system only focuses on number plate in English language. The resultant system has a precision rate of 62% and recall rate of 94.3%. However, the study was limited for number plates in regional lang-

uage like Marathi.

[2] Recognition of Vehicle Number Plate by Using Python and Open CV (Prof. Aditya Bakshi, Neha Devendra Parande, Shubhada Sudhir Kekapure, Radhika Shankarrao Gawande, Tejaswini V. Rathod, Ketan Kale) (7 April 2023): This Study developed a system for detecting the Vehicle number. It uses Bilateral Filtering technique to remove the noise and enhance the image making it easier to extract the number plate. Segmentation is done by using Connected Component Analysis. The system uses the Tesseract OCR engine to recognize and convert the characters into text format. The only limitation by which the system struggles is with images containing a poor background condition. The results and study show that the performance on plate with white background was better compared to noisy or complex background

[3] Number Plate Recognition by using OpenCV-Python (Tella Pavani, DVR Mohan) (March 2019): The Author builds a system which can detect and analysis a Number plate by using OpenCV. The system also uses KNN with addition of Tesseract OCR to convert segmented characters to ASCII format. The recognized characters are displayed as final output. This system achieves the high success rate of 97.2% for character segmentation and recognition reliability of 90.9%. This system may struggle in challenging environments like poor lighting.

[4] Automatic Vehicle Number Plate Recognition System Using Tensorflow Object Detection (D. U. Onyishi, E. E.Emina) (April 2024): The system uses Tensorflow object Detection and Easy OCR for the Text extraction. The model is trained by using dataset of 203 Nigerian Number Plate. This system results into 100% success rate for plate detection and 93.3% for OCR accuracy. The system is efficient to transfer into real time. However, the only limitation is that the OCR components show less accuracy.

[5] An Automatic Framework for Number Plate Detection using OCR and Deep Learning Approach (Yash Shambharkar , Shailaja Alagrama , Kanhaiya Sharma , Om Mshra , Deepak Parashar) (2023): The system is trained using the Indian Number plate dataset. The techniques used are CNN for detecting the number plate and OCR for character recognition. The system results in 96.23 % of accuracy for the Indian License Plate with advanced CNN.

[6] Automatic Number Plate Recognition System (Shubham Nandanwar, Vijay Rawal, Aditya Parab) (5 May 2021): The study focuses on developing a ANPR system using Tensorflow Object detection and OCR mainly for the high-security areas such as military zones, government offices, and parking systems. However, the model is trained to capture only the Straight forward images.

[7] Application of Machine Learning for Automatic Number Plate Recognition Using Optical Character Recognition Engine (Osakwe Anthony Abuchi, Dr. Arul Lenna Rose. P. J, Dr. Aarthi. E) (5 May 2024): The Author majorly focuses on Nigeria Vehicles real-time tracking and identification. The system aims to provide real-time vehicle identification to improve law enforcement, particularly for traffic control & tracking stolen vehicles. It results in detection rate of 80% to 88%. But the system does not work for any Government Vehicles.

[8] Automatic Number Plate Recognition System for Indian Number Plates using Machine Learning Techniques (Gayatri Hajare , Utkarsh Kharche , Pritam Mahajan , and Apurva Shinde)(2022): The system utilizes the YOLOv5 model for detecting number plates and Google Tesseract for Optical Character Recognition (OCR) to read the characters on the plates. The proposed method showed notable success with a recall rate of **94.3%** and precision of **62.9%** during testing.

4. Future Scope

As we know there is always a room for improvement in any system and thus, our system is no exception. Currently, we offer Vehicle Monitoring, validation and access control unit but we can enhance it further by integrating additional technology.

Some of the key points may include:

- **To integrate Biometric:** Biometric recognition such as fingerprint scanning / facial recognition for more secure driver authentication.
- **Advanced analytical and predictive algorithms:** We can use Machine Learning to predict patterns and identify suspicious activities.
- **Expand Vehicle classification:** Include new vehicles such as Autonomous vehicles.
- Develop a Mobile Application.
- **Add more languages:** We plan to add regional language like Marathi.

5. Conclusion

Here we have presented a "SecurePass: Intelligent Vehicle Access Management System" solution designed to address the challenges like inefficiencies and security vulnerabilities of traditional vehicle monitoring methods in private organizations. SecurePass offers a robust system for real-time vehicle number plate detection, classification, and validation. The system ensures that only authorized vehicles are granted access while also checking compliance with regional transport regulations, thereby enhancing security and operational efficiency. The successful integration of machine learning and image processing technologies into vehicle access management demonstrates the potential of intelligent systems in automating and optimizing security processes. As organizations continue to face increasing demands for secure and efficient access control, SecurePass offers a scalable, flexible, and user-friendly solution that can be easily tailored to meet varying organizational needs.

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