PlateGuard: Ensuring Security with YOLOv5 ANPR Technology

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Abstract—**The accomplishment of an Automatic Number Plate Recognition (ANPR) system stands as a pivotal solution in fortifying security measures for compounds necessitating stringent access control, such as educational institutions. In this pursuit, the focus lies on designing an efficacious ANPR system tailored to ensure only authorized vehicles gain entry into campus premises. Utilizing the advanced functionalities of the YOLOv5 (You Only Look Once) algorithm, celebrated for its instantaneous object detection abilities, the system excels in promptly recognizing vehicles as they approach the specified entry points. Upon detection, it promptly captures comprehensive vehicle images to initiate subsequent processing stages. Extracting the vehicle's number plate becomes paramount, followed by cross-referencing it against a meticulously curated registry of authorized faculty members' vehicles. Should a match occur, access is seamlessly granted; contrarily,unauthorized vehicles elicit a distinctive alert, signalling denial of entry. Implemented using Python, the system's performance undergoes rigorous evaluation using authentic real-world images sourced from campus gates.**

Keywords—component; formatting; style; styling; insert (key words)

I. INTRODUCTION

Utilizing image processing methods, the process of recognizing number plates involves extracting the image of license plates from a vehicle [1]. The intention of this paper is to design a smart ANPR set-up for Vehicle Access Control that is both cost-effective and efficient, achieved through the integration of computer vision and deep learning (DL). The introduction of an ANPR system at the college gate signifies a notable progression in enhancing campus security and access control measures. This system is specifically tailored to allow only approved faculty vehicles, thereby improving efficiency and security. The ANPR system employs the YOLOv5 algorithm, renowned for its real-time object detection capabilities. Upon vehicle detection, the system captures images for subsequent analysis. The system utilizes the OCR.Space engine to precisely recognize optical characters from the captured image, enabling the extraction of license plate details. For connectivity with the gate control system's physical elements, PyFirmata is employed. This programming ensures effortless entry for authorized faculty vehicles while preventing access for unauthorized ones. Incorporating OpenCV elevates the system's image processing capabilities, guaranteeing precision in both vehicle detection and the extraction of license plate information. Beyond simplifying access, this ANPR system also reinforces security by issuing alerts and preventing unauthorized vehicle entry. In summary, the project serves as a prime example of successfully integrating advanced technologies to create an intelligent, efficient, and secure access control system at the college gate.

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II. SURVEY OF LITERATURE

The real-time Automated Number Plate Recognition (ANPR) system has become indispensable for access management and traffic control, finding diverse applications from traffic regulation to the upkeep of intelligent surveillance data [1]. Earlier iterations of ANPR systems employed a variety of methods, including edge detection and contouring, to pinpoint the region housing a vehicle's license plate.

Fakhar et al. introduced a Raspberry Pi based cost-effective ANPR system [2]. This system captures real-time camera images and processes them through denoising, filtering, and segmentation to identify license plate characters. The Raspberry Pi handles the computational workload, resulting in a noticeable 3-second delay before producing recognition results, which are then stored in a database.

An additional ANPR system was created to streamline the check-in and check-out procedures [3]. This system rapidly detects license plate numbers from CCTV camera images using image processing techniques and saves pertinent data into a database using a web-based interface, aiming to decrease check-in times and improve overall travel efficiency.

Virakwan and Nui Din proposed an ANPR System tailored for POLIMAS, ensuring only registered vehicles access specific areas [4]. Their system employs grayscale conversion, histogram equalization, and plate localization techniques to achieve high accuracy. Character recognition is then performed using Optical Character Recognition followed by database comparison for effective verification of registered vehicles.

Chou and Liu proposed a Truck Number Plate Recognition (TNPR) system in real-time, employing YOLO and CNN-based architectures, as detailed in their study [5]. Their approach achieves high performance in identifying individual characters and overall recognition rate, significantly reducing manual efforts and time spent on plate identification.

Chen and Hu presented an Intelligent Transportation System (ITS) emphasizing video-based methods for vehicle identification and classification [6]. Their approach combines static and motion features to enhance performance and maintains robustness across diverse environmental conditions.

Hsieh and colleagues employ morphological approaches to expedite license plate detection by reducing potential candidate areas [7].

Yu et al. leverage wavelet transform and empirical mode decomposition techniques to identify license plates, whereas Wang et al. utilize a cascaded AdaBoost classifier along with a voting mechanism for the same purpose.

III. METHODOLOGY

The methodology proposes a real-time Automatic Number Plate Recognition (ANPR) system which involves a series of sequential steps to effectively capture, identify, and recognize vehicle license plates for access control purposes. At the outset, the system utilizes frames captured by the installed camera, leveraging YOLO object detec[1]tion algorithms to distinguish between the front and rear views of vehicles, thereby establishing their check-in or check-out status accurately. Following this, the YOLO algorithm is utilized again to localize the number plate within the captured frame. Finally, efficient OCR.Space technology is applied to identify the characters or labels on the identified vehicle number plate. This integrated approach ensures the accurate and timely identification of vehicles for access control applications.

Fig. 1 Steps involved

A. Data Collection

Camera Setup and Image Capture: Set up cameras or surveillance equipment at strategic vantage points near the college's second gate to continuously capture images of vehicles entering or exiting. Ensure that the camera settings and positioning allow for clear visibility of vehicle number plates. Once captured, review the images to filter out any where the number plates are not clearly visible or are obstructed. Organize Data: Once the images are filtered, organize them into a structured dataset. Categorize the images based on criteria such as date, time, vehicle type, and number plate visibility. Ensure that the dataset is well-organized and easily accessible for training and testing purposes.

B. Preprocessing

1 Image Reading

During this stage, the images captured by the installed camera are accessed through the utilization of the 'cv2.imread()' function from the

OpenCV library. This particular function facilitates the extraction of images from designated file paths, converting them into a compatible format suitable for additional processing.

2 Resizing

After the images are retrieved, they are resized using OpenCV's 'cv2.resize()' function. This resizing procedure modifies the dimensions of the images to a predetermined size, aiding in uniformity across various frames. Consistent dimensions are essential for reliable analysis and interpretation in subsequent computer vision applications.

3 Normalization

The photos' pixel values are standardised to a predetermined range after resizing by means of normalisation strategies.This is essential for enhancing the numerical stability and convergence of machine learning models trained on the images. Normalization ensures that pixel values are uniformly distributed, which aids in optimizing the performance of algorithms applied to the images.

4 Saving Preprocessed Images

After preprocessing, the images are saved if necessary for further processing or analysis. This ensures the availability of preprocessed images for subsequent stages of the computer vision pipeline. Saved images serve as a reference point for analysis or can be utilized in scenarios where real-time processing is not feasible, providing flexibility in the workflow.

C. License Plate Retrieval

In the image processing workflow for automatic number plate recognition (ANPR), the initial critical step involves preprocessing the image to enhance clarity, typically by converting it to grayscale and

applying various techniques like blurring or thresholding. 4 Contour detection methods from the OpenCV library are then used to identify object outlines in the preprocessed image. These detected contours are filtered based on size, shape, and proximity to isolate the contour corresponding to the number plate region. Once the relevant contour is identified, the next step is to extract the number plate region from the original image. This enables focused analysis on interpreting the characters displayed on the plate. Optical Character Recognition (OCR) tools like OCR.Space are employed to convert the visual data within the recognized contour into text. Post-processing steps refine the extracted text, including tasks like eliminating unnecessary characters or correcting errors to ensure accuracy. The final outcome of this process involves displaying or storing the successfully extracted characters for further processing or detailed analysis.

D. Authorization Check

After successfully extracting characters, the subsequent crucial stage entails comparing them with entries in the authorized vehicles list. This comparison serves as a crucial validation step to determine the legitimacy of the vehicle seeking access. If the recognized number plate corresponds to an entry on the authorized vehicles list, access is granted to the vehicle. Conversely, if there is no match, access is promptly denied. As an optional but valuable enhancement, the system incorporates a notification mechanism to inform relevant authorities or personnel about the access decision. This notification feature ensures that appropriate actions or interventions can be taken in cases of unauthorized access attempts, contributing to the overall security and integrity of access control systems.

E. Implementation and Evaluation

The system, developed using Python and key libraries like OpenCV and NumPy, underwent rigorous real-world testing with actual gate-captured images. Performance was meticulously evaluated, focusing on vehicle detection precision, number plate extraction efficacy, and authorization process efficiency. Continuous refinement through iterative testing aimed to enhance accuracy and reliability. Ongoing improvements targeted optimal system performance. The goal is to ensure effectiveness in real-world scenarios.

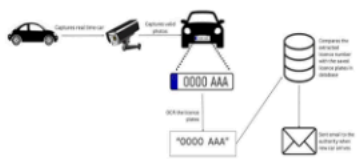

Fig. 2 Implementation diagram

IV. RESULTS

The ANPR system consisted of modules for license plate detection, license plate recognition, and end-to-

end recognition, each employing specialized algorithms to perform their respective tasks.

Experimental Results

The experimental results demonstrated the efficacy of the ANPR system in accurately detecting and recognizing vehicle license plates, as well as its seamless integration into the access control process within educational institutions.

1 License Plate Detection

The ANPR system exhibited a robust performance in license plate detection, achieving a precision rate of 93%. This module accurately identified vehicles as they approached designated entry points, ensuring reliable detection even in varied lighting and environmental conditions.

The detection algorithm utilized advanced techniques such as feature extraction and deep learning-based object detection to achieve high accuracy.

2 License Plate Recognition

In terms of the license plate recognition, the system achieved a success rate of 82% in retrieving number plates from detected vehicles. Leveraging optical character recognition (OCR) algorithms and pattern recognition techniques, the system adeptly extracted crucial information from captured license plates, facilitating validation processes for authorized access. Despite challenges such as occlusion and distortion, the recognition module demonstrated robust performance in accurately identifying alphanumeric characters on license plates.

3. End-to-End Recognition

The end-to-end recognition process seamlessly integrated license plate detection and recognition modules to enable efficient access control. Authorized vehicles were swiftly granted access by matching their detected license plates with the registry of faculty members' vehicles. Conversely, unauthorized vehicles triggered distinct alerts, effectively thwarting unauthorized entry attempts. This end-to-end recognition mechanism showcased the system's efficacy in enhancing security measures within educational institutions while preserving operational efficiency.

Fig. 3 Detection of car in real-time.

Fig. 4 Snapshots of cars with 60 percentage accuracy

V. CONCLUSION

The Automatic License Plate Detection System emerges as a formidable tool for enhancing security and access control measures within institutional settings. Through rigorous evaluation, it has demonstrated robust performance, characterized by high accuracy in license plate identification, swift alert mechanisms, and insightful data analysis capabilities. Despite encountering occasional challenges, its efficiency and reliability surpass traditional methods, offering institutions a sophisticated solution for maintaining regulatory compliance and mitigating security risks. Moving forward, continued refinement and optimization further strengthen its capabilities, solidifying its position as a valuable asset in safeguarding premises and ensuring operational integrity.

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