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Original Article

Study of An AI-Powered Vehicle Monitoring System: An Ensembled Approach for Intelligent Surveillance

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Abstract *- This paper presents an AI-powered vehicle Monitoring System using EasyOCR, OpenCV, and HaarCascade algorithms. The project is the detection of the license plate of a vehicle entering a gate and saving the date, time, and license plate number in a database to enhance the security of the institution. The system is good at detecting vehicle license plates in real-time. EasyOCR is used for reading license plates and we used it to help the system track vehicles better. OpenCV provides computer vision capabilities to process images and helps in real-time detection. We used the HaarCascade machine learning object detection method to identify objects in images to detect license plates of vehicles. Also provides a simple and attractive graphical user interface for users to access vehicle information. This system can be applicable in institutions, hospitals, and factories. This will be helpfull to others who are into making vehicle detection systems.*

Keywords *- EasyOCR, HaarCascade, Vehicle monitoring, Computer vision.*

1. Introduction

The research paper explores the development and implementation of an AI-Powered Vehicle Monitoring System designed for real-time license plate detection. Uses technologies such as EasyOCR, OpenCV, HaarCascade algorithms, and PHP. Our objective is to create a robust system capable of accurately identifying and tracking vehicles through efficient license plate detection and store the license details date, and time in a MYSQL (database). The project will involve the development of a software system that can be installed at the institutions. The system will use cameras to capture the number plates of vehicles entering the gate and extract the alphanumeric characters using systems. The extracted characters' entry date and time will be stored in a database, which can be easily retrieved from a simple user interface. The system undergoes a lot of tests to check whether the system works well because wanted to make sure it can handle different situations and keep working. An institution without an automated tracking system, the institution faces several challenges related to the accuracy and efficiency of vehicle entry management. Manual methods result in time and cost-consuming processes. The verification of vehicle entry becomes a hard task for administrative staff; it leads to delays. An institution with an automated tracking system makes work faster to take details of vehicle entries. Management can get a ready-to-print database at any interval of time.

2. Literature Review

In the paper [1], the author builds a Self-Driving Autonomous car model but on a minimalistic basis, which basically will be focused on three main features, which are to operate by the surroundings depending on the direction of the road, to detect stop signs and halt for 5-10 seconds and detect traffic signs and make decisions accordingly. The miniature self-driving car will detect the two-lane path and perform the above functions. In the paper [2] main aim is to create a model for handling challenges like traffic jams in parking areas due to incorrect parking, automobile insecurity, etc. In the study, an approach of Automatic Vehicle Plate Recognition using Livestream is discussed by considering image size, success rate and processing time as parameters. In this paper [3], the author builds a traffic surveillance prevention system with vehicle number plate identification and speed detection using machine learning to provide a complete traffic solution. By using only camera captures, a traffic observation system can measure major traffic boundaries from video layouts. This paper proposes to identify over-speeding vehicles' number plates and initiate an emergency message on detecting accidents. Utilizing the CCTV footage, vehicle detection takes place, and the speed of the vehicle is derived using Open CV.

The accident will be detected from the video input using the Convolutional Neural Network Algorithm and Computer Vision. On detecting an accident, an emergency message is initiated to the nearest control room with the corresponding location. The paper [4] aims to identify the number plate in vehicles during difficult situations like distorted, high/low light and dusty situations. The paper proposes the use of the Faster R-CNN to detect the number plate in the vehicle from the surveillance camera which is placed on the traffic areas etc. The created system is used to capture the video of the vehicle and then detect the number plate from the video using frame segmentation and image interpolation for better results. The proposed system can

achieve a 99.1% accuracy in detecting the number plate of the vehicle and showing the vehicle's owner information. In this paper [5] author presents a programmed traffic observation framework to gauge significant traffic boundaries from video arrangements utilizing just captures from cameras. A traffic control kit is developed to detect over speeding cars on highways, number plates in Bengali, and initiate emergency calls to 999 on detecting accidents. OCR Tesseract is used to detect number plate which has very high performance in detecting noisy texts. To identify a case of an accident, a simple Python code with Dens-net Architecture is used. A GSM module of the experimental kit initiates the call and message after analyzing the data through a code of C language. Machine Learning (ML) is used to train the program in identifying number plates.

In the paper [6] author proposed a solution for this problem by considering college buses o BVRIT as an organization. College bus number plate Registration Detection is a crucial part of smart BVRIT planning and BVRIT transport management. This paper presents the YOLO V8 algorithm for Detecting college buses using number plate registration detection. YOLO - You Only Look Once. This YOLO-V8 algorithm is a state-of-the-art (SOA) model or algorithm. It's a real-time object detection algorithm that can detect objects in any image, that has many classes in it with high accuracy and speed. In this paper [7], the author builds The odd-even rule on vehicle number plates in DKI Jakarta aims to reduce congestion that occurs in DKI Jakarta.

The application of these regulations is constrained by the limitations of the manual supervision function by officers. This problem can be overcome by implementing intelligence in the form of detecting number plate objects with the YOLO v5 algorithm and the character extraction process with Optical Character Recognition technology using Tesseract OCR. Based on this research, the average percentage of objects detected in each video is 92.38%, and the average confidence value obtained in object detection is between 75.55%. The success rate of the character extraction process on number plates is 95.45%, and the average proportion according to the detected number plate category is 97.2%. The implementation of the YOLO Algorithm has succeeded in detecting license plates with odd and even categories on videos that can provide signs and save violations of vehicles that violate the odd and even rules. In this paper [8], the author builds a Vehicle Number Plate (VNP) technology that is used in applications like parking management, traffic control and management. It involves tasks such as detecting and recognizing vehicle licence plates. Most of the VNP systems in use today don't perform well enough in real-time image/video scenarios.

To trim and save the localized plate, NVIDIA Compute Unified Device Architecture (CUDA) APIs are employed, which resulted in speeding up the processing. The performance of three different optical character recognition (OCR) techniques, OCR, Tesseract OCR, and ONNX OCR mode, is compared to choose the best one. In terms of accuracy and time complexity, the Easy OCR model is proven to be the best. The author suggests using Single Shot Detector (SSD) Mobilenet V3-based architecture to locate licence plates and Easy OCR due to its superiority for character recognition. In terms of accuracy and time complexity, the Easy OCR model is proven to be the best. In this paper [9], the author builds an Acquiring image, and detecting number plates of moving vehicles using motion platforms presents a challenge. To address this challenge, mobile cameras are utilized to capture license plate images of moving vehicles, which are then labelled and stored in a database. The test results obtained from our work show a relatively high accuracy in terms of number plate recognition. The primary goal of our ANPR system is to achieve high accuracy in recognizing Odisha license plates. Other ANPR systems available use different types of pre-trained model methods, such as Alex Net and GoogleNet. The results show that using our scheme a good accuracy was achieved using a smartphone camera. The paper [10] named AVNPR is to recognize the license plate using image processing techniques or optical character recognition by applying the pytesseract OpenCV Python package. It has a focus on the detection of vehicle license plates, character segmentation and character recognition. In this paper [11], the author seeks to prevent the increasing traffic accidents and crime. The younger generations are still engaging in reckless driving, even though the government has implemented legislation and traffic regulations to lower the number of accidents and fatalities on the roads. This model first detects the presence of cars, then calculates their speeds, and lastly decodes the number plates of the fast-moving automobiles. The report offers an analysis of the effectiveness of the implemented method via comparisons using various video datasets. In this paper [12], the author builds an Automatic Vehicle number plate detection which is an image processing prototype, which will first process an image and then identify the number plate to get information about the vehicle.

The main objective is to correctly design an automatic car identity machine with the aid of the usage of the vehicle's number plate. If the vehicle is an un-authenticate, then it becomes a very tedious and time-consuming and very hard task to search that vehicle. It can also be used on the entrance for security management of, e.g. shopping malls, and college campuses. The machine is carried out on Python (Programming Language) and OpenCV as an image processing library, and its performance is tested on real photographs. It has been determined from the experiment that the evolved device readily acknowledges and detects the automobile's quantity plate on real images. Key Words: ANPR, OCR, CNN, OpenCV, Flask. In this paper [2], the author builds a Vehicle Number Plate Detection technology that is applied in urban areas to help law enforcement in investigation and crime prevention. Vehicles going at illegal speeds, stolen vehicles, etc., can all be recognized automatically using the system without human intervention or human errors. It has been used widely in-vehicle toll booths on the highways as well as in Parking Management Systems where there is a rigid shooting angle that can

capture the licence plates of the vehicles efficiently. In this study, an approach of Automatic Vehicle Plate Recognition using Livestream is discussed by considering image size, success rate and processing time as parameters. In this paper [14], an efficient and simple method is used to recognize the number plate. In the proposed method, the OpenCV library, along with Python language, is used for image processing using pytesseract. The input image is taken and converted into a grayscale image, and the processed image is filtered through the bilateral filter to remove unwanted characters. In this paper, the Canny edge detection method is used to detect the edges of license plates. TESSERACT is used as an Optical Character Recognition.

In the paper [15] author designed to perform functions such as capturing the image of the vehicle and storing the captured image along with the transcript of the licence plate. Open CV plays an important role in preparing images and videos to identify objects, and Tesseract OCR is used for text recognition in our prototype. The main purpose of this system is to design and develop an accurate image-processing method along with the successful recognition of alphanumeric characters. In this paper [16], a system of car license plate number detection and recognition is proposed. The implemented system consists of four main stages: image processing, segmentation, noise removal and deep learning. A Raspberry Pi 4 device-aided Python language and camera are used. After image preprocessing and segmentation, the system will detect the License plate from an image of a vehicle using the YOLOv4 algorithm and Cascade Classifier with accuracy in the YOLOv4 technique is 0.999, in Cascade Classifier with a database of Russian numbers is 0.982 and in the Cascade Classifier with Indian numbers is 0.906. Then, the characters of the license plate have been extracted. The facility of an easy OCR library has been used to convert this picture to text characters. Then, the process of license plate recognition was implemented step by step using Python, OpenCV, Numpy, and easy OCR libraries. In this paper [17], the author builds The Intelligent Image Text Reader can capture an image and extract the text from the image using the Easy OCR library and display it in the form of speech output. The Text to Speech conversion methodology was earlier useful for the visually impaired but now it has got a wider scope. In the era of Digitalization, text is seen on almost all online websites, blogs, and e-learning materials. Text plays a vital role in some of the real-time applications like vehicle license plates, traffic sign boards, banners, etc.

In this paper [18], the author builds an Automatic Number Plate Recognition information system that uses data extraction from a given vehicle image and applies the data for further usage in a safe, secure, and modernistic Transportation System. The Novelty of the project is that even if the image is blurred, our system can deblur the given image and apply it to the Machine Learning models further. In the proposed work, the You Only Look Once [YOLO] V3 model for Region of Interest [ROI]; Convolution Neural Network [CNN] for optical character recognition was implemented. After the ROI is detected, it will be enhanced with preprocessing steps before it is fed to the CNN model. A dataset of different Indian Number Plates' Fonts was created, consisting of 6439 images of different alpha-numerical characters. An accuracy of 91.5% is obtained. The extracted and sorted characters of the number plate are cross-checked with the Indian RTO database, and the information has resulted. In this paper [19], the author builds a number plate recognition system. The method used is YOLOv3 (You Only Look Once), and Darknet-53 is used as a feature extractor. In this study, the data used were number plate images derived from the extraction and cropping of motorized vehicle videos that had been taken using cell phones and cameras. Testing is done with two different models, namely, the model obtained with additional preprocessing data and the model obtained without any preprocessing data.

In this paper [20], the author builds a model that combines the wheel speed and satellite communication information to calculate the impact of road navigation on the IMU and its horizontal speed compared to average wheel speeds and wheel Speed Department (CRT) information. A longitudinal vehicle speed estimator using triangulation is generated from tests conducted by participants, consisting of three virtual sensors that build synthetic longitudinal speed tracks by combining multiple data points. The speed estimation is being evaluated in a detailed and analytical way under a variety of driving scenarios under the testing hardware-in-the-loop tests. In this paper [21] author tries to develop a model that can locate a particular vehicle that the user is looking for depending on two factors: 1. The Type of vehicle and 2. The license plate number of the car. The proposed system uses a unique mixture consisting of a Mask RCNN model for vehicle type detection, WpodNet and pytesseract for License Plate detection and prediction of letters.

In this paper [22] author builds a "License Plate Recognition System Using OpenCV and Tesseract OCR Engine," addressing the critical issue of traffic control and vehicle identification by proposing a three-staged LPR system. With advancements in automobile technology, tracking vehicles violating traffic rules has become challenging, particularly in developing countries. This system, employing OpenCV and Tesseract OCR, focuses on license plate detection, character segmentation, and recognition, utilizing infrared illumination for day-night operations. Prior research highlights the effectiveness of OpenCV for detection and Tesseract OCR for accurate text recognition, paving the way for an implementable solution to efficiently process images, capture vehicle data, and recognize alphanumeric characters, which is crucial for enhancing traffic management and law enforcement. In this paper [15] author builds a Real-Time Vehicle Number Plate Detection and Recognition System. Within this document, they proposed a real-time vehicle number plate recognition (RVNPR) system for the recognition of number plates, which can extract the characters from the number plates of vehicles passing by a particular location using image processing algorithms; it's not necessary to put in additional

devices like GPS or radio frequency Identification (RFID) to implement the proposed system. Using high-definition cameras, the system takes images of every passing vehicle and sends the image to the computer for processing by RVNPR software. The plate recognition software uses different algorithms like Yolo (You Only Look Once), segmentation and, at last, character recognition. The resulting data is applied to match with the records in a database; if the vehicle has been detected as stolen, then the system automatically notifies the police and sends the location of that vehicle. In this paper [24] author builds a License plate detection using YOLO v4.

The real-time object detector YOLO (You Only Look Once) - darknet deep learning framework is used in this article to detect car number plates in parking lots in real time. The YOLOv4 deep learning technique was utilized in this proposed strategy to automatically recognize a car's number plate from a video stream. An OCR technique is applied to extract the number from the image of the number plate. The system detects license plates with an accuracy of around 89%. In this paper [25] author builds a License Plate Detection and Recognition using YOLO v4. The proposed work performs small object detection like locating and recognizing the number plate, colour of the number plate and character on the number plate by using Yolov4 and the feature fusion approach. The proposed method can overcome different challenges in object detection and shows competitive results for small object detection with 86% detection accuracy at 45fps.

In this paper [26] author builds a Deep Learning Model for an Automatic Number/License Plate Detection and Recognition System in Campus Gates. Automatic Number Plate Recognition (ANPR) is a critical technology that enables the monitoring and control of road traffic and parking management, towing systems, vehicle gate entry management, etc. This paper explores the use of deep learning techniques, including OpenCV, YOLO, PaddleOCR, and Tesseract OCR, in combination with Python programming language, to develop ANPR systems. In this paper [27] author builds a Detection of Vehicular Number Plate System using a Deep Learning Approach. Automatic Number Plate Recognition (ANPR) is a type of Intelligent Transport System. While numerous studies on plate identification, character segmentation and character recognition have been performed, several challenges remain. An efficient Vehicle Detection System is necessary to ensure traffic monitoring.

In the last 4-5 years, several image processing and learning methods have been developed, such as the Optical Character Recognition (OCR) technique. The aspect of object detection, though, hasn't been exploited for the ANPR framework in the previous research focused on object detection. In this paper [28] author builds an OCR-based Automated Number Plate Text Detection and Extraction. This work focuses on the automation of text detection and extraction. In this method, the photos of vehicles are captured. Then the part of the number plate is identified, and the plate information (number) is extracted and sent to the concerned authorities via WhatsApp number. The concept is based on Optical Character Recognition (OCR). A bilateral filter is used for edge detection and a canny algorithm is applied for edge detection. In this paper [29] author builds an Analysis of the Object detection Method using Open CV – Python. Various applications for object detection have been well-researched, including face detection and recognition, character recognition and prediction, and number plate detection. Object detection and recognition are used in very vast cases and scenarios including retrieval, surveillance, detection of overspeeding of vehicles and a lot more cases.

In this research, various basic concepts used in object recognition and detection while making use of the OpenCV library of Python 3.8, increasing and improving the efficiency and accuracy of object recognition and detection are presented. This paper [30], "License Plate Number Detection Using OpenCV and Python", presents an innovative approach to building a real-time embedded Automated License Plate Recognition System (ALPR) for automatically detecting license plate numbers of moving cars. Such systems find applications in complex security setups, communal spaces, parking access control, and urban traffic management. The challenges of ALPR, including the impact of lighting conditions and vehicle speed, are addressed through the utilization of the Open Computer Vision Library and Python programming language. The system not only detects license plates but also provides essential details related to emission testing and insurance. This research builds upon prior work in ALPR, demonstrating the potential of OpenCV and Python in creating efficient and versatile solutions for license plate recognition and vehicle data processing, which is crucial for enhancing security and traffic management systems. In this paper [31] author builds a Systematic Number Plate detection using an improved YOLOv5 detector. A system based on YOLOv5s is used for training the model with annotated images in the dataset. The process was divided into several steps, comprising acquisition, detection, segmentation, and finally, text recognition in an image. The automobile is recognized from each photograph in the first stage. The next stage is to identify the automobiles' license plates from the identified cars. After the segmentation, the license plates are cropped. The characters are recognized in the last phase from the collected number plates.

YOLOv5 is used by the system for number plate detection and Keras for character recognition. The characters from a number plate are retrieved and entered into an Excel spreadsheet. Images of Indian license plates are used to evaluate the model's performance. The accuracy for automobile detection, number plate identification and character recognition are 97.6%, 98.2%, and 99.1%. In this paper [13] author builds An Efficient Number Plate Detection System Based on Indian Traffic Rules. Based on the Indian traffic road system, monitoring the violation of such an incident is a huge task and a tedious system. However, steps are taken to monitor traffic breach that

happens in road transport through the License Plate Detection mechanism for vehicles that are involved in overspeeding or violating the rules. License plate location is a very important concept in vehicle license plate recognition for intelligent transport systems. Number plates can have different shapes and sizes along with different colours. The most common vehicle number plate in India has the background colour yellow or white with the font colour black. The identification of number plates for vehicles in India has been discussed in this paper, and the numbers have been segmented to identify them specifically.

In this paper [23] author builds a YOLO Advanced Smart Traffic Assistance Platform for Number Plate and Helmet Detection. Here is the software using YOLO V8 to recognize the motorbike drivers, who are not obeying helmet law in an automated way. The helmet and license plate detection system using YOLO V8 is a computer vision technology-based system that utilizes the You Only Look Once (YOLO) object detection algorithm to detect helmets and license plates in real-time. The system is designed to improve safety on roads and highways by detecting riders without helmets and vehicles without proper license plates. The system consists of motorcycle detection, helmet and no helmet detection as well as bike license plate recognition.

The system is capable of processing images from a variety of sources, including traffic cameras and drones. It can detect the presence or absence of helmets and license plates in the image frames. It uses a deep learning model trained on a large dataset of annotated images to identify and classify objects. The output of the system includes a bounding box around each detected object and a label indicating whether it is a helmet or a license plate. The system can also be configured to generate alerts or notifications when violations are detected. Overall, this system provides a valuable tool for law.

3. Methodology

The AI-powered Vehicle Monitoring System project combines advanced technologies like Python, PHP, EasyOCR, OpenCV, HaarCascade, and Rest API. It extensively used Python as the primary programming language. The integration of advanced technologies such as EasyOCR, OpenCV, and HaarCascade done with Python Use of Python allows for effective coordination between the different components and well-optimized solutions for vehicle monitoring. Also used two Python scripts in the project. One for the detection of the number plate and another one for extracting characters from the detected license plate.

3.1. OpenCV

OpenCV, or Open-Source Computer Vision Library, is a widely used open-source computer vision and image processing library. It integrates well with machine learning algorithms, enabling the incorporation of advanced algorithms like HaarCascade for object detection, which is used for dynamic image processing, allowing the system to analyze and manipulate images in real-time. Figure 1 is a sample of the object-detecting method flow. In the project, the Python code uses the OpenCV library to implement a real-time license plate detection system from a live webcam. Set the path to a pre-trained Haar Cascade XML file designed for license plate detection. Stream frame converted to grayscale and passed through the Haar Cascade Classifier to detect license plates. Then, draw a rectangle around the license plate and show the region of interest in a separate window if a plate is detected. Detected license plate figures are shown below in Figures 2 and 3.

3.2. EasyOCR

EasyOCR is a Python module for optical character recognition. Used to accurately identify and extract alphanumeric characters from license plates. It can be easily combined with other technologies, such as OpenCV.

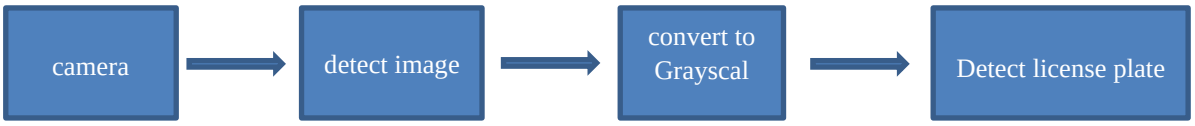

Fig. 1 The first flow of the program

Fig. 2 Sample image of detected plate-1

Fig. 3 Sample image of detected plate-2

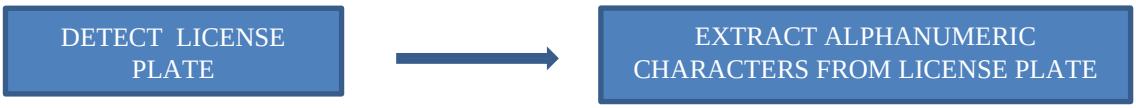

Fig. 4 Diagram of easyOCR

Fig. 5 Sample image of grayscale image

Fig. 6 Sample image applied to easyOCR

```
Neither CUDA nor MPS are available - defaulting to CPU. Note: This module is muc
h faster with a GPU.
Text in scaned_img_0.jpg: MH 20 EJ 03647
{"status":true}
```

Fig. 7 Extracted license plate characters

The easyOCR script for each unprocessed image of the license plate reads the image and applies grayscale conversion, Gaussian blur, and adaptive thresholding to enhance OCR accuracy. EasyOCR is used to extract text from the processed image. The script prints the extracted text along with the corresponding image file name. The grayscale-converted plate is shown below in Figure 5.

Figure 6 is a sample that is applied to easyOCR for extracting characters; the output sample is shown in Figure 7.

3.3. HaarCascade

Haar Cascade is a machine-learning object detection method used for identifying objects in images or video frames. It is used to enhance the system's capability for robust object detection and low configuration system needed. It was First published by Paul Viola and Michael Jones in their 2001 paper, Rapid Object Detection using a Boosted Cascade of Simple Features; this original work has become one of the most cited papers in computer vision literature. In their paper, Viola and Jones propose an algorithm that can detect objects in images regardless of their location and scale in an image. This algorithm can run in real-time, making it possible to detect objects in video streams. Haar Cascade is a machine learning-based approach where a lot of positive and negative images are used to train the classifier. Positive images – These images contain the images which we want our classifier to identify. Negative Images – Images of everything else which do not contain the object we want to detect. Haar-like features involve simple rectangular filters applied to different regions within an image. These filters capture basic image characteristics like edges, lines, and corners. By combining various Haar-like features at different scales and locations, the model can detect more complex patterns. Haar cascades on a feature extraction approach called Haar-like features, which involve simple rectangular filters applied to different regions within an image. These filters capture basic image characteristics like edges, lines, and corners. By combining various Haar-like features at different scales and locations, the model can detect more complex patterns.

3.4. Other Tools

Rest API is used in the project for passing some parameters to PHP to create and manipulate the database. PHP is used in the project for ease of creating and managing the database where the license plate date and time are stored. From the PHP scripts, some filtering of alpha-numeric characters is done. Camera used in the project for real-time detection of license plates. A laptop web camera is used to detect the license plate in this system. The database is used to store information on licence plates. In the project, MYSQL is used as the database. It makes data insertion and retrieval so easier process. A sample image database is given below in Figure 8.

License Number	Date	Time
KL11BM8089	05 Mar 2024	10:53 PM
KL11BM8089	05 Mar 2024	10:54 PM
KL11BM8089	05 Mar 2024	10:54 PM
KL11BM8089	05 Mar 2024	10:54 PM
KL11BM8089	05 Mar 2024	10:54 PM
KL11BM8089	05 Mar 2024	10:55 PM
KL11BM8089	05 Mar 2024	10:55 PM

Fig. 8 Database sample

Table 1. Performance matrix of experiments

Metric	Metric value (0-1)
precision	.6667
Recall	.6667
F1 score	.6667

4. Experimental Results

The integration of Haarcascade, OpenCV, EasyOCR, and Web camera produced noteworthy results across key aspects: The license plate detection is fast while using the Haarcascasde object detection model. It quickly detects the number plate almost if a proper license plate is present on the video stream (camera). If the system is designed using Yolo it can get far better results. The EasyOCR Python module is used for character recognition. It helped to extract alpha-numeric characters from the detected number plate. In the project, the license plate is stored in a folder, and the image (region of interest) is passed to the EasyOCR class. Easy OCR predicts 75% accurately. pytesseract module is also used, it sometimes gives good results, but 70% of predictions are inaccurate. So eliminated it. In the project, low low-configured laptop Webcam is used as a camera for detecting number plates in real time and has got the maximum good results that a laptop webcam can do. Also used a mobile camera by setting up an irium-cam server, which connects a mobile camera to a laptop. But it showed connection lags which negatively affected the output. It is far better to use a camera with a high shutter speed and resolution for better results. The database is used to store the license alpha-numeric characters date, and time of entry. The Database used is MYSQL. It helped to retrieve the vehicle entries easily to the website for the user. In the project, the simplest user-friendly interface is provided for users to access the vehicle details. And used HTML, and PHP to build the user interface. Users can access data by filtering with vehicle license number or date or by both.

YOLOv8 is the newest state-of-the-art YOLO model that can be used for object detection, image classification, and instance segmentation tasks. YOLOv8 was developed by Ultralytics.first started the project using yolov8 and paddleocr. After realizing the Yolo v8 and paddlepaddlegpu didn't support or meet computer requirements, dropped it. It needs Cuda-enabled GPUs also, so tried it with Google Colab. But faced many errors in accessing the webcam to make it real-time detection. So dropped it. Then realized that Google Colab does not meet the requirements because it cannot access the webcam. Then started to restart the project with Yolo v4. It also failed because it could detect license plates from images, but in real-time, it struggled and felt intense lag on the computer. So, it also dropped. The precision, recall, and F1 scores in these cases are all 0.6667, which means they have the same value.

Precision is the ratio of correctly predicted positive observations to the total predicted positives. It means that out of all the predicted positive instances, 66.67% are correct. Precision = True Positives / (True Positives + False Positives). Recall, also known as sensitivity or true positive rate, is the ratio of correctly predicted positive observations to all observations in the actual class. This means that 66.67% of the actual positive instances were correctly predicted. Recall = True Positives / (True Positives + False Negatives). The F1 score is the harmonic mean of precision and recall. It is a measure that combines both precision and recall into a single metric. The F1 score is 0.6667, which is the same as precision and recall. F1 Score = 2 * (Precision * Recall) / (Precision + Recall). Having the same values for precision, recall, and F1 score indicates that the model is achieving a balanced performance.

5. Discussion

In the project, a low-configured computer is used, so that couldn't use the modern, highly accurate CNN like yolov8.pytorch, etc. A normal laptop webcam is used for streaming; it has a lower shutter speed and low resolution, making the license plate images weird, which affects extracting characters as the system is configured with low-specification computers and cameras in the project. It was difficult to use the modern algorithm, which can make project accuracy slightly low. For better accuracy, a camera with high shutter speed and resolution and a computer with GPU with Cuda-enabled graphics are necessary for localizing the project.

There are great possibilities for the future integration of the project 'AI-powered vehicle monitoring system'. The current project, utilizing EasyOCR, OpenCV, and HaarCascade algorithms, lays the groundwork for future advancements and collaborations. Future integration could involve adding machine learning models for even more accurate and adaptive recognition. Deep learning algorithms, Convolutional Neural Networks (CNNs), could enhance the system's ability to recognize licenses in complex situations.

6. Conclusion

The research paper is an AI-powered vehicle monitoring system. The system is good at monitoring vehicles in real-time, EasyOCR makes reading license plates, and OpenCV makes smart decisions. HaarCascade helps in finding car license plates. The system has been tested a lot in different situations to make sure it's integrated and works well, so it can be used for any institution which needs an automated vehicle register. The system also tried using Yolo for detecting license plates, but Yolo needs a super-configured computer for its working. Yolo can recognize fast and make a good quality prediction. The system also tried with pytesseract for extracting alphanumeric characters from license plates, but it did not detect characters, and the image is a little weird. The project can help students and people who want to make a license plate detection-based project. Putting the latest technologies together makes everything safer and works smoother. The research shows there's more contribution can do to make surveillance systems for vehicles even better. It's like a starting point for more cool ideas and improvements. The project work encourages others to join in and make smart, efficient, and safe monitoring systems.

References

[1] Tejas Walke et al., "Miniature Model of Autonomous Vehicle Using Arduino UNO and Open CV," *International Journal for Research in Applied Science and Engineering Technology*, vol. 10, no. 4, pp. 3294-3305, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[2] Ananya Sri Shetty et al., "Vehicle Number Plate Detection through Live Stream Using Optical Character Recognition (OCR)," *2023 7th International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India*, pp. 1548-1553, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[3] P. Siva Kumar, S. Shanmugasundaram, and S. Mahalakshmi, "Vehicle Number Plate Identification and Speed Detection for Traffic Surveillance Prevention Using Machine Learning," *International Conference on System, Computation, Automation and Networking (ICSCAN)*, Puducherry, pp. 1-5, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[4] N. Palanivel Ap et al., "Automatic Number Plate Detection in Vehicles Using Faster R-CNN," *2020 International Conference on System, Computation, Automation and Networking (ICSCAN)*, Pondicherry, India, pp. 1-6, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[5] S.M. Sunny et al., "Image Based Automatic Traffic Surveillance System Through Number-Plate identification And Accident Detection," *2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST)*, DHAKA, Bangladesh, pp. 467-472, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[6] Ayesha Naureen et al., "College Bus Number Plate Registration Detection Using YOLO-V8," *2023 International Conference on Evolutionary Algorithms and Soft Computing Techniques (EASCT)*, Bengaluru, India, pp. 1-7, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[7] Reezky Illmawati, and Hustinawati, "YOLO V5 for Vehicle Plate Detection in DKI Jakarta," *Journal of Computer Science and Agri-Informatics*, vol. 10, no. 1, pp. 32-43, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[8] Pooja Suresh Puri, and Prashant P. Bartakke, "SSD Based Vehicle Number Plate Detection and Recognition," *2023 International Conference on Network, Multimedia and Information Technology (NMITCON)*, Bengaluru, India, pp. 1-6, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[9] Henakshi Das, Prasant Kumar Sahu, and Kukil Khanikar, "AI-Based License Plate Detection of on-Road Vehicle," *2023 International Conference on Microwave, Optical, and Communication Engineering (ICMOCE)*, Bhubaneswar, India, pp. 1-4, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[10] K. Suneetha, and K. Mounika Raj, "Automatic Vehicle Number Plate Recognition System (AVNPR) Using OpenCV Python," *Proceedings of the 2nd International Conference on Computational and Bio Engineering*, pp. 487-496, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[11] P.S. Gaikwad et al., "Real-time Vehicle Count, Speed Estimation and Number Plate Detection Using CCTV Footage," *2023 1st International Conference on Cognitive Computing and Engineering Education (ICCCEE)*, Pune, India, pp. 1-4, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[12] Nita Thakare et al., "Automatic Vehicle Number Plate Detection System," *International Journal of Scientific Research in Engineering and Management (IJSREM)*, vol. 7, no. 3, pp. 1-3, 2023. [CrossRef] [Publisher Link]

[13] A. Kathirvel et al., "Systematic Number Plate Detection Using Improved YOLOv5 Detector," *2023 2nd International Conference on Vision Towards Emerging Trends in Communication and Networking Technologies (ViTECoN)*, Vellore, India, pp. 1-6, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[14] A.S. Mohammed Shariff et al., "Vehicle Number Plate Detection Using Python and Open CV," *2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)*, Greater Noida, India, pp. 525-529, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[15] B. Rithik et al., "Licence Plate Recognition System Using Open-CV and Tesseract OCR Engine," *International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)*, vol. 9, no. 9, pp. 69-73, 2022. [Publisher Link]

[16] Qudes Mb Aljelawy, and Tariq M Salman, "Detecting License Plate Number Using OCR Technique and Raspberry Pi 4 With Camera," *2022 2nd International Conference on Computing and Machine Intelligence (ICMI)*, Istanbul, Turkey, pp. 1-5, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[17] C. Jeeva et al., "Intelligent Image Text Reader Using Easy OCR, NRCLex & NLTK," *2022 International Conference on Power, Energy, Control and Transmission System (ICPECTS)*, Chennai, India, pp. 1-6, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[18] R. Shashidhar et al., "Vehicle Number Plate Detection and Recognition using YOLO- V3 and OCR Method," *2021 IEEE International Conference on Mobile Networks and Wireless Communications (ICMNWC)*, Tumkur, Karnataka, India, pp. 1-5, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[19] M. Maria Rubiston et al., "Vehicle Speed Determination Using Haarcascade Algorithm," *2023 9th International Conference on Smart Structures and Systems (ICSSS)*, Chennai, India, pp. 1-5, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[20] Raghav Puri, and Harneet Kaur, "Automatic Number Plate Detection System," *International Journal of Creative Research Thoughts (IJCRT)*, vol. 10, no. 5, pp. c34-c46, 2022. [Publisher Link]

[21] Vishal Singh et al., "Recognition of Vehicle Number Plates and Real-Time Identification using Open CV," *International Journal for Research in Applied Science and Engineering Technology (IJRASET)*, vol. 7, no. 4, pp. 1917-1920, 2019. [CrossRef] [Publisher Link]

[22] Mudit Shrivastava et al., "Vehicle Owner Recognition and Speed Estimation through LPD Using Deep Learning (VORSELD)," *ITM Web of Conferences*, pp. 1-9, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[23] M. Maheswari, A. Saranya, and S. Aruna, "An Efficient Number Plate Detection System Based on Indian Traffic Rules," *IOP Conference Series: Materials Science and Engineering*, vol. 993, pp. 1-7, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[24] Divya Rastogi et al., "A Real-Time Vehicle Number Plate Detection and Recognition System," *Journal of Xi'an University of Architecture & Technology*, vol. 12, no. 4, pp. 5005-5009, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[25] Rishabh Rathi et al., "License Plate Detection Using YOLO v4," *International Journal of Health Sciences*, vol. 6, no. S2, pp. 9456-9462, 2022. [CrossRef] [Publisher Link]

[26] Meena Deshpande, and M.B. Veena, "License Plate Detection and Recognition Using YOLO v4," *Webology*, vol. 18, no. 4, pp. 237-244, 2021. [Google Scholar] [Publisher Link]

[27] Twana Mustafa, and Murat Karabatak, "Deep Learning Model for Automatic Number/License Plate Detection and Recognition System in Campus Gates," *2023 11th International Symposium on Digital Forensics and Security (ISDFS)*, Chattanooga, TN, USA, pp. 1-5, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[28] Shally Gupta et al., "Detection of Vehicular Number Plate System using Deep Learning Approach," *Journal of Emerging Technologies and Innovative Research (JETIR)*, vol. 8, no. 3, pp. 1627-1636, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[29] Sarthak Ranjan et al., "OCR based Automated Number Plate Text Detection and Extraction," *2022 9th International Conference on Computing for Sustainable Global Development (INDIACom)*, New Delhi, India, pp. 621-627, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[30] Nandan Verma, Mohit Jauhari, and Rashmi Mishra, "Analysis of Object Detection Method Using Open CV–Python," *International Journal for Research in Engineering Application & Management*, vol. 6, no. 1, pp. 422-426, 2020. [CrossRef] [Publisher Link]

[31] Shivganga Patil, and Ashwini, "Licence Plate Number Detection Using Open CV and Python," *International Journal of Creative Research Thoughts (IJCRT)*, vol. 10, no. 8, pp. 257-268, 2022. [Publisher Link]