VEHICLE NUMBER PLATE DETECTION

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I. ABSTRACT

Our goal is to create a system that can recognize and license plates on automobiles. The inconsistency of plate designs, lighting circumstances, and the requirement for real-time processing provide the difficulties. Deep learning algorithms and sophisticated computer vision techniques are used in our method. The system will be trained to identify different plate forms, adjust to different lighting conditions, and guarantee recognition accuracy. We'll use convolutional neural networks, and we might even use a two-step localization and recognition procedure. Regarding performance and outcomes, the measures will center on detection speed, accuracy, and environment adaptation. We will perform a thorough assessment on a variety of datasets to make sure our solution is resilient.

II. INTRODUCTION

Vehicle Number Plate Detection is a image processing and computer vision technique. The technology contains Identification and recognition of area of interest i.e. license plate on vehicle. The model starts from capturing image or video frames containing automobiles. The primary objective is to automate the process of accurate identification and efficiently extracting alphanumeric character from the license plate.

There are various approaches proposed for detection of number plate and recognition of character. Popular approach are, Convolution Neural Network , YOLO model for image processing and Feature Extraction which are performed on huge dataset for better and accurate outcomes. The next phase includes optical character recognition for analyzing patterns and shapes of characters and convert it to machine readable text. This model helps in various application including automobile tracking , toll collection. As technology advances then the potential of vehicle number plate recognition is refined and scaled. There are many constraints to which challenges the system such as blur images, dynamic fonts and their size, reflection of sunlight on plate. When a model is well trained for above constraints then outcome results robust and reliable number plate detection system.

Image Segmentation techniques must extract meaningful segments. Which results extraction ofregion of interest accurately. Edge Detection algorithm finding boundaries within images. Hough transformation is used for finding line in the images which can be applied to identify the straight lines on license plate.

Refining the results by filtering out false positives in post processing and testing the accuracy of various models helps for selecting a efficient model for implementing in project.

III. LITERATURE SURVEY

Hengliang Shi et.al., [1] on “Vehicle Number Plate Detection Using Improved YOLOv5 Model Link to IEEE paper” published on 30 January 2023. The model uses an enhanced channel attention mechanism in the you only look once(YOLOv5) works better to improve the accuracy of feature extraction of the model. Less relevant parameters on the input side is minimized, and single class is placed in the YOLO layer, which make model better in efficiency and accuracy in detecting number plate. Gated recurrent units + connectionist temporal classification is used to create a optical recognition network to handle the character recognition task, makes training time more efficient and maintain the consistency speed and optical recognition accuracy of the model.

Md. Atikuzzaman et.al., [2] proposed a vehicle number plate detection algorithm based on YOLOv5 in 2018.Three steps made up their method: segmentation of the letter classes, recognition, and plate detection. They used their special method for letter extraction and HAAR feature-based classifier for plate detection, and a Convolutional Neural Network (CNN) for letter recognition. Their algorithm demonstrated a commendable recognition rate of 91.38% and operated at an efficient frames-per-second rate.

Xiuqin Pan et.al., [3] introduced “A hybrid deep learning algorithm” in December 2022, dedicated for detecting number plate and recognition of detected region of interest in vehicle-to-vehicle (V2V) transport. They integrated the concept of YOLOv3 for its efficiency and consistent accuracy with the Convolutional Recurrent Neural Network (CRNN) known for its excellent detection capabilities.

Preeti Arora, Vinod M Kapse et.al., [4] presented a 2021 paper titled "Number Plate Recognition System Using Convolutional Neural Network". Here the automatic plate recognition in performed using CNN. The three components of their system architecture were character recognition, segmentation, and number plate detection. The authors employed the (YOLO) algorithm to detect license plate numbers instantly, achieving a 98.5% accuracy rate on their dataset of 1000 Indian license plate images.

Md. Atikuzzaman et.al., [5] in their 2019 publication, "Vehicle Number Plate Detection and Categorization Using CNNs", detailed plate detection, letter class segmentation, and identification are the three stages of the approach. For plate detection, they used a classifier based on HAAR features. 91.38% of the system's frames were recognized at a speed of about 30 frames per second. They reported 96.92% accuracy for their License Plate Detection system and 94.61% accuracy for Class Letter Segmentation after testing their system with 390 test photos.

N.Palanivel Ap, T. Vigneshwaran et.al., [6] 2020 paper, "Automatic Number Plate Detection in Vehicles using Faster R-CNN", discussed a technique to discern number plates in challenging scenarios such as distorted views, variable lighting, and dusty conditions. They advocated for the use of Faster R-CNN, especially for surveillance cameras in traffic zones.

Lin Xu et.al., [7] in 2021, shared a study titled "License Plate Detection Methods Based on OpenCV". They performed two detection techniques based on OpenCV: one relying on Sobel edge detection a method that uses the gradient of the image's intensity to find edges in an image and the second method is based on morphological gradient detection technique for drawing attention to borders or boundareis in an image, It is predicated on morphological processes like erosion and dilatattion.

Mohit Kumar Kushwaha et.al., [8] in their 2022 paper "Car Number Plate Detection using Deep Learning". Research is made on deep learning-based approach for automatic number plate recognition using a convolutional neural network. Like other systems, consist of 3 phase: segmentation, recognition of character, and number plate detection.

Sarthak Babbar et.al.,[9] described in their work, "A New Approach for Vehicle Number Plate Detection", a method to refine number plate images using diverse filters, After implementing ratio analysis and CCA to segment the alphabets, they used a variety of approaches to compare the recognized characters, including SVC (linear), Extra Tree, KNN, SVC+KNN, and LR+RF.

Khin Pa Pa Aung et.al,[10] published paper of title" Automatic License Plate Detection System for Myanmar Vehicle License Plates. Image data were employed in the suggested system. Even though a lot of early research had been done on ALPR, effectively detecting license plates in an open area remained a difficult challenge. The primary challenges are the variety of plates, which include dynamic fonts, color, and style of region of interest across different countries, as well as the conditional changes, which include different lighting and backdrop settings when the images are recorded.

Mohit Kumar Kushwaha et.al, [11] in 2022 published a paper titled "Vehicle Number Plate Detection Using a Deep Learning- Based Ensemble Model, where they introduced a deep learning model for area of interest i.e. number plate identification.

Md. Atikuzzaman et.al., [12] on 2019 paper, "Vehicle Number Plate Detection Using a Deep Learning-Based Attention Model", implemented an Automatic Number Plate Recognition system for live vehicle plate detection and recognition.

Lin Xu, Wenqian Shang et.al., [13] presented a 2021 paper, "Vehicle Number Plate Detection Using a Deep Learning- Based FPN Model", discussing two OpenCV-based license plate detection techniques: firstly implemented Sobel edge detection and the secondly morphological gradient detection.

Md. Atikuzzaman et.al., [14] in 2019 proposed an ANPR system titled "Vehicle Number Plate Detection Using a Deep Learning-Based

Recurrent Neural Network ", attaining a 90.90% recognition rate. In this study, a real-time Automatic Number Plate Recognition system for identifying license plates on cars is proposed.

Sapna Sinha, Saksham Gera et.al., [15] in 2022 authored "Vehicle Number Plate Detection Using a Deep Learning-Based Contextual Embedding Model" for the International Conference on Intelligent Engineering and Management, presenting a system that achieved a 98.5% recognition rate.

Ruixiang Li, Na Sun Gera et.al., [16] in 2022 also authored a paper titled "A Hybrid Deep Learning Algorithm for the License Plate Detection and Recognition in Vehicle-to-Vehicle Communications", YOLOV3 and CRNN are integrated into a hybrid deep learning algorithm that powers the license plate detection and identification model. The results indicate that this suggested model has superior resilience, greater mean average accuracy, and higher performance.

N.Palanivel Ap et.al., [17] in 2020 introduced a paper titled "Automatic Number Plate Detection in Vehicles using Faster R- CNN", highlighting its high recognition rate of 99.1%. The research based on a deep learning-based Number Plate Recognition system that can detect and recognize region of interest from vehicle.

Navroz Dewan, Kartik Shangle, Sanjeev Patel et.al., [18] in 2018 presented "A New Approach for Vehicle Number Plate Detection", presenting an identification technique that achieves a 95.5% recognition rate by combining edge detection, morphological procedures, and SVM. presenting a computer vision approach for obtaining car number plate extraction. Plate localization, character segmentation, and character identification are the three primary stages of the suggested method, which is intended to be used with camera-captured films.

Md. Tanvir Shahed et.al, [19] in 2017 presented a paper titled "Automatic Bengali number plate reader" Offering a method for breif analysis to automatically recognize and read Bengali number plates used in the major cities of Bangladesh. The automatic number plate recognition system uses morphological analysis and image pre-processing, edge detection, regional localization, and character segmentation to efficiently and computationally light-footedly identify the Bengali characters in the number plate. The suggested technique has an average processing time of 0.75 seconds and a detection accuracy rate of about 95% for different weather scenarios.

Dongnan Zhao et.al., [20] in 2023 introduced a paper titled "License Plate Recognition System Based on Improved YOLOv5 and GRU" describing an ANPR system intended for use in natural settings in IEEE Access. An end-to-end deep learning-based Automatic Number Plate Recognition (ANPR) system that can identify and detect license plates on cars in real-world situations is proposed in this work. The three primary stages of the suggested method are plate detection, segmentation, and recognition.

IV. Problem Statement and Backgroung

A. Problem Statement

Build a model for vehicle number plate detection and Character Recognition of extracted number plate.

B. Objectives

Title: Design and Train ML Model

Description: Develop a ML model that can

detect the number plate from the image of vehicle and extract the alpha numeric character using Optical Character Recognition.

Title: Implement Real-time Decision Making

Description: Integrate the ML model to trace the automobiles that violates traffic rule . In public parking area, it is used to trace the license plates of the cars being parked .

C. Assumptions

The street cameras are reliable for providing relevant data to the ML model.

D. Background

The dataset for applying model is consist of 433 images and annotations. We extract annotation from xml to csv of all images in lable.csv then we will work on data preprocessing, build and train a deep learning object detection model (CNN). After that we preform Object Detection model training phase, then segmentation of area of interest then we will crop the image and perform Optical Character Recognition.

V. System Model / Architecture

The proposed system model for Vehicle Number Plate Detection using Machine Learning Techniques, specifically CNN, consists of several interconnected modules. Below is an overview of the system architecture, along with subsections for each module.

A. Data Acquisition Module:

Train the model on dataset contains 433 images with bounding box annotations of the car license plates within the image.

B. Image Preprocessing Module:

Focuses on preprocessing the image data obtained from cameras. Includes operations like resizing, normalization, and other transformations to prepare the images for CNN input.

C. Convolutional Neural Network Module:

Utilizes a trained CNN model for image-based feature extraction. The CNN processes input images and extracts relevant features for predicting the number plate part.

D. Real-time Decision-Making Module:

Integrates the output from the CNN to Optical Character Recognition. Implements algorithms for real-time decision-making to predict the vehicle number plate.

TABLE I

EVALUATION OF REVIEWED RESEARCH PUBLICATIONS FOR .... TECHNIQUE.

Author	Year	Approach	CNN	YOLOv5	KNN	SVM	LR
Hengliang Shi et.al., [1]	2023	Vehicle Number Plate Detection Using Improved YOLOv5 Model	Yes	Yes	--	--	--
N.Palanivel Ap et.al., [17]	2020	Automatic Number Plate Detection in Vehicles using Faster R- CNN	Yes	--	--	--	--
Sarthak Babbar et.al.,[9]	2019	A New Approach for Vehicle Number Plate Detection	--	--	Yes	--	Yes
Xiuqin Pan, Ruixiang et.al., [16]	2022	A Hybrid Deep Learning Algorithm for the License Plate Detection and Recognition in Vehicle-to-Vehicle Communications	Yes	--	--	--	--
Md. Atikuzzaman et.al., [14]	2021	Vehicle Number Plate Detection Using a Deep Learning-Based Recurrent Neural Network	Yes	Yes	--	--	--

Implementations and Performance Analysis

A. Experimental Setup

Project Implementation:

- The project was implemented using Python as the primary programming language.
- Libraries and packages included TensorFlow and Keras for CNN model implementation, scikit-learn for machine learning functionalities, and OpenCV for image processing.
- SVM for Optical Character Recognition.

Machine Specifications:

- The experiments were conducted on a machine with the following specifications:
- Visual Studio Code 1.85.1
  Processor Intel Core i5-1135G7
  RAM: 8 GB
  GPU: NVIDIA GeForce GTX 3050

Assumptions:

- The street cameras are reliable for providing relevant data to the ML model.
- The training data for the CNN model is representative of diverse environment and scenarios.
- The training data for the SVM model is depend on accuracy of number plate detected.

Experiment Parameters:

CNN Model Hyperparameters:
Number of Convolutional Layers: 3
Kernel Size: 7 for the first layer, 3 for subsequent layers
Activation Function: ReLU ,Sigmoid
Pooling: Max pooling with a 2x2 pool size

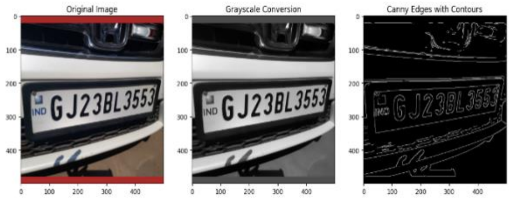
Fully Connected Layers: 2 with 128 and 64 nodes, respectively
Output Layer Activation: Softmax (indicating a classification task with three classes)
Learning Rate: 1e-4 (0.0001)
Optimizer: Adam
Loss Function: Mean Squared Error (MSE)
Batch Size: 20
Epochs:150
Image Preprocessing:

Resizing images to 224x224 pixels.
Normalization of pixel values to a range of [0, 1].

B. Results

List of experiments performed:

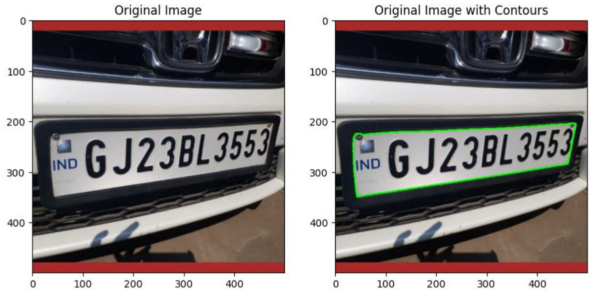
1. Image grayscaling and edging.
2. Applying contours on number plate using xml.
3. Split the dataset.
4. Train the CNN model



5. Test the model
6. Train the SVM model
7. Test the model

1. Image gray scaling and edging:

2. Applying contours on number plate using xml:



This helps the model to understand the nature of number plate in the images.

3. Split the dataset:

```
Shapes of the sets:
x_train shape: (346, 224, 224, 3)
x_test shape: (87, 224, 224, 3)
y_train shape: (346, 4)
y_test shape: (87, 4)
```

4. Train and Test the model:

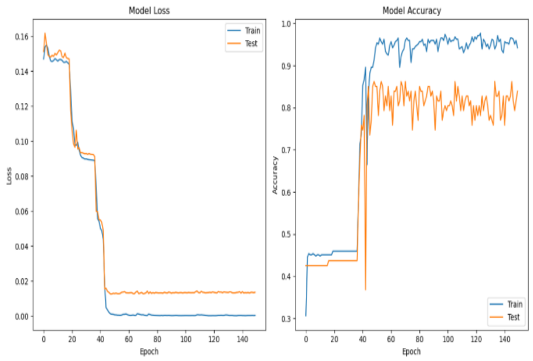
- CNN

Epoch 150/150
18/18 [==============================] - 47s 3s/step - loss: 4.7218e-04 - accuracy: 0.9422 - val_loss: 0.0136 - val_accuracy: 0.8391

3/3 [==============================] - 11s 4s/step - loss: 0.0136 - accuracy: 0.8391
Test Loss: 0.0136
Test Accuracy: 83.91%

6.Model loss and model accuracy:

- CNN



- SVM

```
y_pred = clf.predict(X_test_flat)
acc = np.sum(y_test == y_pred) / y_test.shape[0]
print('Test accuracy: ', acc)
```

```
Test accuracy:  0.9581653225806451
```

```
x_train_flat = x_train.reshape(x_train.shape[0], -1)
x_test_flat = x_test.reshape(x_test.shape[0], -1)

scaler = StandardScaler()
x_train_flat_std = scaler.fit_transform(x_train_flat)
x_test_flat_std = scaler.transform(x_test_flat)

svm_regressor = SVR()

svm_regressor.fit(x_train_flat_std, y_train_reshaped)

y_pred = svm_regressor.predict(x_test_flat_std)

mse = mean_squared_error(y_test_reshaped, y_pred)
print(f"Mean Squared Error: {mse:.4f}")
```

```
Mean Squared Error: 0.0318
```

VI. Conclusion

Vehicle tracking has grown in importance as a study topic because to the rise in automobiles, which helps with effective traffic management, surveillance, and the recovery of stolen vehicles. Efficient real-time license plate detection and identification are crucial for this reason. License plate identification is a major difficulty in developing nations because of variations in backdrop and text color, font style, license plate size, and non-standard characters. This work uses a deep learning approach to increase the effectiveness of license plate identification in order to get around such problems. The gathered photos have been taken at several angles of rotation, at different distances from the camera, and with different lighting and contrast settings. They have also been verified to yield a high identification rate.

VIII. REFERENCES

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