Final Capstone Project: 03

Automatic Number Plate Recognition Using C.N.N

IOT Academy, IIT Guwahati

	Prepared By	Reviewed by
Name	Ms. Jayashri Pacharane	Mr. Arihant Jain
Designation	Trainee	Manager
Signature (with Date)		

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1. Title of The Project: Automatic Number Plate Recognition

2. Objective:

The primary objective of Automatic Number Plate Recognition (ANPR) using Convolutional Neural Networks (CNNs) is to develop an efficient and accurate system for automatically identifying and extracting vehicle license plate numbers from images or video streams. This technology aims to enhance real-time processing capabilities, ensuring rapid recognition for applications such as traffic law enforcement, toll collection, parking management, and security surveillance. By leveraging deep learning, ANPR systems can achieve high accuracy even in challenging conditions, including varying lighting, different angles, motion blur, and occlusions. Additionally, CNN-based ANPR models are designed to be robust and adaptable, allowing them to recognize license plates with different fonts, sizes, and formats from multiple regions. The system should also be scalable and easily deployable in existing infrastructures while maintaining efficiency and minimizing computational costs. Furthermore, ANPR using CNNs contributes significantly to security and law enforcement by aiding in stolen vehicle identification, monitoring traffic violations, and enhancing border security. Overall, the integration of CNNs into ANPR systems helps automate and streamline vehicle identification, reducing manual effort and improving accuracy, reliability, and speed in real-world applications.

- Develop a system to detect and recognize vehicle number plates automatically.
- Use machine learning and deep learning techniques, specifically CNNs, for character recognition.
- Pre-process images to improve recognition accuracy.

3. Brief on The Project:

Automatic Number Plate Recognition (ANPR) is a computer vision-based system designed to automatically detect, extract, and recognize vehicle license plate numbers from images or video feeds. This project utilizes Convolutional Neural Networks (CNNs) and deep learning techniques to enhance accuracy and efficiency in real-time applications such as traffic law enforcement, toll collection, parking management, and security surveillance. The process involves several key steps, including image acquisition, preprocessing to enhance quality, license plate detection using object detection models like YOLO or Faster R-CNN, character segmentation, and Optical Character Recognition (OCR) for text extraction. By leveraging deep learning frameworks such as TensorFlow along with OpenCV for image processing, ANPR systems can effectively handle various challenges like varying lighting conditions, occlusions, and different plate formats. This technology plays a crucial role in modern Intelligent Transportation Systems (ITS) by automating vehicle identification, reducing manual effort, and improving the accuracy and speed of license plate recognition in various real-world applications.

4.Project Overview

This project is focused on Automatic Number Plate Recognition (ANPR) using Convolutional Neural Networks (CNN). The goal is to detect and recognize vehicle license plates from images and extract their alphanumeric characters.

5. Problem Statement:

In many urban areas, traffic congestion, vehicle-related crimes, and parking management require efficient vehicle identification methods. Manual identification and logging of

vehicle number plates are time-consuming, prone to human error, and inefficient, especially in high-traffic areas.

An Automatic Number Plate Recognition (ANPR) system aims to automate the process of recognizing and extracting license plate information from vehicles using image processing and deep learning techniques. The system captures images of vehicles, detects the number plate region, extracts alphanumeric characters, and converts them into machine-readable text.

6. Use Cases:

ANPR systems have a wide range of applications across multiple industries. Below are some of the most common use cases:

6.1. Traffic Law Enforcement:

- **Speed Limit Violations:** Captures license plates of speeding vehicles using radar and cameras.
- **Red Light Violations:** Identifies vehicles that run red lights.
- **Wrong Lane or Unauthorized Entry:** Detects vehicles in restricted lanes (e.g., bus lanes, emergency lanes).

6.2. Parking Management:

- **Automated Parking Entry/Exit:** Recognizes number plates for seamless access without human intervention.
- **Payment Automation:** Integrates with payment systems for ticketless parking.
- **Time-Based Parking Monitoring:** Tracks vehicles' entry and exit to prevent overstays.

6.3. Toll Collection & Smart Highways:

- **Electronic Toll Collection (ETC):** Automatically bills vehicles without stopping.
- **Traffic Flow Monitoring:** Helps in analyzing congestion and rerouting traffic.

6.4. Security & Surveillance:

- **Stolen Vehicle Detection:** Cross-references plates against law enforcement databases.
- **Crime Investigation:** Tracks suspect vehicles in criminal activities.
- **Access Control in Restricted Areas:** Ensures only authorized vehicles enter secured premises.

6.5. Border Control & Customs:

- **Vehicle Tracking Across Borders:** Automates vehicle registration at checkpoints.
- **Illegal Vehicle Monitoring:** Detects unregistered or blacklisted vehicles.

6.6. Fleet Management & Logistics:

- **Vehicle Tracking:** Monitors the movement of company vehicles.
- **Route Optimization:** Helps in efficient dispatching of transport services.

6.7. Smart Cities & Urban Planning:

- **Traffic Pattern Analysis:** Gathers data to optimize city traffic management.
- **Environmental Monitoring:** Tracks high-emission vehicles to enforce eco-friendly policies.

7. Project Deliverables:

In this Project, we will focus on Recognition of the yield of automatic number plate of car using CNN based Deep Learning Models. we have collected data from website or Kaggle link.

7.1 Data Collection and Pre-Processing:
The first phase of the project focuses on gathering relevant data from multiple sources, websites or Kaggle link. The collected data will be cleaned to address missing values, and inconsistencies.

7.2 Model Development:

The second stage of the project involves the selection and development of CNN model.

7.3 Model Evaluation:

In this phase, the trained models will be evaluated on a testing dataset to assess their performance. Evaluation metrics will include **Accuracy** to measure prediction accuracy and the proportion of variance explained by the model.

8. Resources:

8.1 Data Set Sources:

The Source of the data set is Kaggle.

Dataset link: https://www.kaggle.com/code/sarthakvajpayee/license-plate-recognition-using-cnn/notebook

8.2 Software:

Google Collab Software is being used to build the CNN Based Deep Learning Model.

9. Individual Details:

9.1 Name: Jayashri Pacharane
9.2 E-Mail ID: pacharanejayashri@gmail.com
9.3 Contact Details: 8411921362

10. Milestones:

10.1 Define a Problem:
In many urban areas, traffic congestion, vehicle-related crimes, and parking management require efficient vehicle identification methods. Manual identification and logging of vehicle number plates are time-consuming, prone to human error, and inefficient, especially in high-traffic areas. An Automatic Number Plate Recognition (ANPR) system aims to automate the process of recognizing and extracting license plate information from vehicles using image processing and deep learning techniques. The system captures images of vehicles, detects the number plate region, extracts alphanumeric characters, and converts them into machine-readable text.

10.2 Get the Data:

Dataset link: https://www.kaggle.com/code/sarthakvajpayee/license-plate-recognition-using-cnn/notebook

10.3 Explore and Pre-Process Data:

In training data Found 864 images belonging to 36 classes.
In validation (testing data) Found 216 images belonging to 36 classes.

Choosing the Google Collab Platform.
I have Selected Google Collab as a platform for creating
the CNN Based Deep Learning Model.

11. EDA:

While Performing the EDA, the following are our Observations:

11.1   Understanding the Dataset:
In training data Found 864 images belonging to 36 classes.
In validation (testing data) Found 216 images belonging to 36 classes.

11.2   Data Preprocessing:

11.2.1 Data Collection:

- Gathering images of vehicles with number plates from various sources.
- Creating a labelled dataset for training and testing the model.

11.2.2 Image Pre-processing:

- Converting images to grayscale.
- Applying noise reduction and edge detection techniques.
- Resizing images for uniform input.

11.2.3 License Plate Detection:

- Using OpenCV and deep learning-based object detection methods.
- Extracting the region of interest (ROI) containing the number plate.

11.2.4 Character Segmentation & Recognition:

- Segmenting individual characters from the number plate.
- Using CNN-based Optical Character Recognition (OCR) to classify characters.

12. Create Model:

I create CNN Based Deep learning model for automatic number plate recognition. Training a CNN model on segmented characters. And model compile on accuracy & getting 100 % accuracy.

13. Model Evaluation:

13.1 Training a CNN model on segmented characters.

13.2 Evaluating performance using accuracy and loss metrics.

13.3 Comparing the All alphanumeric characters using "For Loop".

13.4 In the Performance Metrices, we see the best Performance in the both training (100%) and testing in (100%).

13.5 Checked the accuracy score of the model.

14. Report Writing:

Abstract:

Automatic Number Plate Recognition (ANPR) is a crucial technology in intelligent transportation systems, aiding in vehicle identification and traffic management. This project leverages Convolutional Neural Networks (CNN) and computer vision techniques to develop an efficient ANPR system. The proposed model processes images to detect and recognize license plates, extracting alphanumeric characters with high accuracy. Key steps include image preprocessing, plate detection using OpenCV, character segmentation, and deep learning-based OCR for recognition. The system's performance is evaluated on real-world datasets, with considerations for deployment in surveillance and traffic monitoring applications.

14.1 Introduction:

Automatic Number Plate Recognition (ANPR) is a cutting-edge technology used in intelligent transportation systems to automatically identify and read vehicle license plates. With the rapid increase in the number of vehicles, traditional methods of vehicle identification have become

inefficient. ANPR provides a robust solution for traffic management, security enforcement, and automated toll collection.

The core functionality of ANPR involves detecting, segmenting, and recognizing license plate characters from images or video feeds. This project utilizes computer vision techniques and deep learning, specifically Convolutional Neural Networks (CNNs), to develop an effective ANPR system. The system processes images by detecting license plates, extracting their alphanumeric characters, and recognizing them with high accuracy. The integration of ANPR can significantly enhance security, reduce human effort, and improve efficiency in monitoring roadways.

14.2 Problem Statement:

With the growing number of vehicles on the roads, there is an increasing need for an efficient and automated system to identify and manage vehicle information. Traditional methods of manually verifying vehicle registration numbers are time-consuming, prone to errors, and inefficient in handling large-scale traffic scenarios.

The main challenges in number plate recognition include:

- **Variability in License Plates:** Different countries and regions have diverse formats, fonts, and sizes for number plates.
- **Environmental Factors:** Poor lighting conditions, low image resolution, and occlusions can hinder accurate recognition.
- **Real-Time Processing:** ANPR systems need to be fast and efficient to work in real-world applications like toll booths, parking systems, and law enforcement.
- **Data Quality Issues:** Noisy images, distorted plates, and variations in character spacing can impact the accuracy of recognition models.

This project aims to address these challenges by developing a robust, deep learning-based ANPR system that can efficiently detect, segment, and recognize vehicle number plates in real-time with high accuracy.

14.3 Methodology:

14.3.1 Data Collection:

- Gathering images of vehicles with number plates from various sources.
- Creating a labelled dataset for training and testing the model.

14.3.2 Image Pre-processing:

- Converting images to grayscale.
- Applying noise reduction and edge detection techniques.
- Resizing images for uniform input.

14.3.3 License Plate Detection:

- Using OpenCV and deep learning-based object detection methods.
- Extracting the region of interest (ROI) containing the number plate.

14.3.4 Character Segmentation & Recognition:

- Segmenting individual characters from the number plate.
- Using CNN-based Optical Character Recognition (OCR) to classify characters.

14.3.5 Model Training and Evaluation:

- Training a CNN model on segmented characters.
- Evaluating performance using accuracy and loss metrics.

14.3.6 Deployment & Testing:

- Integrating the trained model into an application.
- Testing on real-world images and videos.

14.4 Model Evaluation:

14.4.1 Training a CNN model on segmented characters.

14.4.2 Evaluating performance using accuracy and loss metrics.

14.4.3 Comparing the All alphanumeric characters using "For Loop".

14.4.4 In the Performance Metrices, we see the best Performance in the both training (100%) and testing in (100%).

14.4.5 Checked the accuracy score of the model.

15. Technologies Used:

- Python
- OpenCV
- TensorFlow/Keras
- NumPy, Pandas
- Matplotlib, Seaborn

16. Conclusion:

The Automatic Number Plate Recognition (ANPR) system developed in this project demonstrates the potential of deep learning and computer vision for real-world applications. By

leveraging Convolutional Neural Networks (CNNs) and OpenCV, the system effectively detects, segments, and recognizes license plates with high accuracy. The implementation of ANPR can significantly contribute to various domains, including traffic management, law enforcement, and security surveillance.

Despite its effectiveness, challenges such as varying lighting conditions, occlusions, and different plate formats remain areas for improvement. Future enhancements could include refining the model with more diverse datasets, improving real-time performance, and integrating ANPR with cloud-based databases for large-scale deployment. This project lays the foundation for more advanced and scalable ANPR solutions, paving the way for smarter and more efficient transportation systems.

16.1 BEST MODEL: (Training- 100% & Testing- 100%)

Reason: It achieves the highest Accuracy both training and testing datasets.

Balanced performance on training and testing data suggests the model generalizes well and very good.

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