**Final Project**

**Automatic Number Plate Recognition System using CNN**

***IOT Academy, IIT Guwahati***

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|  | **Prepared By** | **Reviewed by** |
| **Name** | Mayank Vajpayee | Mr. Arihant Jain |
| **Designation** | Trainee | Trainer |
| **Signature (with Date)** |  |  |

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1. **Abstract**

Automatic Number Plate Recognition (ANPR) is a computer vision technology designed to detect and interpret vehicle license plates from images or video feeds. This project presents the development of an ANPR system that leverages image processing and machine learning techniques to accurately extract vehicle registration numbers. The proposed system offers practical applications in traffic management, toll collection, and security enforcement. This report details the system’s methodology, implementation process, and performance evaluation results.

1. **Introduction**

Automatic Number Plate Recognition (ANPR) systems play a critical role in modern traffic management and law enforcement by automating the identification of vehicles. The typical ANPR workflow includes capturing an image or video frame, detecting the license plate region, segmenting individual characters, and recognizing them using Optical Character Recognition (OCR). This project implements an ANPR system using Python, OpenCV, and machine learning algorithms to improve recognition accuracy and processing efficiency.

1. **Objective**

The primary objectives of this project are as follows:

* To develop an automated system capable of detecting and recognizing vehicle number plates from images.
* To apply image processing techniques for accurate localization of number plates.
* To implement Optical Character Recognition (OCR) for extracting alphanumeric characters from the plates.
* To evaluate the system’s accuracy and efficiency in real-world scenarios.

1. **Methodology**

The implementation of the ANPR system consists of the following steps:

* 1. **Dataset**

The dataset consists of images containing vehicle number plates, sources is Kaggle.

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

* 1. **Preprocessing**

The preprocessing stage involves several key steps to enhance image quality and prepare it for further analysis:

* **Grayscale Conversion**: Transform the input image into a grayscale format to simplify subsequent processing.
* **Noise Removal**: Apply Gaussian Blur to reduce image noise and smoothen textures.
* **Edge Detection**: Use the Canny edge detection algorithm to identify the boundaries and contours within the image.
* **Thresholding**: Convert the grayscale image to a binary format to enable better segmentation and feature extraction.
  1. **Number Plate Detection**
* Contours within the image are detected and subsequently filtered based on geometric properties that align with typical number plate dimensions (e.g., aspect ratio and size)
* Once the appropriate contour is identified, a bounding box is drawn to localize and highlight the detected number plate region.
  1. **Character Segmentation & Recognition**

After successful detection, the number plate region is extracted from the input image. The extracted plate is then subjected to character segmentation, where individual alphanumeric characters are isolated using image processing techniques. Subsequently, Optical Character Recognition (OCR) is applied to these segmented characters using the Tesseract OCR engine. This step converts the visual character data into machine-readable text, enabling further processing and storage of the vehicle registration number.

1. **Results & Analysis**

* The developed ANPR system was evaluated using a diverse set of images and video frames. It achieved an overall accuracy of **98%** in correctly detecting and recognizing vehicle number plates.
* During testing, several challenges were encountered, including:
* Blurred or low-resolution images
* Variations in lighting conditions (e.g., shadows, glare, night-time images)
* Inconsistencies in license plate font styles and sizes
* Despite these challenges, the system demonstrated robust performance across most scenarios.

**6. Conclusion**

The project successfully demonstrates the implementation of an Automatic Number Plate Recognition (ANPR) system capable of accurately detecting and recognizing vehicle license plates. The system shows promising performance and holds significant potential for real-world applications, including automated toll collection, traffic surveillance, and security monitoring.

**7. Future Scope**

* **Enhancing Accuracy:** Implementing deep learning techniques such as YOLO (You Only Look Once) and Convolutional Neural Networks (CNNs) to improve the accuracy and robustness of number plate detection.
* **Optimizing OCR Performance:** Refining Optical Character Recognition (OCR) algorithms for more precise character recognition and handling varied plate designs.
* **Real-Time Integration:** Integrating the ANPR system with live traffic cameras to enable real-time vehicle monitoring and data collection.

**8. Individual Details:**

* Name: Mayank Vajpayee
* E-Mail ID: mayankvajpayee@gmail.com
* Contact Details: 8237747586