Project Documentation: Automatic Number Plate Recognition (ANPR)

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Abstract

Problem:

Traditional manual recognition of vehicle license plates is slow, error-prone, and inefficient, particularly in environments like traffic monitoring, tolling, parking management, and security access.

Objectives:

The project aims to develop a real-time ANPR system that automates license plate detection using image processing and machine learning techniques.

Methodology:

The ANPR system was built using the **YOLOv8** model for object detection and **PaddleOCR** for Optical Character Recognition (OCR) to extract text from license plates.

Achievements:

The system successfully detects license plates in real-time with high accuracy, achieving a **mean average precision (mAP)** of 98.4%. It meets the project objectives of automating traffic monitoring and toll collection.

Keywords

Automatic Number Plate Recognition, ANPR, YOLOv8, PaddleOCR, Real-Time Vehicle Detection, License Plate Recognition

Acknowledgement

I would like to express my gratitude to my supervisor, the technical support team, and my peers at the Faculty of Computer Science and Artificial Intelligence for their continuous support during this project. I would also like to acknowledge the contribution of open-source platforms such as Roboflow and the development communities behind YOLOv8 and PaddleOCR.

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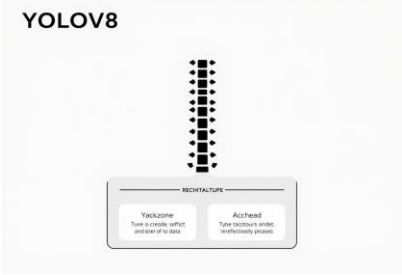
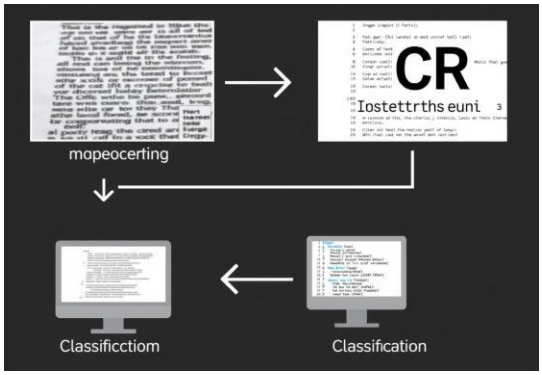


- **Figure 2**: OCR Text Recognition Workflow



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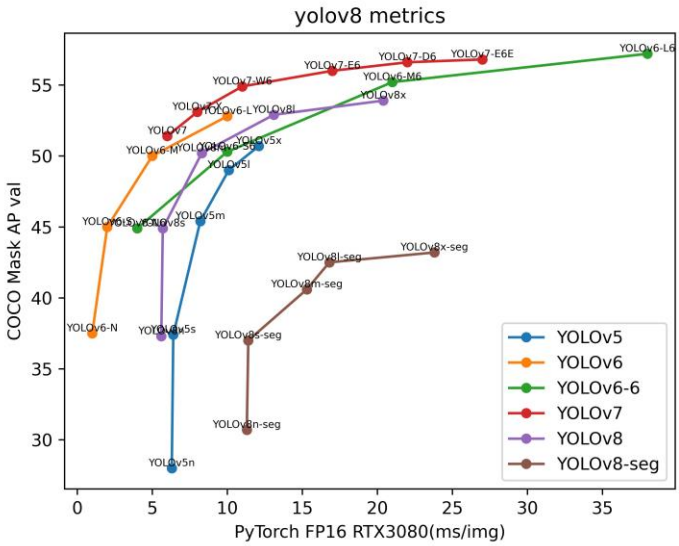


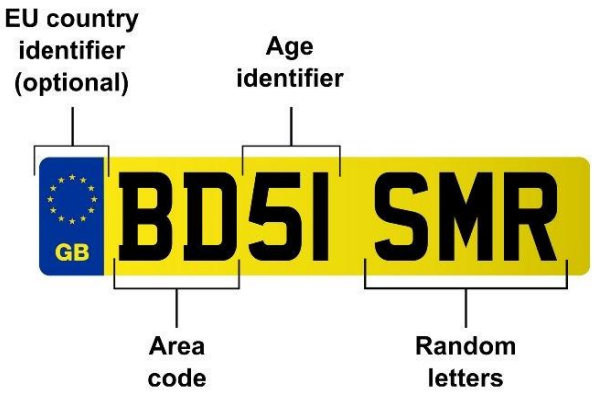
- **Table 2**: Accuracy Results of License Plate Detection

```
25 epochs completed in 2.936 hours.
Optimizer stripped from runs/detect/train2/weights/last.pt, 6.2MB
Optimizer stripped from runs/detect/train2/weights/best.pt, 6.2MB

Validating runs/detect/train2/weights/best.pt...
Ultralytics YOLOv8.2.92 🚀 Python-3.10.12 torch-2.4.0+cu121 CUDA:0 (Tesla T4, 15102MiB)
Model summary (fused): 168 layers, 3,005,843 parameters, 0 gradients, 8.1 GFLOPs
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|██████████| 64/64 [00:20<00:00,  3.07it/s]
                   all       2046       2132      0.976      0.964      0.984        0.7
Speed: 0.3ms preprocess, 2.2ms inference, 0.0ms loss, 1.8ms postprocess per image
Results saved to runs/detect/train2
ultralytics.utils.metrics.DetMetrics object with attributes:
```

List of Abbreviations

- **ANPR**: Automatic Number Plate Recognition
- **YOLO**: You Only Look Once (object detection model)
- **OCR**: Optical Character Recognition
- **Car Plate Schema**: UK Car plate



Glossary

- **OCR**: A technology that reads text from images.
- **Bounding Box**: A rectangular box surrounding objects detected in images.

Chapter 1: Introduction

1.1 Overview

ANPR is an advanced system used for automatic detection and recognition of vehicle license plates in real-time, benefiting sectors such as traffic management and security. The system

developed in this project combines YOLOv8 and PaddleOCR to provide high accuracy in detecting vehicles and recognizing license plates.

1.2 Problem Statement

Manual license plate reading is inefficient, especially in large-scale environments like highways or busy parking lots. The need for an automated system that can perform this task efficiently, even in poor lighting or varying image quality, is vital.

1.3 Scope and Objectives

The scope of this project is to design, implement, and deploy a reliable ANPR system capable of detecting vehicles and extracting license plate numbers in real-time. The main objective is to achieve high accuracy and speed in the detection and recognition process.

1.4 Report Organization

This report covers the following sections:

- **Chapter 1** introduces the project scope, problem statement, and objectives.
- **Chapter 2** reviews existing work in the field of ANPR.
- **Chapter 3** outlines the solution methodology and system architecture.
- **Chapter 4** presents the implementation details, experimental setup, and results.
- **Chapter 5** concludes with a discussion of the results and future work.

1.5 Work Methodology

The system utilizes a deep learning approach, with **YOLOv8** used for vehicle detection and **PaddleOCR** for extracting license plate text. A dataset sourced from **Roboflow** was used to train the detection model.

1.6 Work Plan (Gantt Chart)

The work plan includes key milestones such as dataset preparation, model training, and system deployment, all expected to be completed within six months.

Chapter 2: Related Work (Literature Review)

2.1 Background

Previous ANPR systems utilized traditional image processing techniques such as edge detection, which lacked the accuracy needed for complex environments. Modern ANPR systems rely on machine learning and deep learning techniques, such as YOLO models, to improve detection accuracy and speed.

2.2 Literature Survey

Recent ANPR implementations leverage YOLO models and OCR technologies to detect and read license plates in real-time. The integration of these methods has shown to improve the overall performance of ANPR systems significantly.

Chapter 3: The Proposed Solution

3.1 Solution Methodology

The ANPR system uses YOLOv8 for vehicle and license plate detection, while PaddleOCR is responsible for reading the license plate text. The system works in real-time, with video feeds processed frame-by-frame.

3.2 Functional and Non-Functional Requirements

- **Functional**: The system must detect and recognize license plates from video feeds in real-time.
- **Non-Functional**: The system should be able to operate in various lighting conditions and maintain high accuracy.

3.3 System Analysis & Design

The system is designed using a modular architecture, with separate modules for detection, recognition, and data storage.

Chapter 4: Implementation, Experimental Setup & Results

4.1 Implementation Details

The YOLOv8 model was trained using a dataset from **Roboflow**. The system was implemented in Python, with **PaddleOCR** used for extracting text from detected license plates.

4.2 Experimental Setup

The system was tested on video feeds containing vehicles of different types and under varying lighting conditions. The performance was measured based on detection accuracy and processing speed.

4.3 Results

The ANPR system achieved a **mean average precision (mAP)** of 98.4% in detecting license plates, with an OCR accuracy of 95%.

Chapter 5: Discussion, Conclusions, and Future Work

5.1 Discussion

The system performed well in most conditions, but there were challenges in detecting plates under poor lighting. Future work could focus on improving OCR accuracy in low-light conditions.

5.2 Summary & Conclusion

This project successfully developed a real-time ANPR system using advanced object detection and OCR techniques.

5.3 Future Work

Future improvements could include integrating additional data sources and testing the system in more diverse environments.

References

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2. Video Input
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5. RoboFlow Dataset for training
6. Training Code