Xi'an Jiaotong-Liverpool University
西交利物浦大學

School of Advanced Technology

Final Year Project

Project Specification Report

Project Title: License Plate Recognition

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Project field: Image Recognition

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Co-supervisor (if applicable):

1- Project Description and Problem Statement

1.1 Background

Currently, license plate recognition is widely used in traffic management and law enforcement systems, and is an indispensable part of intelligent transportation systems [1]. There are roughly two types of license plate recognition methods. One is a more traditional method, which mostly uses manual selection to frame and locate the position of the license plate [2]. However, this approach will result in high costs due to the need for a significant amount of manual labor. Another approach is using deep learning to improve the efficiency of license plate recognition and reduce the proportion of manual labor. And this approach will be the main method used in the project, and detailed algorithms will be introduced in "Challenges and Methodology".

In this project, it is necessary to build a system for detecting license plates. By using image processing, computer vision, and other methods to detect the edges of Chinese characters, letters and numbers on license plates. And use algorithms to recognize license plate content.

1.2 Challenges and Methodology

There are several factors that can affect the implementation of license plate recognition. One is that the environment in real scenes can affect recognition, such as brightness and weather [3]. The second issue is that the angle of photography can affect the obtained image, leading to recognition errors. These challenges will be attempted to be resolved in the future.

To achieve the function of license plate recognition, the entire system roughly includes the following modules:

- Image preprocessing: Convert color images into grayscale images using grayscale to reduce computational complexity. The cvtColor function in OpenCV can implement this process, and the formula is as follows [4]:

$$Y = 0.212671 \times R + 0.715160 \times G + 0.072169 \times B$$

Use histogram equalization to redistribute the frequency distribution of pixel values to stretch the brightness dynamic range of the image [5]. This operation can improve the contrast of the image for subsequent segmentation and recognition operations.

- License Plate Localization: Use edge detection algorithms, such as Canny algorithm, to find the license plate area through connected component analysis. To reduce the influence of uncertain factors such as lighting, Sobel algorithm can also be used to detect vertical edges [6]. The calculation formula for template convolution is as follows:

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \times A, \quad G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ +1 & +2 & +1 \end{bmatrix} \times A$$

$$G = \sqrt{G_x^2 + G_y^2}, \quad \theta = \arctan \quad (G_y/G_x)$$

Alternatively, deep learning object detection models such as YOLO and Faster R-CNN can be used to directly detect the position of license plates.

- Character Segmentation: Using the projection method, the spacing between characters is determined by calculating the horizontal and vertical projections. Use connected domain analysis to analyze pixel connectivity and extract characters.

- Character recognition: The main algorithm used is Convolutional Neural Network (CNN) in deep learning for high-precision character segmentation and recognition [1]. In order to improve the recognition accuracy affected by the environment during this process, Sultan et al. [7] proposed combining fast convolutional neural networks with morphological operations. Kim et al. [8] proposed building an Adaptive Feature Attention Network (AFA Net) to address the issues of low resolution and motion blur in driving recorder images. They also introduced Joint-Image Restoration and License Plate Recognition Network (Joint-IRLPRNet) to further improve performance by restoring and recognizing license plates simultaneously. The YOLOv7 tiny network trained on synthetic data can also effectively improve the license plate recognition rate during severe weather and day night scene changes [9]. The experimental results of calculating the CCPD dataset show that the average accuracy of this method reaches 99.4% [10].

2- Aims and Objectives

Aim:

Build an efficient and accurate license plate recognition system using Python to provide the entire process of extracting text from a license plate by recognizing its character edges.

Objectives:

Analyze project requirements and divide design modules

Design system architecture and develop algorithms

Test the model and process/analyze the data

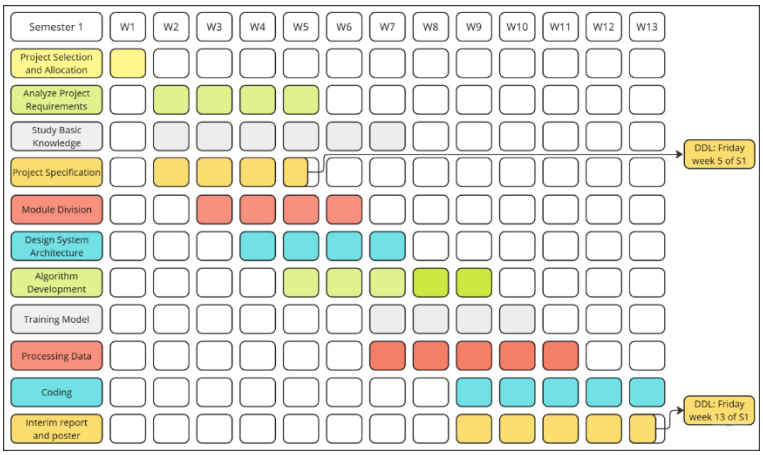
Write programs to implement image processing

Conduct integration testing and performance testing

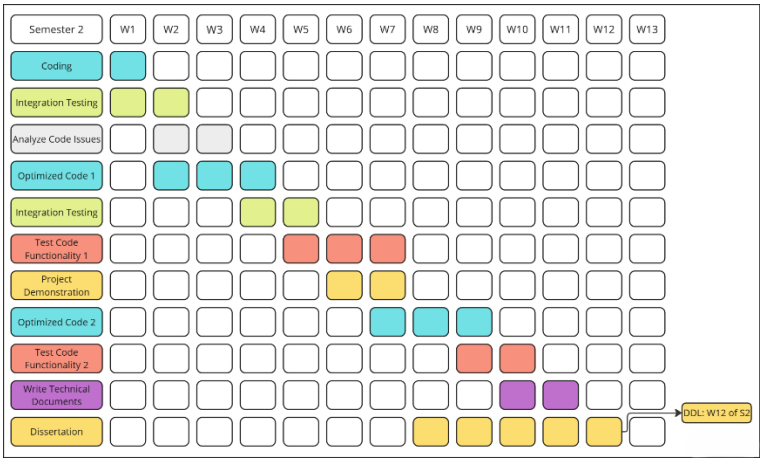
3- Project Plan: Tasks and Milestones

This project will be completed within two semesters of senior year. In the first semester, the main focus will be on learning theoretical knowledge and constructing basic models that might be used in this project. In the second semester, the model will be implemented in code and tested and optimized. The specific project plan will be presented through two Gantt charts, with important milestones marked in it.

SEMESTER 1



SEMESTER 2



4- Project Deliverables

At the end of the entire project, the following project outcomes will be completed and delivered:

a. Project specification

The document will introduce the basic information of this project

b. Interim report and poster

- Interim report: Elaborate on the current project progress, development status, implemented technologies, difficulties encountered, and corresponding possible solutions

- Interim poster： Demonstrate and summarize the milestones of the project, the technical methods adopted, the algorithms that will be applied, and the expected results

c. License Plate Recognition Program Based on Python

A completed Python program that can implement basic license plate recognition functions. Contains files such as image preprocessing, character block

recognition, license plate detection, etc. The source code will be modularized and version controlled through Git to ensure it can be tested and deployed in different environments

d. Project demonstration materials

Project Overview: Summarize the main content of the project to help relevant readers understand the implementation process of the license plate recognition system

Presentation documents required for project presentation: presented in the form of PPT or poster, introducing the following content related to this project: Project Introduction and Objectives to be Achieved; System architecture and technical design; System demonstration and code presentation; Test results and analysis; Future work and improvement directions

e. Dissertation

A formal paper report detailing the development process of the entire project. The content roughly includes: Introduction (Overview of the motivation and objectives of the project); Related Development (Overview of Existing License Plate Recognition Systems and Related Technologies); Method (Provide a detailed explanation of the technical solutions, professional algorithms, and overall system design used in this project); Code Implementation (Display the source code and provide a detailed explanation of the main functions of each code, demonstrating the process of using the code); Result (Display test results and data, and analyze remaining issues); Summary (Summarize the project achievements and analyze the limitations and future improvement methods of the project)

5- Project Industrial Relevance

License plates play an important role in maintaining the transportation system, and a lot of information can be recognized through license plate recognition. Accurate and real-time recognition is widely used in the following scenarios: vehicle recognition, intelligent toll collection, intelligent driving, and traffic control. Therefore, the related projects of license plate recognition have received widespread attention from researchers and the public in order to achieve more efficient and fast recognition.

References

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