

Institute of Technology, Carlow

B.Sc. Hons. in Software Engineering

CW228

Design Manual

Project Title: Number Plate

Recognition

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Table of Contents

| | |
|---|----|
| 1. Introduction..... | 3 |
| 2. Architectural Design..... | 4 |
| 3. Interfaces Design..... | 5 |
| 3.1 Main GUI Design | 5 |
| 3.2 Menu Design | 6 |
| 4. Modular Design of Each Sub-system..... | 8 |
| 4.1 Modular Design Overview..... | 8 |
| 4.2 Sub-system of Pre-processing..... | 9 |
| 4.2.1 Overview | 9 |
| 4.2.2 Detailed description of each module | 9 |
| 4.3 Sub-system of Localization..... | 11 |
| 4.3.1 Overview | 11 |
| 4.3.2 Detailed Description of Each Module | 11 |
| 4.4 Sub-system of Segmentation | 13 |
| 4.4.1 Overview | 13 |
| 4.4.2 Detailed Description of each module | 13 |
| 4.5 Sub-system of Character Segmentation | 14 |
| 4.5.1 Overview | 14 |
| 4.5.2 Detailed Description of Each Module | 14 |
| 5. Conclusions..... | 15 |

1. Introduction

This document describes the requirements for developing the NPR system. The NPR system can read the registration number automatically from the number plate area in digital image and change the number into plain ASCII text. This project is only deal with the software part of NPR, it will analysis the inputted digital image and output the registration number of a vehicle.

The steps involved in NPR include image pre-processing which contains the grayscale and Gaussian smoothing. Next step is called plate isolation separate number plate area from the whole image. After find the number plate area, the individual characters in the number plate are separated and identified through character segmentation and optical character recognition by using vertical projection algorithm and grid feature method.

2. Architectural Design

As is shown in figure 1, the NPR system has four main components: Pre-processing component, Localization component, Segmentation component and Recognition component.

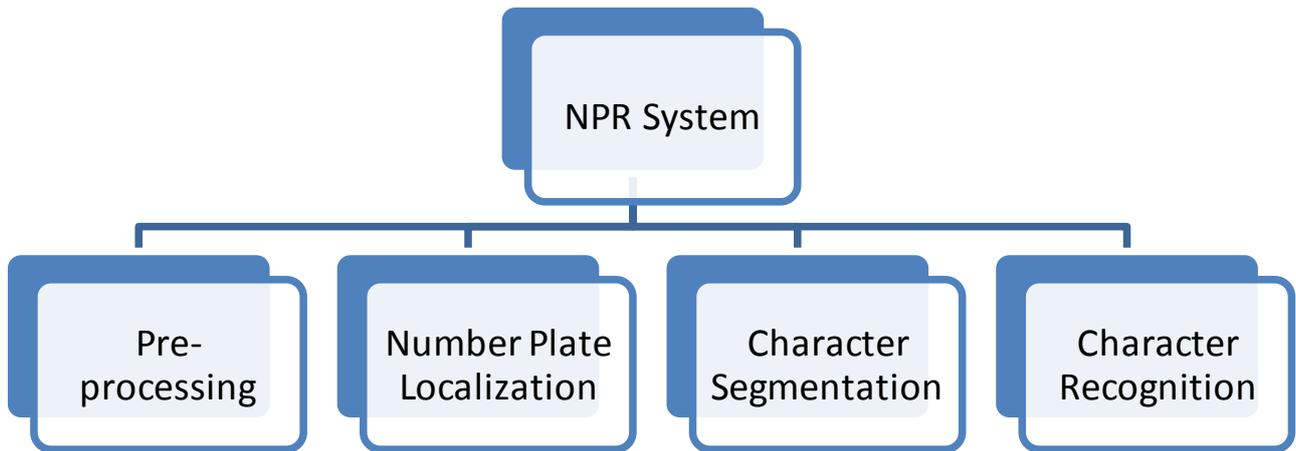


Figure 1 NPR system architectural

Pre-processing sub-system first applies grayscale algorithm to the inputted image to change the color image into grayscale format and then applies Gaussian smoothing algorithm to the inputted image to remove the noises. Pre-processing can improve the success rate of number plate localization and character recognition.

Number plate localization sub-system first takes the pre-processed image provided by the pre-processing sub-system and then applies Canny edge detection algorithm to the pre-processed image to detect edges in the image. The last step is to find out the number plate area by using a number plate isolation algorithm.

Character segmentation sub-system is used to separate every single character in the number plate area by using vertical projection algorithm, it outputs a set of sub-images and each of these sub-images contains a single character.

Character recognition sub-system identifies the characters which are contained in each sub-image and outputs them in text format.

3. Interfaces Design

3.1 Main GUI Design

The screenshot of main user interface of NPR system is shown in figure 2.

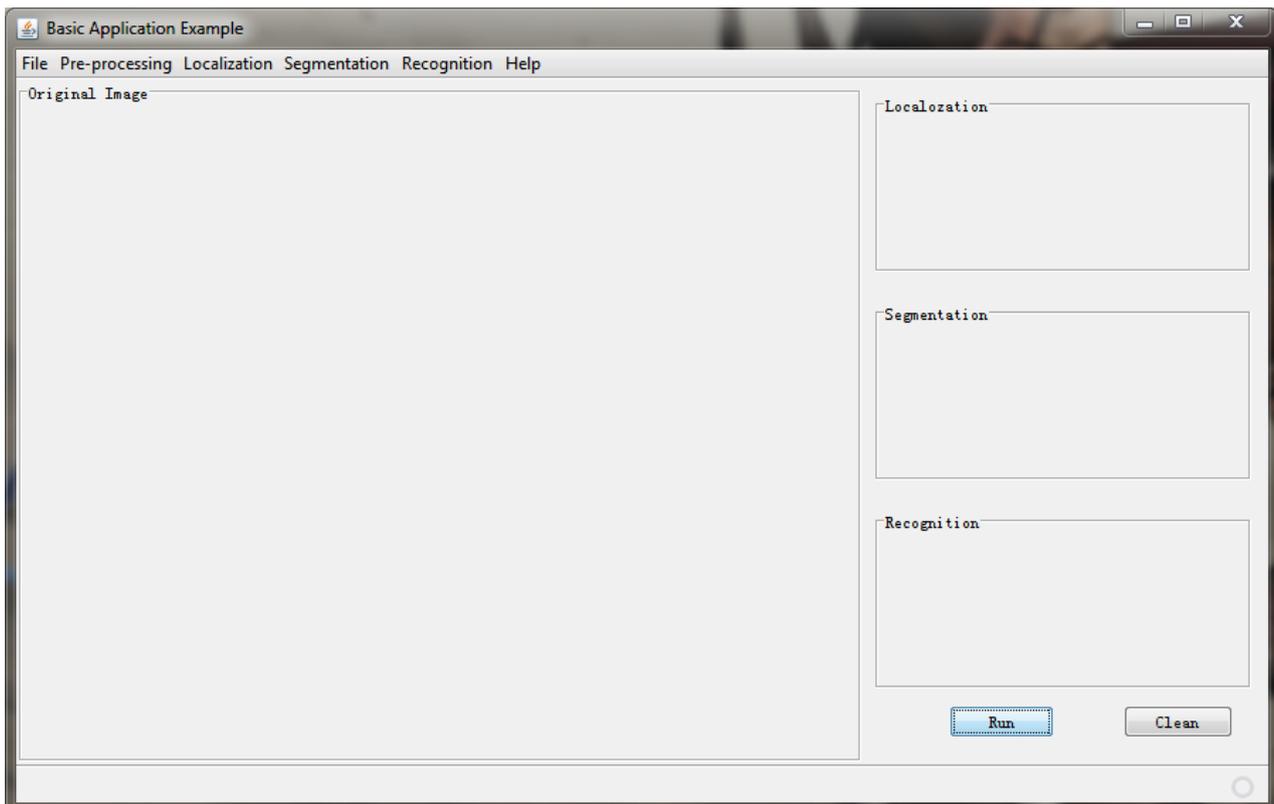


Figure 2 main user interface screenshot

On the top is menu bar which contains six menus.

There are four panels below the menu bar: original image panel, localization panel, segmentation panel and recognition panel. When running the application, results of each main step will be shown in these panels.

Two buttons below the recognition panel: run and clean. Button "run" can run the whole process to output the plate number in text form by using the inputted image. Button "clean" is used to clean all the previous changes and return the application back to original status.

3.2 Menu Design

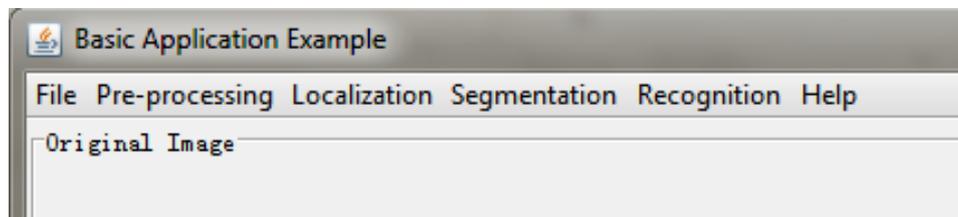


Figure 3 menu bar

As is shown in figure 3, there are six menus in menu bar: file, pre-processing, localization, segmentation, recognition and help.

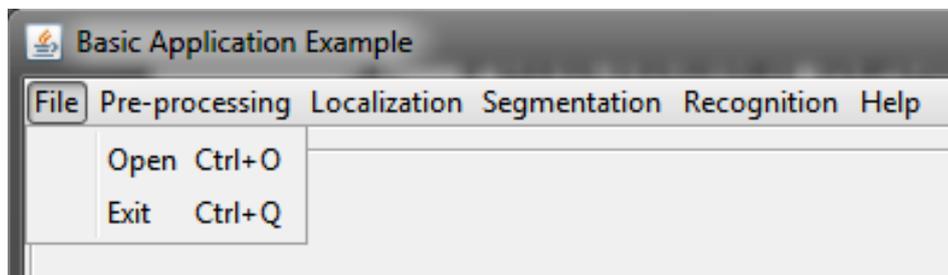


Figure 4 menu of file

There are two options in file menu (figure 4): open and exit. User can use this menu to input image or exit the system.

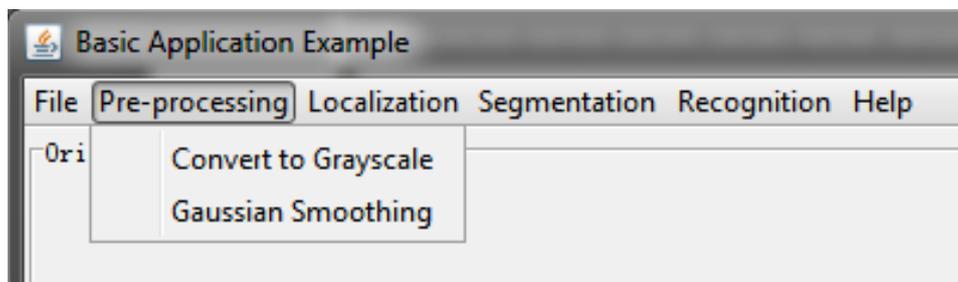


Figure 5 menu of pre-processing

There are two options in pre-processing menu (figure 5) which allow user to see the result after convert imputed image to grayscale or after applied Gaussian smoothing algorithm to the grayscale image.

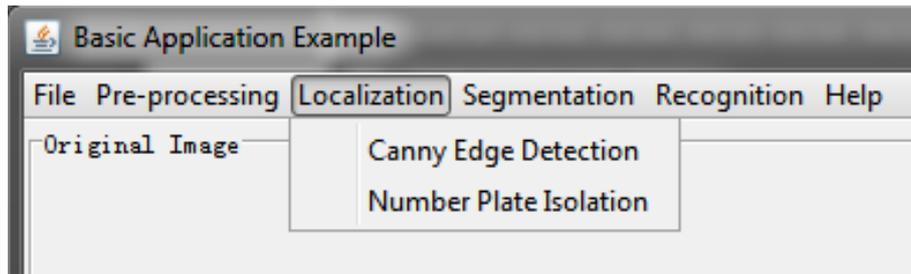


Figure 6 menu of localization

There are two options in localization menu (figure 6) which allow user to see the result after edge detection or number plate isolation.

Segmentation, recognition and help menus don't have sub-menus. So when user can check the result after character segmentation and recognition by click these two menus. When user clicks help menu, a user manual will pop-up to teach user how to use this software.

4. Modular Design of Each Sub-system

4.1 Modular Design Overview

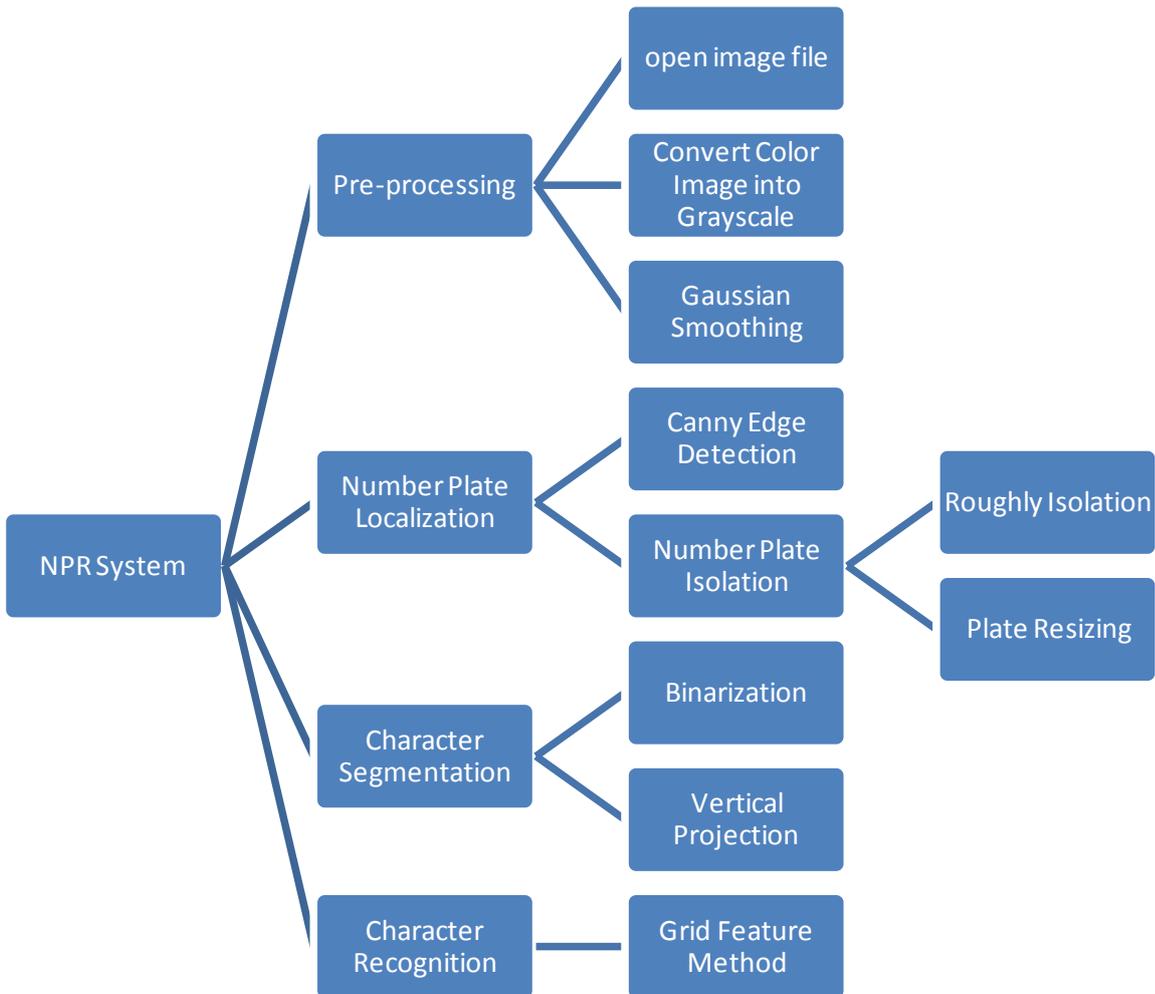


Figure 7 module design overview

The whole NPR system is composed of four sub-systems: pre-processing, number plate isolation, character segmentation and character recognition. Each of these sub-systems also composed of several modules as shown in figure 7.

4.2 Sub-system of Pre-processing

4.2.1 Overview

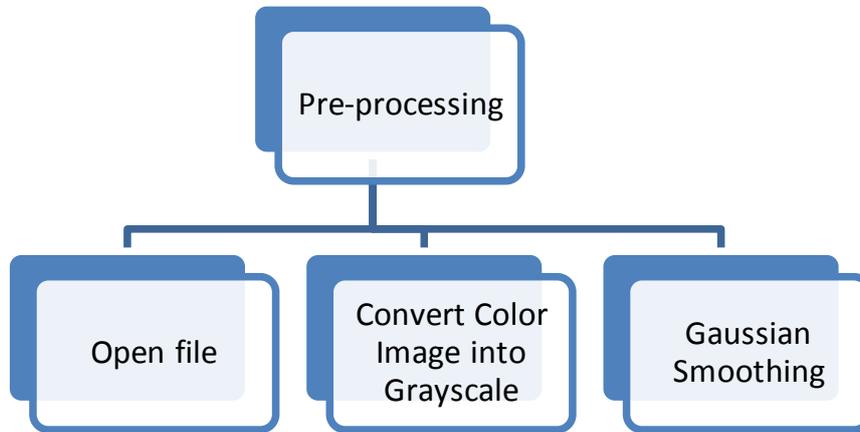


Figure 8 modular design of pre-processing sub-system

The pre-processing sub-system has three modules: open file, grayscale and Gaussian smoothing. After an image file is opened, it then can be converted into grayscale form and the noises in the image can be removed through Gaussian smoothing module.

4.2.2 Detailed description of each module

Module name: **open file**

Description: load an image file

Input: image file (.jpg or .bmp)

Main success scenario:

- 1) Click the Menu "File" in the main interface.
- 2) Click the "Open" option.
- 3) The "file open" window will appear, user can choose the directory, select the file, or type the file name into the "file name" column and then click "OK" button. The selected image will be loaded and displayed in the original panel in the main user interface. (the default file type is .bmp)

Extensions: if user chose a file which is not .jpg or .bmp type or typed a wrong file name, an error window will appear to tell user they made a mistake.

Module name: **convert color image into grayscale**

Description: change the inputted image into grayscale format

Input: original image

Output: grayscale image

Main success scenario:

- 1) Click the Menu "Pre-processing" in the main interface.
- 2) Click the "Convert to grayscale" option.
- 3) Original image displayed in the original image panel will be changed into grayscale image

Module name: **Gaussian smoothing**

Description: remove noises in the image

Input: grayscale image

Output: grayscale image with fewer noises

Main success scenario:

- 1) Click the Menu "Pre-processing" in the main interface.
- 2) Click the "Gaussian smoothing" option.
- 3) The grayscale image displayed in the original panel will be changed into the grayscale image with fewer noises.

4.3 Sub-system of Localization

4.3.1 Overview

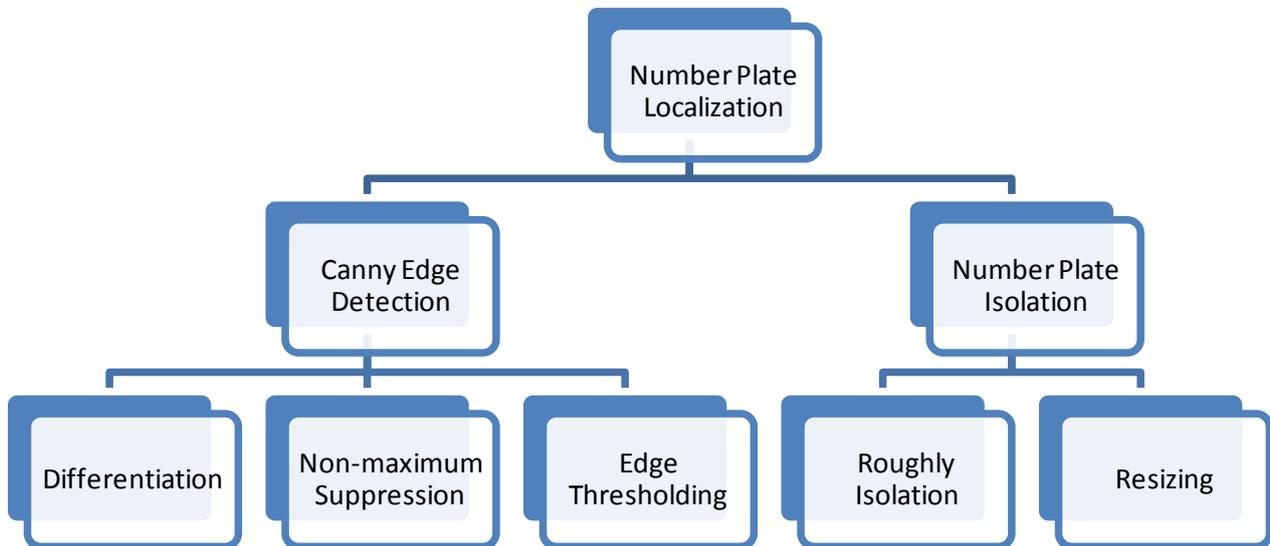


Figure 9 modular design of number plate localization sub-system

Sub-system of number plate localization contains two main modules: Canny edge detection and number plate isolation. The grayscale image first converted into edge detected form through Canny edge detection module and then the number plate area is identified through number plate isolation module from the edge detected image. Each of these two modules is contains several small modules.

4.3.2 Detailed Description of Each Module

Module name: **Canny edge detection**

Description: perform the edge detection algorithm to remove all the other information except the edges in the image.

Input: grayscale image after Gaussian smoothing

Output: edge detected image

Main success scenario:

- 1) Click the Menu "Localization" in the main interface.
- 2) Click the "Canny edge detection" option.
- 3) Perform the differentiation algorithm onto the grayscale image to find the edge strength by calculating the gradient of the image.
- 4) Perform non-maximum suppression algorithm
- 5) Perform edge thresholding algorithm onto the image to remove all the other information in the image except edges.
- 6) The grayscale image displayed in the original panel will be changed into the edge detected image.

Module name: **number plate isolation**

Description: separate the number plate area from the edge detected image

Input: edge detected Image

Output: location information of number plate area

Main success scenario:

- 1) Click the Menu "Localization" in the main interface.
- 2) Click the "number plate isolation" option.
- 3) Defines a slide window which has the same ratio of length and width of number plate but larger than it. And then move this window around in the edge detected image to find the area has most edge information.
- 4) Perform plate resizing algorithm to find the exact boundaries of the number plate.
- 5) The isolated sub-image will be displayed in the localization panel.

4.4 Sub-system of Segmentation

4.4.1 Overview

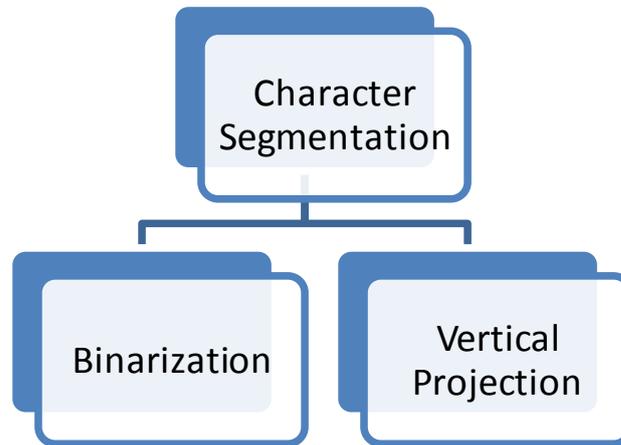


Figure 10 modular design of character segmentation sub-system

Character segmentation has two modules: binarization and vertical projection. Number plate area is first separated from the original image and converted into black and white form by performing Binarization algorithm onto it, then the vertical projection algorithm is performed to separate single character in the number plate area.

4.4.2 Detailed Description of each module

Module name: character segmentation

Description: separate isolated number plate sub-image into several parts and each separated part is supposed to contain one character

Input: number plate sub-image

Output: a set of sub-image, each of these sub-images contains a character.

Main scenario:

- 1) Click the Menu "Segmentation" in the main interface.
- 2) Get the sub-image from the original image as the same size and position of the resized number plate area, convert the sub-image into binary image.

- 3) Apply vertical projection algorithm onto the binary sub-image to separate the single character.
- 4) The isolated single character sub-image will be displayed in the segmentation panel.

4.5 Sub-system of Character Segmentation

4.5.1 Overview

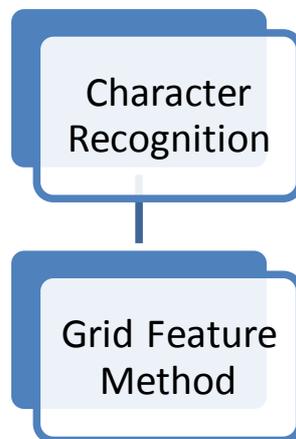


Figure 11 modular design of character recognition sub-system

Character recognition contains a module called grid feature method to identify the characters in number plate area and output them as text format.

4.5.2 Detailed Description of Each Module

Module name: character recognition

Description: identify the characters in the different part of number plate sub-image

Input: segmented sub-image

Output: plate number in text form

Main scenario:

- 1) Click the Menu "Recognition" in the main interface.

- 2) Apply grid feature method onto each segmented sub-image
- 3) The registration number on the number plate will be displayed in the recognition panel.

Extensions: if some character cannot be identified, it will be displayed as a question mark“?”.

5. Conclusions

The whole development process can be divided into four main steps: pre-processing, number plate localization, character segmentation and character recognition. An executable version will be delivered and then tested at the end of each step to check the performance and fix the bugs.