Digital Image Processing Course Presentation

MSER and Machine Learning-based License Plate Recognition

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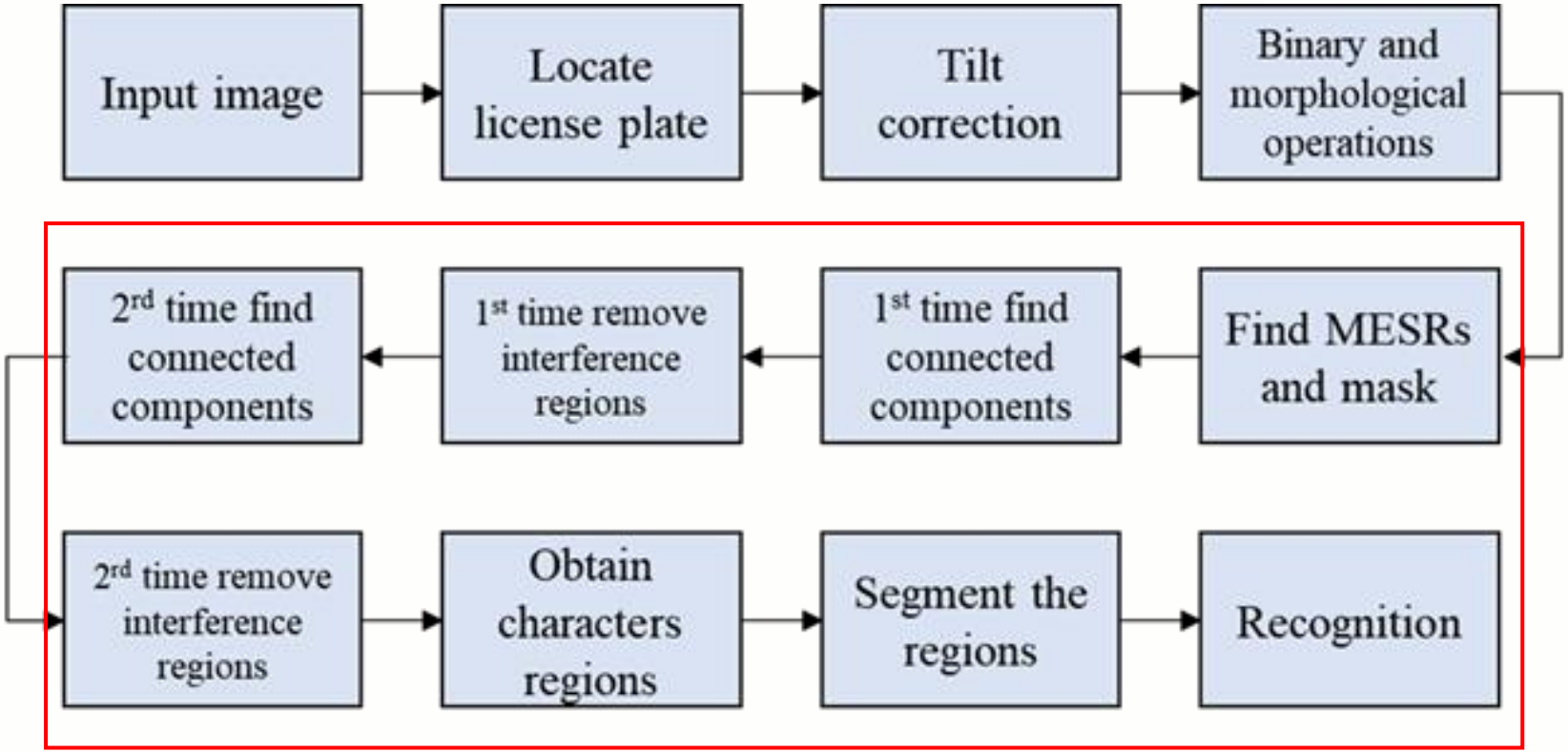
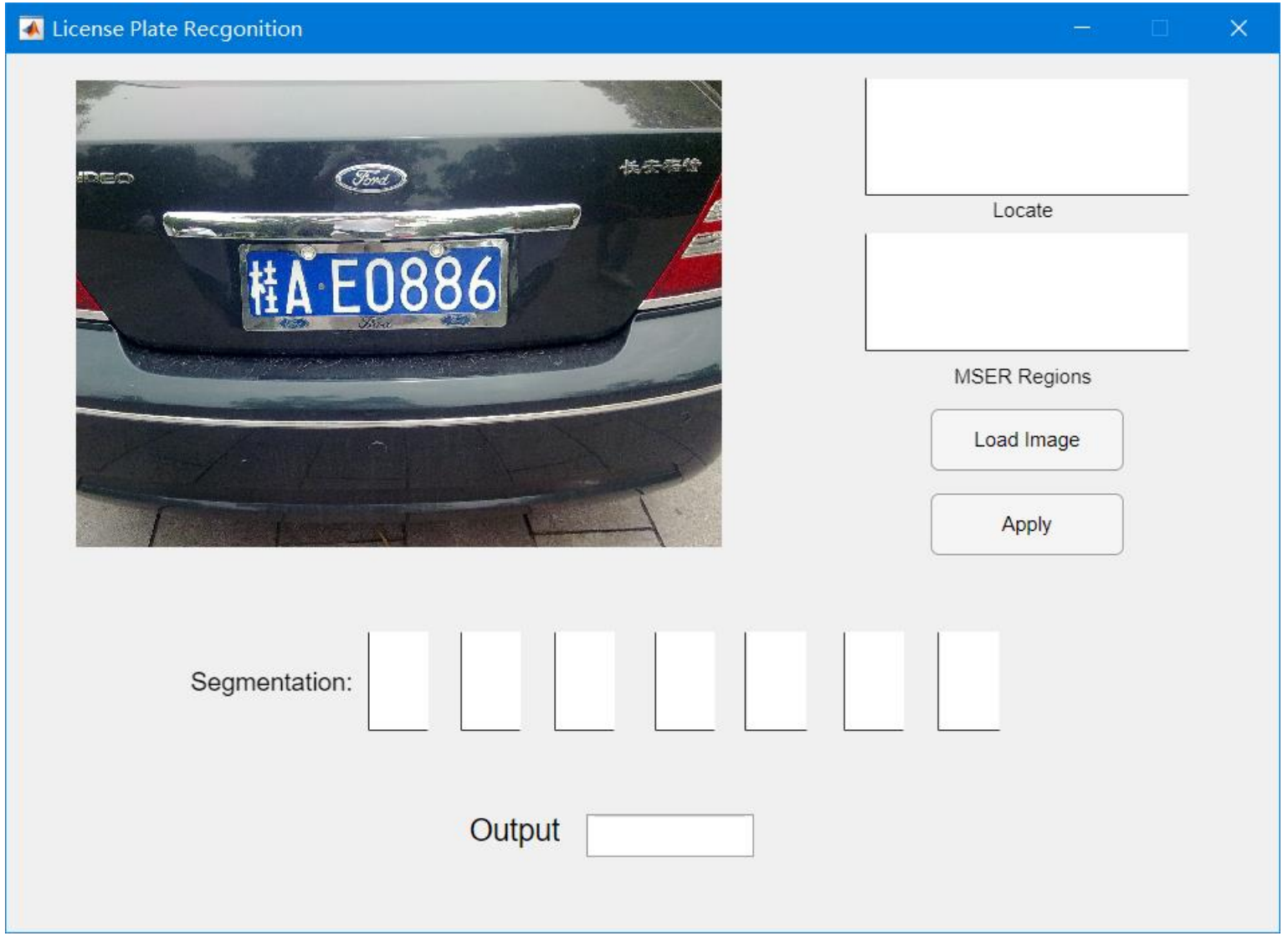
Contents

01 Introduction

Introduction



Introduction



https://www.mathworks.com/products/matlab/app-designer.html

02 Methods

Methods

1. Locate License Plate

Directly looks for connected regions in the image where the **color, shape and texture** match the license plate features

Hue between 200 and 255 degrees, saturation between 0.4 and 1, value between 0.3 and 1.

Pros:

1. Eliminates the need for more complex color distance calculations, which can save a lot of time when color segmenting

2. Eliminates complex morphological operations

Cons:

1. Not applicable to multiple colors (yellow, black, white)

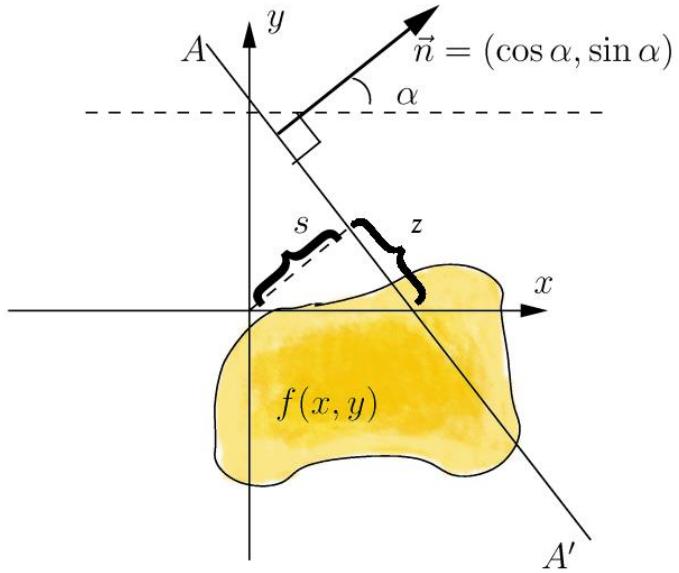
2. Error may be caused when there are manly rectangle blue areas

Methods

2. Tilt Correction

Radon transform

In mathematics, the Radon transform is the integral transform which takes a function f defined on the plane to a function *Rf* defined on the (two-dimensional) space of lines in the plane, whose value at a particular line is equal to the line integral of the function over that line. The transform was introduced in 1917 by Johann Radon.

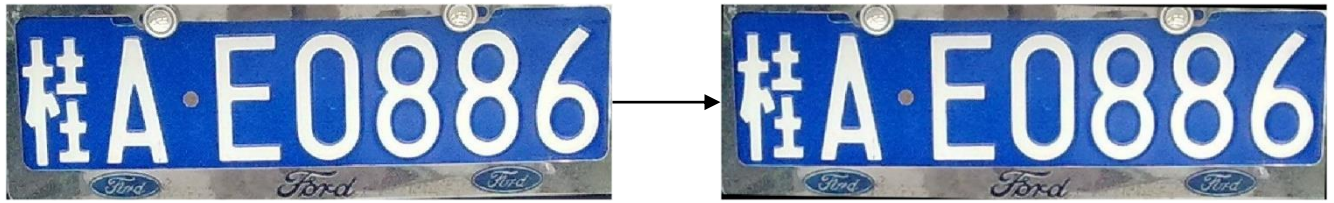


Radon transform. Maps *f* on the (*x, y*)-domain to *Rf* on the (*α, s*)-domain

https://en.wikipedia.org/wiki/Radon_transform

Methods

2. Tilt Correction



Before After

In MATLAB:

R = radon(I) returns the Radon transform R of 2-D grayscale image I for angles in the range [0, 179] degrees. The Radon transform is the projection of the image intensity along a radial line oriented at a specific angle.

[R,xp] = radon(___) returns a vector xp containing the radial coordinates corresponding to each row of the image.

https://ww2.mathworks.cn/help/images/ref/radon.html?lang=en

Methods

3. MSER Detection

What is MSER?

In computer vision, maximally stable extremal regions (MSER) are used as a method of blob detection in images. This technique was proposed by Matas et al. to find correspondences between image elements from two images with different viewpoints.

Why MSER?

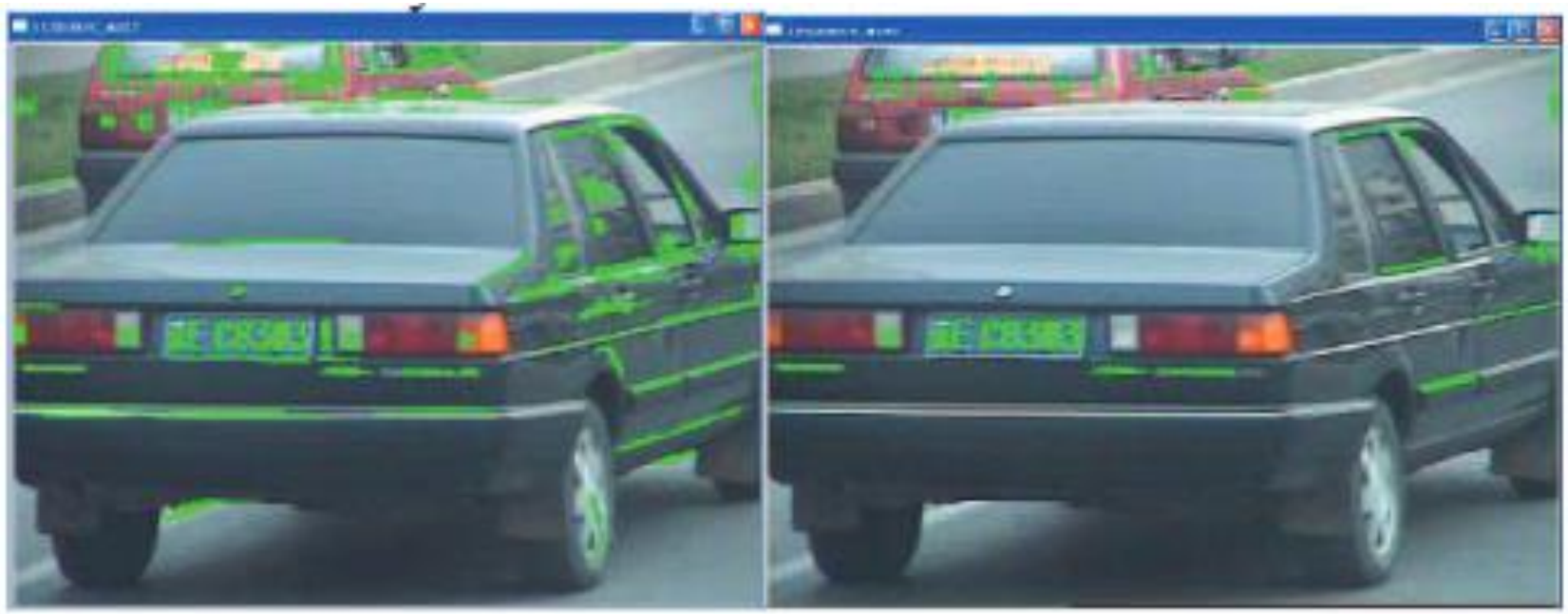
The MSER method works well for finding text regions, because the consistent color and high contrast of text leads to stable intensity profiles.

> In many applications, the MSER approach makes the locating step no longer necessary. Aiming for higher accuracy, the locating of license plates is still performed.

https://en.wikipedia.org/wiki/Maximally_stable_extremal_regions
https://ww2.mathworks.cn/help/vision/ug/automatically-detect-and-recognize-text-in-natural-images.html
Matas J, Chum O, Urban Metal, “Robust wide baseline stereo from maximally stable external regions,” Image and Vision Computing, 2004, 22(10): 761-767.
W. Wang, Q. Jiang, X. Zhou and W. Wan, "Car license plate detection based on MSER," 2011 International Conference on Consumer Electronics, Communications and Networks (CECNet), XianNing, 2011, pp. 3973-3976, doi: 10.1109/CECNET.2011.5768335.

Methods

3. MSER Detection



(a) original MSER

(b) MSER after gray stretching

W. Wang, Q. Jiang, X. Zhou and W. Wan, "Car license plate detection based on MSER," 2011 International Conference on Consumer Electronics, Communications and Networks (CECNet), XianNing, 2011, pp. 3973-3976, doi: 10.1109/CECNET.2011.5768335.

Methods

3. MSER Detection

RGB | Binary | Binary (color for MSERs)

MATLAB Computer Vision Toolbox

regions = detectMSERFeatures(I) returns an MSERRegions object, regions, containing information about MSER features detected in the 2-D grayscale input image, I. This object uses Maximally Stable Extremal Regions (MSER) algorithm to find regions

https://ww2.mathworks.cn/help/vision/ref/detectmserfeatures.html

4. MSER Processing

Too many interference regions!!!

4. MSER Processing

Analyze the connected components, then filters out some non-text regions based on the region's area and aspect ratio. Two filters, Chinese license plates have 7 characters, if 7 character regions are detected in this step, the next region filtering step will not be performed.

Algorithm 1 MSER Connected Components Analysis and Processing (Coarse Filtering)

Input: MSER mask and binary license plate image

Output: Processed MSER mask and segmented images

```
function CompAnalysis (MSERmask, lpbwimg)
    ConnectComp ← findConnected(MSERmask);
    ConnectComp.Area ← getArea(ConectComp);
    for i from 1 to number_ConnectComp
        if ConnectComp.Area(i) < 10 || ConnectComp.Area(i) > 0.3 * area_lpbwimg)
           || width / height < 0.1 || width / height > 2
            delete ConnectComp.Area(i);
        else
            SegImgs ← Segment(lpbwimg);
        end if
    end for
    return ConnectComp, SegImgs;
end function
if number_SegImgs > 7
    FineFiltering(ConnectComp);
end if
```

Methods

4. MSER Processing

Coarse Filtering

Fine Filtering

Another common metric used to discriminate between text and non-text is **stroke width**. Stroke width is a measure of the width of the curves and lines that make up a character. Text regions tend to have little stroke width variation, whereas non-text regions tend to have larger variations.

https://ww2.mathworks.cn/help/vision/ug/automatically-detect-and-recognize-text-in-natural-images.html

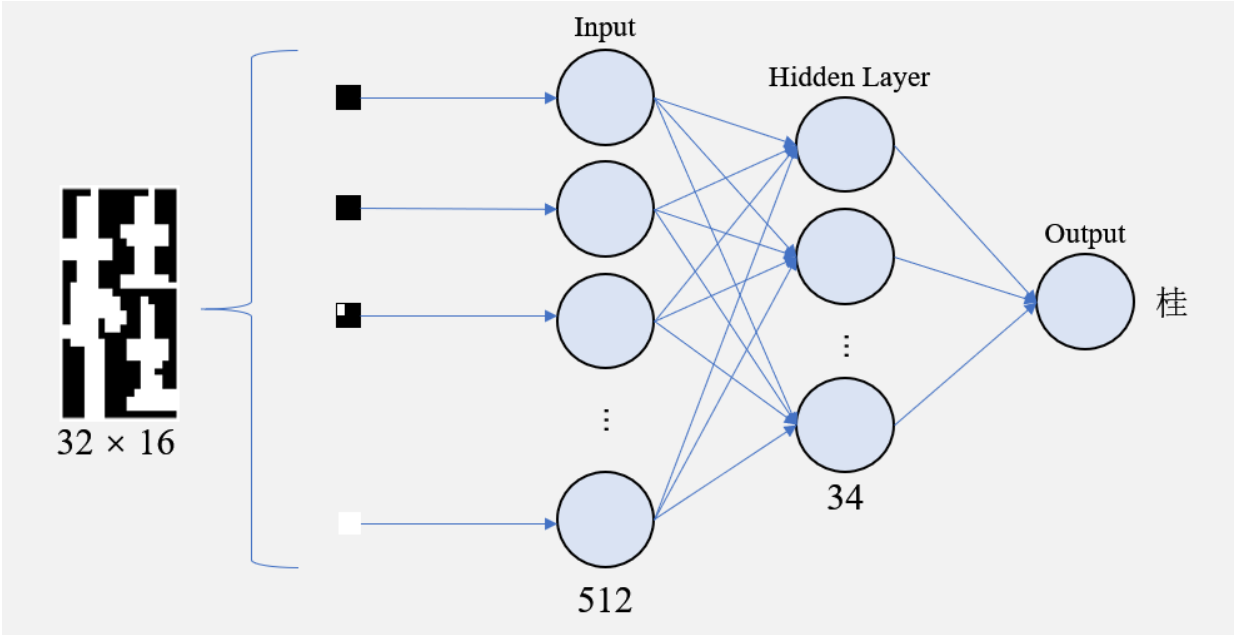
Methods

5. Characters Recognition

Segment the regions images and resize them to **32×16** for neural network input

Methods

5. Characters Recognition



Due to time and environmental constraints, we are not able to obtain a large dataset of license plate images, so we use an open-source trained model. thanks to the work done by CaptYoung.

The neural network includes one hidden layer, uses each pixel value of the binary image for input, and finally uses the sigmoid function for output.

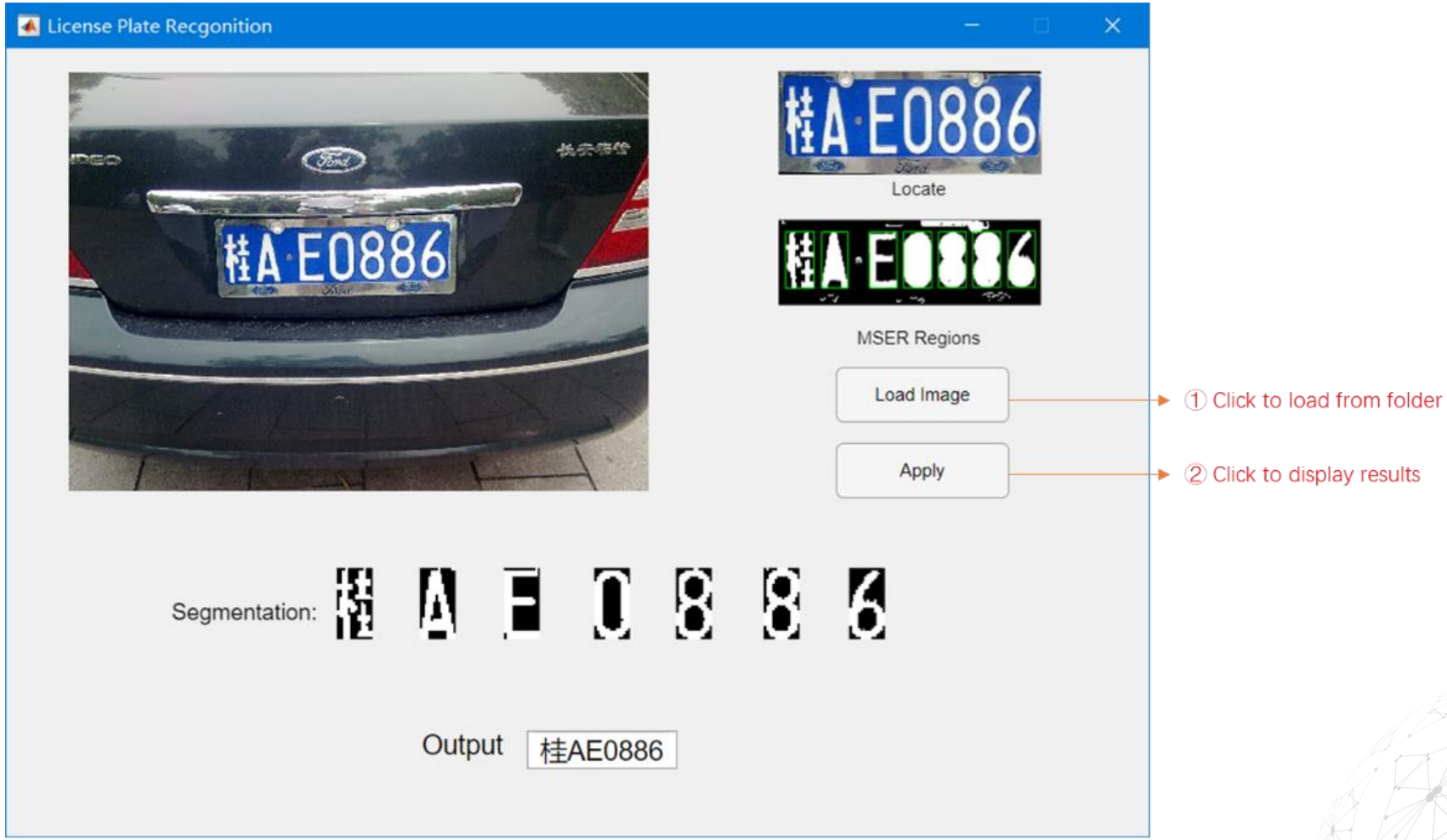
Due to the special characteristics of English and Chinese characters, two models are built and trained separately

https://www.coursera.org/learn/machine-learning
https://github.com/CaptYoung/License-Plate-Recognition/tree/master/Training

03 Result and Discussion

Result

Final Product



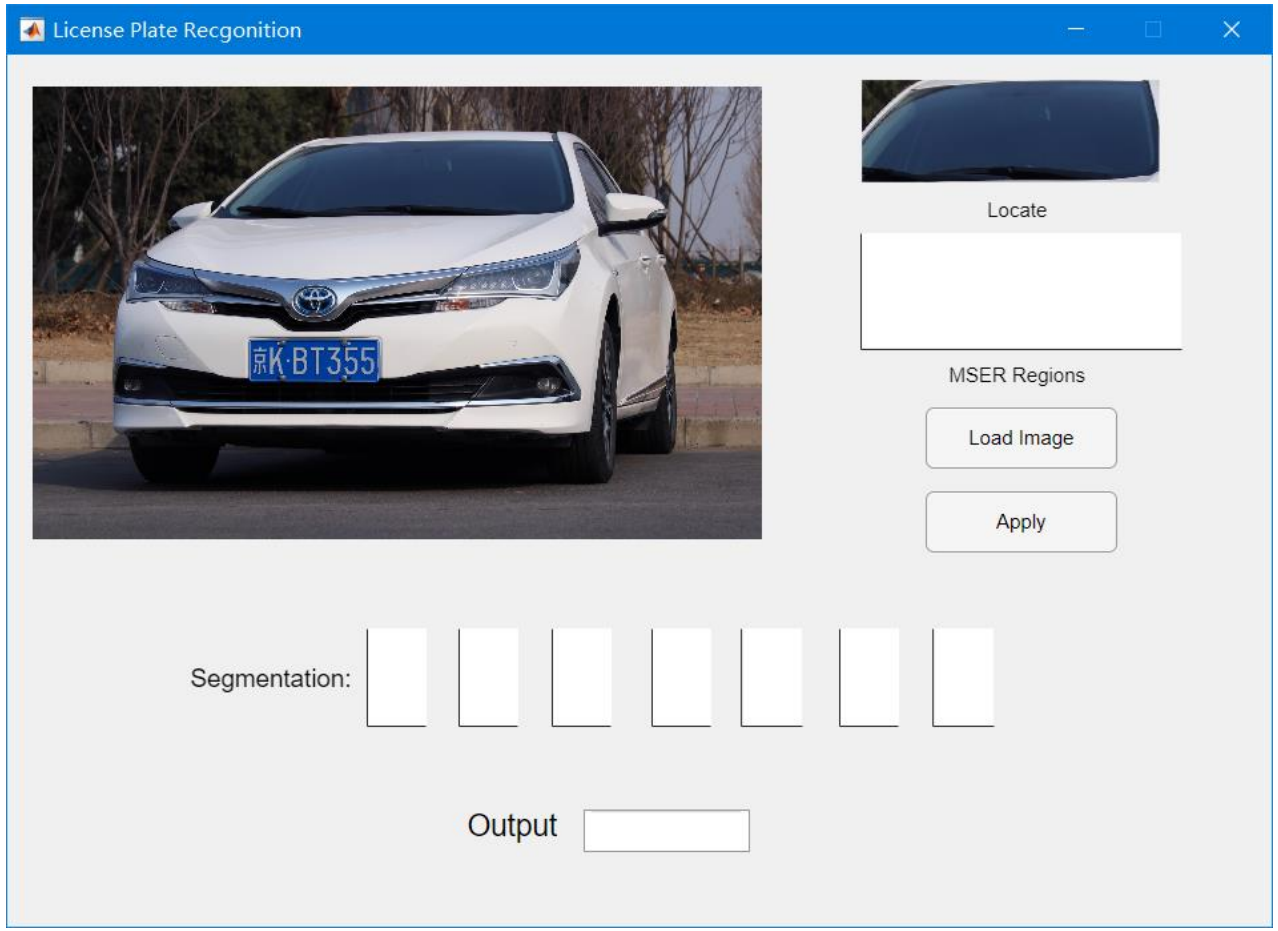
https://www.mathworks.com/products/matlab/app-designer.html

Discussion

For some characters that are loosely formed, it is difficult to integrate the whole character into a connected region

Possible solution:
Special treatment of Chinese characters, such as forcing the fusion of other areas within the first MSER range.

Discussion



In the real scenario, the color-based license plate detection is not accurate.

Possible solution:
Combine with the method that uses binarization and morphological methods such as and open-close operations to accurately locate license plates.

04 Conclusion

Conclusion

The license plate character regions are the typical MSERs. The combination of MSER methods and machine learning methods proposed in this paper is simple and the result is accurate.

THANK YOU!