

Final Project Proposal

The US Car License Plate Recognition

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1. Significance

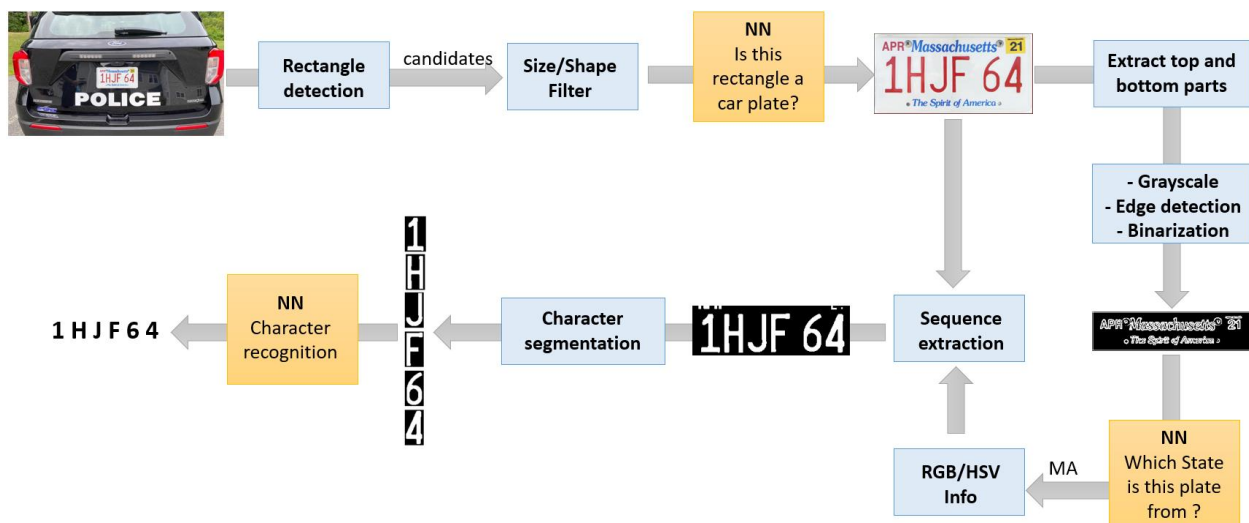
At present, most parking lots in the United States are not equipped with a license plate recognition system. Large-scale parking lot payment uses the *Get Card for Entering, Return Card for Leaving* mode. In this mode, the car owner needs to keep the parking card or parking ticket properly. If, as already applied in some countries or regions, a license plate recognition device is installed at the entrance of a parking lot, and the time difference between the entering and leaving of the same license plate number will be calculated as the parking time, parking payment can be simpler and more environmentally friendly.

2. Differences from Predecessors' Works and Why

We have consulted relevant papers on license plate recognition and tried to find those that can solve the problem of *The US Car License Plate Recognition (USCLPR)*. The predecessors have done a lot of work on the influence of light, angle, clarity, etc., and the related technologies are already mature. But unfortunately, most of the license plates used for recognition in those papers are from China, Japan, South Korea, European countries, Japan, Brazil, etc. In those countries, the license plates themselves do not have complicated background patterns and have consistent background color. And compared with the US, the datasets of these license plates are much larger, thereby reducing the difficulty of direct character recognition. According to some papers that mentioned USCLPR, Yolo-CNN seems to be a very good choice. Yolo-CNN can quickly identify and locate a variety of objects in the picture. However, the focus of the work of those predecessors is not on USCLPR specifically. They were able to use large sets of existing license plates from other countries as training sets. Since the existing US license plate data is not huge, we decided to avoid using a very limited number of data to train Yolo-CNN.

Therefore, we are trying to use 3 separate neural networks with relatively simple structures to replace one powerful network, and decentralize the Plate Detection, State Recognition, Sequence Extraction, Character Recognition processes to reduce the difficulty of implementation of each part and improve the overall stability. If we encounter difficulties in license plate detection, character segmentation, or character recognition in the future, we may reconsider using Yolo-CNN.

3. Overview



4. Technologies

Our project contains 5 main parts: Plate Detection, State Recognition, Sequence Extraction, Character Segmentation, and Character Recognition. The flowchart is shown above.

4.1 Plate Detection

Since the background colors of the US car plates vary among States, **we cannot use color detection to improve the performance like what the predecessors did for other countries**. This does bring a huge challenge for us. Therefore, our plate detection contains the following steps:

1. Use Erosion and Dilation processing to reduce noise.
2. Use Canny edge detection to find all contours on the image.
3. Filtering. Filter out unqualified contours based on the perimeter and area of them, find the minimum circumscribed rectangles for the qualified contours, and filter out unqualified rectangles based on the height-width ratio.
4. Input all rectangles left into CNN to identify whether it is a real license plate.



Preliminary rectangle detection and result after filtering

4.2 State Recognition

We plan to use CNN for State recognition of license plates. The license plate of a State has very significant characteristics of this State in the place other than the sequence, and the characteristics of the license plate of the same generation are stable. The upper and lower parts of the license plate are cropped to obtain sufficient State features, and the image is sequentially grayed, edge detected, and binarized. Since the result is a binarized picture, the pressure they put on the State recognition CNN will be very limited. The following figure shows the State features extraction results of different license plates in the three States, MA, MS, and MD:



The significances of State recognition are: 1. The sequence color of the same generation of license plates in the same State is relatively stable. Given the State of the license plate, the corresponding RGB or HSV range can be used to extract the sequence rather accurately, effectively avoiding the interference of those patterns around the sequence; 2. Even if the sequence cannot be identified, the given State can at least narrow the scope, which has a certain significance in the field of criminal tracking.

4.3 Sequence Extraction

After knowing the State of the license plate, we will obtain the corresponding RGB/HSV range, using which to extract the sequence. However, if simply using this, the sequence extraction image may not be plumped. We plan to use dilation/erosion to enhance the pattern. Since the sequence of the license plates of each State is basically in the middle position, we can appropriately cut off the upper and lower parts of the license plate.

In the actual situation, due to the difference between the new and old license plates and the different illumination, the color or brightness of the sequence might vary accordingly. Properly widening the RGB/HSV range can get good results, as shown in the figure below.

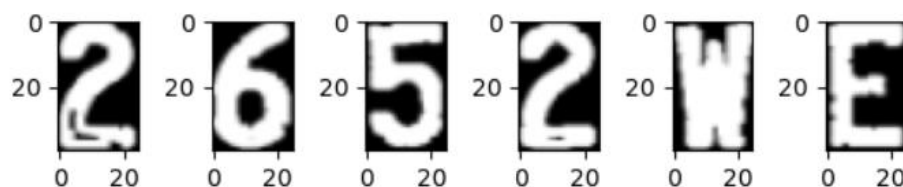


4.4 Character Segmentation

Character segmentation is based on connected domains. After morphological processing, each character becomes a whole block. Then, use edge detection to obtain the contour of each character. After that, find the minimum circumscribed rectangles to identify each character. The result is shown below.



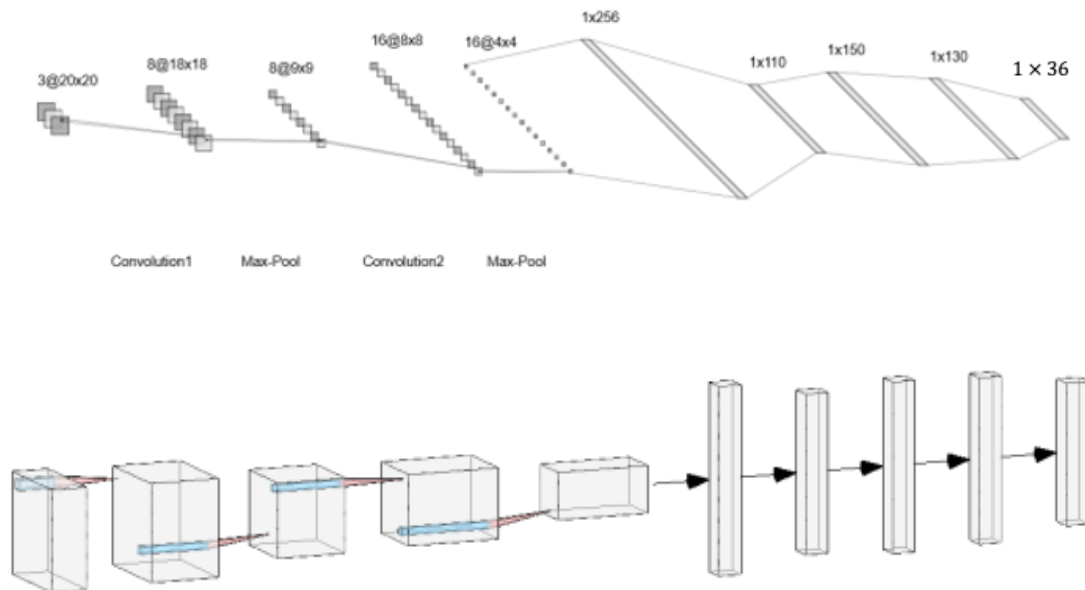
The input of a character segmentation case



The output of the above case

4.5 Character Recognition

The existing supporting technology for this part is already mature. Below is the CNN model we might be intended to use.



5. Dataset

Unlike the last part Character Recognition Net, whose dataset is easy to access, there is no adequate US dataset for the Plate Validation Net (PVN) and the State Recognition Net (SRN). Though we do need those real-life images - with a whole or a part of a car in each - to test the performance, the images for training PVN (those rectangles labeled “not car plate” are even easy to produce) and the SRN only need to be those plate photos with nearly perfect angles, like the pictures below.



Therefore, we will try our best to collect qualified data like above ourselves. We might also try some methods to change the pattern shape, size, or angles of the same images to strengthen our Net.