A Real-Time Streaming Application for License Plate Recognition Using OpenALPR

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Abstract. Image recognition has been widely used in many places in our life. For license plate recognition, it can replace the manual inspection and registration of vehicles in the parking lot to complete automation, and it can also facilitate the management of the place to track the entry and exit of vehicles. In this implementation, we use OpenALPR and Tesseract to realize the basis of image recognition, use Python to connect the real-time image of the camera at the entrance of Tunghai University, and connect the database to compare the license plate and build a webpage to display it, so as to help the school traffic security personnel to be able to It is more convenient to judge whether the current vehicle entering the campus is a qualified vehicle, and to solve the traffic jam at the school gate during peak hours.

Keywords: License plate recognition · Image recognition · OpenALPR · Tesseract · Real-time streaming

1 Introduction

1.1 Research Background and Motivation

Image recognition is a very important part in the field of artificial intelligence applications, especially the use of artificial intelligence and machine learning in cooperative processing. Image recognition is actually quite widely used, from basic handwritten text recognition, object recognition, face recognition, even automated image description and driverless cars are applications that integrate deep learning and image recognition. In addition, applications in this area are bound to be widely used in the future, replacing human visual judgment with software, and even surpassing human beings. This is indispensable foundation for future technology.

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With the advancement of network transmission technology, the application of the Internet is no longer limited to the transmission of text or pictures. The maturity of the interactive multimedia network combining sound and video is an inevitable trend. A large amount of multimedia information is rapidly developed on the Internet by a new transmission technology called "streaming technology". In addition, compared to the traditional multimedia information stored on the Internet, it must be downloaded to the local computer before it can be played. The streaming technology allows the client to download a small amount of data in advance to start playing, saving a lot of waiting time; another advantage of the streaming technology is the use of the client buffer memory, so that the data does not need to be physically stored, directly It is read and played from the buffer memory and discarded, which effectively saves the local disk storage space. Based on the vigorous development of the two, we decided to combine the two [1] as the implementation goal.

1.2 Research Purposes

The license plate recognition system has been used in many places to control the entry and exit of vehicles, but schools still use manual methods to do this work, so I hope this implementation will help schools to complete their homework in a more efficient way. In this article, the license plate recognition application will be implemented, and the recognition rate is expected to reach the system on the market, so that the implementation results have commercial value.

1.3 Area of Research

This topic uses the existing open source suite OpenALPR as the main license plate recognition suite, and uses the Tesseract optical character recognition engine to train the model to improve the recognition accuracy, and integrates this system with real-time streaming, web pages, and databases to make a set a complete license plate recognition system that can be practically applied in daily life. Figure 1 shows the structure of the research process.

2 Related Literature Review

2.1 OpenALPR

OpenALPR is an automatic license plate recognition library written in C++. The software is distributed in commercial and open source versions. OpenALPR uses OpenCV and Tesseract OCR library. It can run as a command-line utility, standalone library, or as a background process. The software also integrates with video management systems such as Milestone XProtect.

2.2 RTSP

Live Streaming Protocol is a network application protocol designed for use by entertainment and communications systems to control streaming media servers. This protocol is used to establish and control media dialogue between terminals. Figure 2 shows the operational architecture of RTSP.

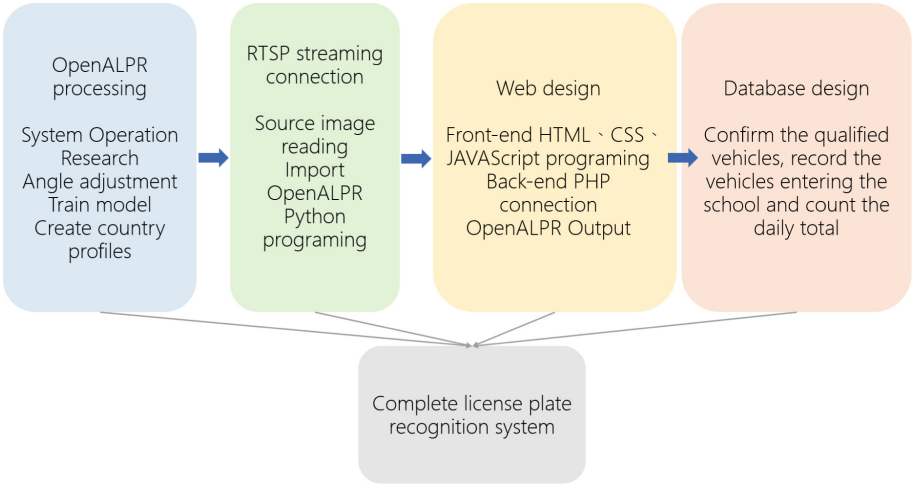

Fig. 1. Research Process Architecture Diagram.

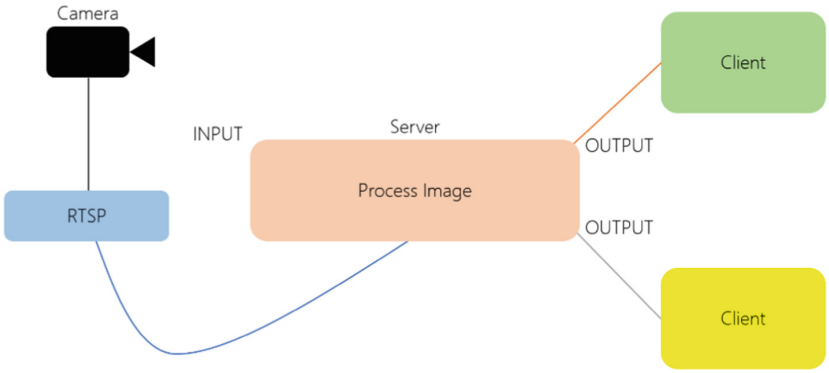

Fig. 2. RTSP Architecture Diagram.

2.3 Image Recognition

The visual image detection technology is to input the image into the analysis instrument for image analysis, especially widely used in the image monitoring system.

2.3.1 OpenCV

OpenCV is a cross-platform computer vision library for developing real-time image processing, computer vision and pattern recognition programs. Figure 3 shows the operation architecture of OpenCV.

2.4 OCR

Optical character recognition refers to the process of analyzing and identifying image files of text data to obtain text and layout information. Input has different storage formats and different compression methods for different image formats. Currently, there are OpenCV, CxImage, etc.

2.4.1 Tesseract

Tesseract is an OCR engine that supports multiple operating systems and is considered one of the most accurate open source OCR engines. Figure 4 shows the Tesseract architecture diagram.

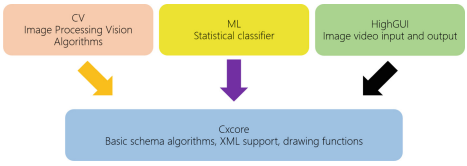

Fig. 3. OpenCV Architecture Diagram.

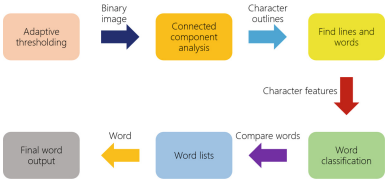

Fig. 4. Tesseract Architecture Diagram.

3 Thematic Research and Development

3.1 Overall Development Process

The system architecture is shown in Fig. 5. Our overall production process and software setup are carried out on Ubuntu, using the monitor stream at the gate of Tunghai University as the identification object, and the license plate identification using the open source software OpenALPR for development, and then establishing a database to store the license plates The relevant information is compared with the identification result, and finally a webpage is created to display the identification result. Figure 6 shows the operation flow chart of the whole system.

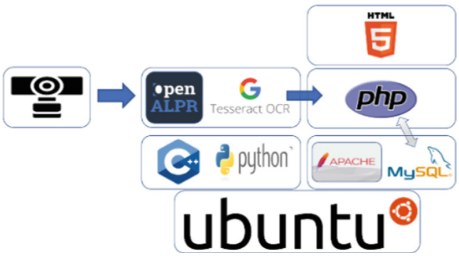

Fig. 5. System Architecture Diagram.

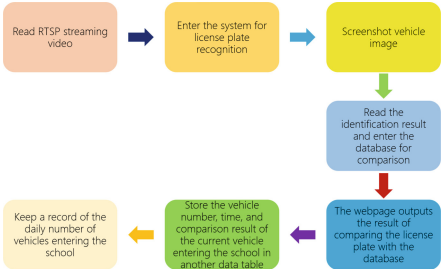

Fig. 6. Flow Chart of the Whole System Operation.

3.2 Research Methods

We use OpenALPR for license plate recognition. OpenALPR is a license plate recognition system written in C++. In the system, images are detected, binarized, character analysis, license plate edge search, license plate correction, and character cutting. The results are imported into Tesseract OCR for identification. The overall operation process of OpenALPR is shown in Fig. 7.

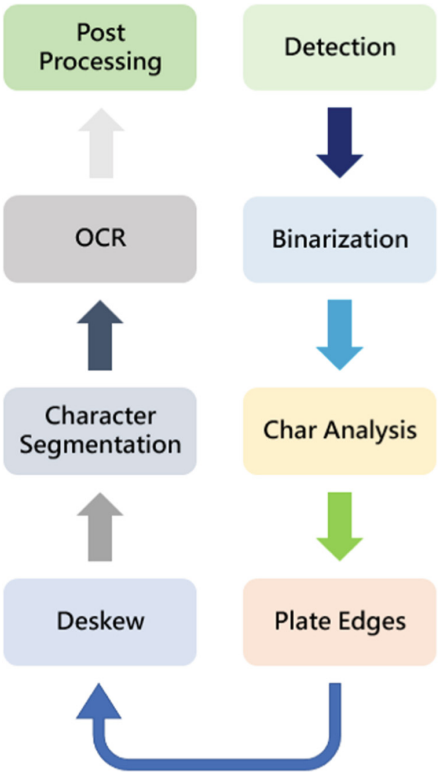

Fig. 7. OpenALPR Identification Flow Chart.

1. Detection
   Find the location of possible license plates in the imagery
2. Binarization
   Binarize license plate
3. Char Analysis
   Find the characters in the license plate through the binarized image
4. Plate Edges
   Find the border of the license plate
5. Deskew
   Re-output the size and orientation based on the license plate frame found

6. Character Segmentation
   Split out each character in the license plate
7. OCR
   Identify each character and output possible results and confidence
8. Post Processing
   Build a list of high-probability license plates based on the output of OCR

3.2.1 Dentification Research

During the development process, we first studied some operating instructions of the OpenALPR system and the parts that allow us to perform recognition optimization, and then we began to study some problems of image recognition. Test how to make the system output the highest accuracy and highest confidence after identification. In order to adjust the content of the system to suit our physical environment, we make many adjustments, the first is to adjust the angle, OpenALPR almost completely detects images that have not been adjusted at all angles. There are not any license plates, so we must first adjust a good angle and input the parameters into OpenALPR. After this step, most of the license plates can be recognized. Then, in order to improve the detection, we have to change the license plate format to Taiwan's data [2, 3], but since there is no Taiwan license plate format data in OpenALPR, we create the Taiwan license plate data by ourselves, let the system recognize the license plate better. After the completion, it is found that there is still a problem that has not been solved. Using the ready-made model to identify, the number 3 of the license plate is easily recognized as 5, and the new license plate is the most serious. Therefore, we trained the local license plate model [4], collect about 200 Taiwan license plates (as shown in Fig. 8), make the license plate binary and segment each character [5], and then compare the license plate set we trained with the Internet Open source license plate set integration, using train-ocr to train Taiwan's.traineddata, the test results can be as accurate as 99% in a good environment.

3.2.2 Implement Integration

When establishing a streaming connection, because we are using an open source version, we cannot directly import RTSP live streaming images into OpenALPR for identification. Therefore, we have studied some ways to deal with this problem, and finally found the most efficient and delay. The lowest method, after the above research and implementation, we can achieve low latency and high accuracy. In addition, a website is also established to display the results of license plate recognition. It is produced through HTML, CSS, JAVAScript, PHP, and Apache. The real-time streaming image of the gate will be output on the webpage. When a vehicle enters and undergoes license plate recognition, the recognition result can be displayed. A pop-up window at the top of a webpage.

3.3 Instructions

In the following, we will introduce the method of making a complete license plate recognition system to improve the accuracy rate and the integration of other systems in detail,

which are mainly divided into training model, angle adjustment, country establishment, license plate format, license plate output, real-time streaming connection, production Websites, build databases.

3.3.1 Train the Model

OpenALPR uses Tesseract as OCR, and the way we make the model of Tesseract is to use Train-OCR. First, each license plate collected is binarized (as shown in Fig. 9), and each character is divided and definition, and finally integrate all the segmented image files into a large.tif image file (as shown in Fig. 10), and train the image file and box file to Train-OCR to get the training result the.traineddata file.

Fig. 8. Crop the Collected Vehicle Photos into Pure License Plates.

Fig. 9. Define the Characters in the License Plate.

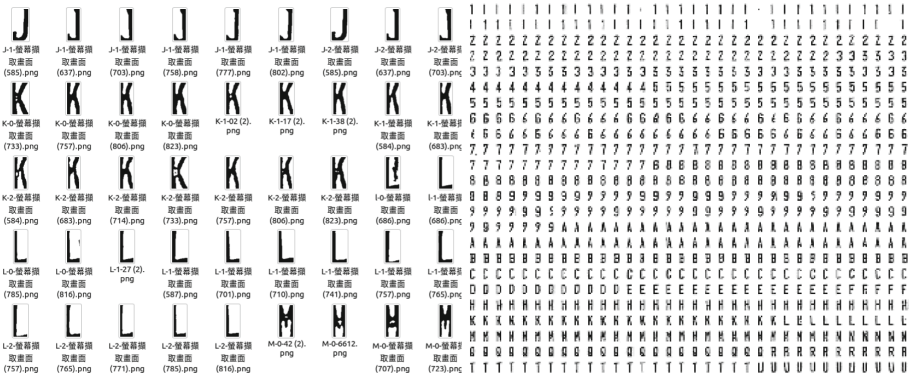

Fig. 10. Characters are Cut and Integrated into a.tif Image File.

3.3.2 Angle Adjustment

OpenALPR provides an instruction to adjust the angle. After inputting the image of the field to be adjusted (as shown in Fig. 11), you can use the pop-up window interface to make adjustments. After adjustment, parameters can be generated (as shown in Fig. 12). After entering the corresponding file and re-make, it can automatically adjust the image of the imported image recognized by the system. In our test, it can greatly improve the detection degree of the license plate compared with the original image.

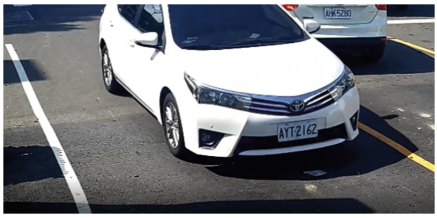

Fig. 11. Adjust the Front Vehicle Image.

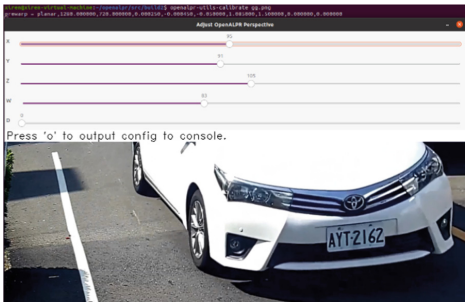

Fig. 12. Adjusted Vehicle Image.

3.3.3 The Establishment of National

In the current version of OpenALPR, license plate information is provided for the United States, the European Union, Singapore and other countries. By default, the system will use the national data of the United States for license plate recognition, but if you want to improve license plate detection, you can use your own However, there is currently no national data for Taiwan [6]. The function of the national data is that after the license plate recognition system reads the image, it will identify the length and width of the license plate, the length and width of the license plate characters, the px of the license plate, and the characters of the license plate. px, the combination of characters and lengths in the license plate, etc., if it does not conform to the set national format, even if there is a license plate in the image, the system will still judge that there is no license plate. The output format conforms to the license plate of Taiwan, which can save the system from outputting some wrong outputs. At the same time, it can also identify the license plate in the most appropriate position, and it will not waste resources to calculate some images when the state is very bad as soon as the license plate is scanned.

3.3.4 License Plate Format

Each country's license plate has a different format. In Taiwan, we have the first two characters in English, the last four in numbers, and the first three in English and the last four in Chinese, and so on. So we established In order to obtain the license plate format from Taiwan, the recognition result must conform to the content in our document (as shown in Fig. 13), and the result will be output.

Fig. 13. Set Taiwanese Self-use (Rental) Passenger Car License Plate Style.

3.3.5 License Plate Output

We use Python to output the result of license plate recognition. The reason for this part is that each frame will output the result of license plate recognition once when recognizing dynamic images, so there will be many identical outputs, Or sometimes it may be because the angle of the car is too oblique when it first enters the recognition area or when it finally leaves the recognition area, resulting in different outputs. Therefore, we compare the recognition output of the previous license plate with the output of the next license plate recognition. If the similarity between the previous output and the next output is more than 0.7, it will be regarded as the same car, and only the license plate with the highest confidence after recognition will be output., if the similarity of the license plate before and after the comparison is below 0.7, it will be regarded as a different car, and the license plate of the next car will be output and entered into the confidence comparison of the next car.

3.3.6 Live Streaming Connection

Because we are using the OpenALPR open source version, the RTSP signal cannot be directly identified to the system. To connect OpenALPR to the real-time image, the RTSP signal needs to be converted into MJPEG using FFmpeg and FFserver before it can be read by OpenALPR. However, in our test results, we found that this method will have a delay of more than ten seconds, so later we switched to using Python to read our OpenALPR suite. Using this method, we can directly let the open source version of OpenALPR receive RTSP signals. License plate recognition, the delay time is also greatly reduced.

3.3.7 Web Production

We use the front-end three Musketeers HTML, CSS, JavaScript to make the front-end of the web page, and the back-end uses PHP, and connects JavaScript and PHP through AJAX, so that the recognized license plate results are transmitted from the back-end to the front-end, We use the webpage to display the real-time video streaming screen. After the vehicle is identified by the license plate recognition system, the result of the identification of the license plate will be displayed in the floating window at the top of the webpage (Fig. 14), the light signal is connected to the database after license plate recognition to determine whether the vehicle is a qualified vehicle that has applied for admission to the school. The control of the light signal is set by using the return value of the database. When the recognized vehicle is a school vehicle. The database will return TRUE when it does not match, and it will return FALSE if it does not match. By using Python to capture the returned value, control the change of the light number. The light number is connected to the database after the license plate recognition to determine whether the vehicle has applied for admission to the school. For qualified vehicles, the green light will be on if the license plate matches, and the red light will be displayed when the license plate does not match. However, after the school traffic security personnel tested and used it, they believed that the output of the font color is more intuitive. Therefore, we will remove the light and change it to the desired interface

of the traffic security team. In this way, traffic security personnel can more quickly and easily determine whether a vehicle needs to be intercepted.

Fig. 14. The Old Version Webpage Shows the Output Screen.

3.3.8 Build a Database

We use MySQL to build a database, and put in the license plate numbers that are qualified to be registered in the school. In addition, the license plate information entering the campus on the day and the number of vehicles entering the campus each day, including the time and identification results, will be recorded, which can facilitate management personnel to check the situation of vehicles entering the campus.

4 Implementation Results

4.1 Implementation Notes

In the implementation of this project, the monitor screen at the gate of Tunghai University is used as the subject of the implementation, and OpenALPR is used as the license plate recognition system to identify the vehicles entering the gate, and the output is compared with the license plate data in the database to verify the result. Output on the web. Authorized personnel are not limited to specific devices when using, as long as the device has Internet access, users can view the results of image recognition through the web at any place and at any time.

4.2 Implementation Display and Identification Data

After we used the gate of Tunghai University to test through real-time video streaming and pre-recorded videos at various times throughout the day, 261 of the 275 vehicles tested could be correctly identified [7], and about three of the remaining erroneous parts were identified by a few characters. Most of them are not recognized due to the high speed of the car, so almost all of them can be accurately recognized when using our system at a speed of about 20 km per hour [8, 9]. Below we provide some pictures

of the test results. Figure 15 shows the background output of the OpenALPR system. Figure 16 shows the identification results displayed on the web page. Figure 17 shows the identification output at night.

4.2.1 License Plate Recognition System Background Interface

We use Python to import the OpenALPR package we made, connect the real-time video stream at the gate of Tunghai University, and use Python to judge whether it is the same car and select the license plate with the highest confidence for the result of license plate recognition. The output will be displayed on the terminal.

Fig. 15. Implementation Demonstration 1—Background Terminal Output Screen.

4.2.2 Display Styles on Web Pages

The actual webpage screen is as follows. After the vehicle enters and is identified by the system, it will take a screenshot of the current screen, and use a pop-up window at the top of the webpage to display the license plate identification result. If the result of the comparison with the database is that the school vehicle font will be displayed in black font, otherwise it will be displayed in red font.

4.2.3 Night Test

Many license plate recognition systems on the market need to install a strong light on the license plate at night because of the brightness problem. We have also suggested installing it at the school gate, but the traffic security team is afraid that the light will interfere with the driver and cannot install it for safety reasons., at the beginning, our system could not successfully identify without a training model, so we improved by increasing the training set. After testing, the correct vehicle number can be recognized at night, even when there is a locomotive, pedestrian interference or from behind the vehicle.

4.2.4 School Vehicle Record

If the traffic security personnel want to inquire about the information of the vehicles entering the school, they can click the “RECORD” button at the top of the webpage to

Fig. 16. Implementation Demonstration 2—The Actual Web Page Displays the Output Screen.

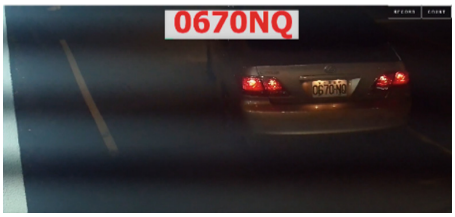

Fig. 17. Implementation Demonstration 3—Night Recognition.

view the database (as shown in Fig. 18), which stores all the recognized license plates, entry time and whether it is a school vehicle. In order to prevent the database from becoming too numerous, the content of the database will be refreshed every day. If you want to view a vehicle, you can also use the search box above. Entering the car number can only display the information of the car (as shown in Fig. 19), allowing managers to quickly make inquiries. In addition, you can also click the "COUNT" button at the top of the web page to record the statistics of vehicles entering the school every day (as shown in Fig. 20). When organizing activities, it is convenient for schools to estimate the number of vehicles in the school in advance for scheduling and adjustment of personnel or vehicles.

搜尋：請輸入搜尋文字

車牌	時間	結果
TDT5861	2022-10-7-00-12	0
AXY6123	2022-10-7-00-12	0
BLP8162	2022-10-7-00-13	0
TDQ0132	2022-10-7-00-13	0
TDT5860	2022-10-7-00-20	0
CP7581	2022-10-7-00-28	0
BHW5671	2022-10-7-00-29	0
AT6016	2022-10-7-00-33	0
ATW6016	2022-10-7-00-33	0

Fig. 18. Implementation Demonstration 4 - Viewing the Information of the Vehicle Entering the School through the Website.

搜尋：8162

車牌	時間	結果
BLP8162	2022-10-7-00-13	0

Fig. 19. Implementation Demonstration 5—Searching for Information on Enrollment of Specified Vehicles.

DATE	COUN
2022-5-9	1314
2022-5-10	1346
2022-5-11	1431
2022-5-12	1374
2022-5-13	1476
2022-5-14	843
2022-5-15	1163
2022-5-16	1130

Fig. 20. Implementation Demonstration 6—Daily Entry Vehicle Statistics.

5 Conclusion

5.1 In Conclusion

The result of the implementation is the combination of license plate recognition and live streaming. The license plate recognition rate can reach a very high recognition rate in both day and night, and the recognition time is nearly instant, achieving low latency. The light output on the webpage will judge whether the vehicle currently entering the campus is a qualified vehicle according to the license plate information in the database. The result is indicated by different colored lights, green qualified vehicles, red unqualified vehicles, intuitive and easy to understand, convenient for authorization personnel use. And establish another table to count the vehicles entering the school, make the application of the whole license plate recognition system more complete, reduce a lot of manual inspection time and save human resources at the same time, and bring relief solutions to traffic jams during peak hours.

5.2 Features of This System

There are some differences between this license plate recognition system and the license plate recognition system of the general parking lot. Generally, the parking lot only needs to store the vehicle information in the database after the vehicle enters. Our database has a list of approved vehicles that can enter. And when the vehicle enters, the information of the vehicle is stored in another table for record; in the identification part, the vehicle needs to be stationary when the identification is performed in the general parking lot, and ours can be identified when the vehicle is moving; the camera installed in the general parking lot The distance between the location and the license plate is also very close. At night, there is strong light near the license plate to increase the detection degree. However, the environment we made does not allow us to have this condition, but we can also make a good accuracy rate.

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