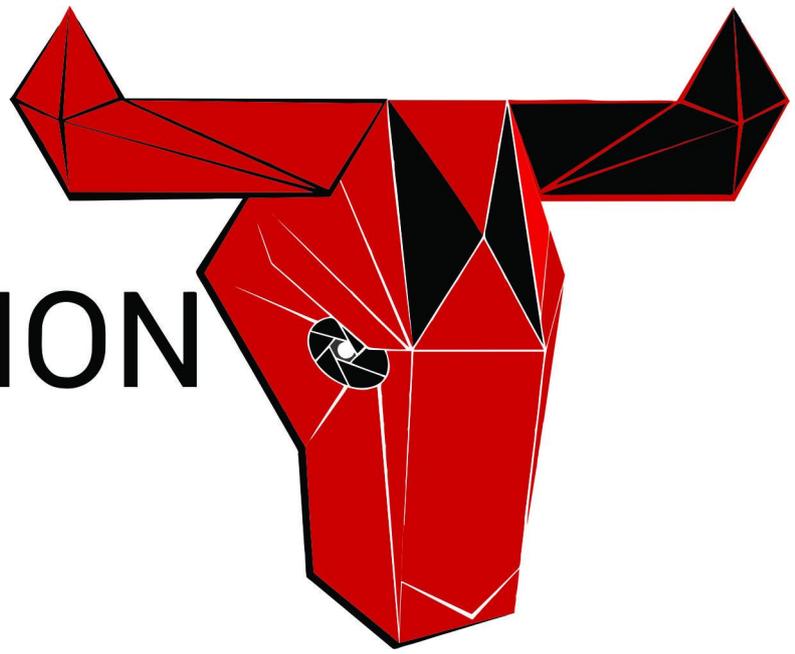


TAURUS VISION



Automatic Number Plate Recognition Technology

A universal and efficient algorithm
for global ANPR application

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1. BACKGROUND

With the vehicle applications gaining popularity in daily life, intelligent vehicle management becomes important in many industries. Hikvision ANPR (Automatic Number Plate Recognition) technology can detect and identify the vehicle's unique license plate number and is an important component of a sophisticated vehicle management system.

While Hikvision's ANPR technology has been approved by many Chinese customers for its high accuracy, lack of a universal license plate format in the overseas market presented a great challenge. Hikvision's ANPR technology was created to be applied globally in diverse places since it does not rely on prior information (such as plate character structure, plate color, etc.).

2. KEY TECHNOLOGIES

Hikvision ANPR technology is able to extract license plates from the complicated background, separate and recognize each character on the plate, and reformat the plate information. The technology consists of plate locating, character partitioning, and character recognition. See the below diagram for the recognition example.



Figure 1 Plate Recognition Flow

2.1. PLATE LOCATING

Plate locating technology does not rely on the plate color or character structure, and can locate monolayer (single section) and bilayer (dual section) plates. The plate locating procedure consists of rough locating, false plate filtering, fine locating, and post processing.

2.1.1. ROUGH LOCATING

The rough locating procedure works based on the characteristic that the contrast between plate characters and the plate background is very pronounced. It searches the part that matches with the feature in the image to locate the license plate.

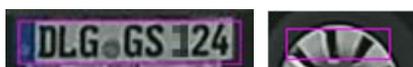


Figure 2 Rough Locating Result

2.1.2. FALSE PLATE FILTERING

Because the surveillance environment might be complex and contain plate-like parts (such as vehicle wheels as shown in Figure 2 and other items), false plate information should be filtered from the rough locating result by confirming that the textural features of the located part correspond with an actual plate.



Figure 3 False Plate Filtering Result

2.1.3. FINE LOCATING AND POST PROCESSING

The edge of the rough located part is not as accurate as that of the actual plate, the plate is precisely locate by analyzing the discriminating features between it and the background, , as shown in the following figure.



Figure 4 Fine Locating Result

Furthermore, to finely locate the main section (the section has more characters) of the multi-sectioned license plate (in the following figure, the content marked by the red frame is the main section), we post-process the license to determine the accurate border of the main section by using the Hikvision character detection algorithm.



Figure 5 Bilayer License Plate

2.2. CHARACTER PARTITIONING

Since the plate locating has now obtained the upper and lower borders of the plate characters, the remaining problem is determining the left and right borders of each character. Here are the common character partition (character's circumscribed rectangle) methods and their advantages and disadvantages.

✧ Vertical Projection

This technique finds the wave troughs by observing the projections. Wave troughs are the spaces between the characters, which are used to locate and partition off every character. However, this method cannot judge where the left border of the first character is. Other methods should be combined to find the plate's left and right borders.

✧ CCL (Connected Component Labeling)

Every character is a connected region or has a part that is connected. We can cut the connected region out of the image to get the shape of the character. But in actual application, an excessive noise may degrade the regions of different characters and interfere with identifying the character partition.

✧ Template Matching

After using character partition methods such as vertical projection, template matching can be applied to locate the character position precisely with the known character order structure and effectively decrease the character partition errors. However, since the worldwide plate types vary, template matching is unreliable.

To solve the universality problem of the character partition algorithm, Hikvision developed an algorithm that combines Vertical Projection and CCL to roughly part the characters, another method to finely part the characters, and a special strategy to identify all the borders of characters on the multi-section plates. Therefore, Hikvision's character partition algorithm is suitable for global application.

2.2.1. ROUGH PARTITION

During the rough partition procedure, Hikvision first uses the CCL estimate the character width and spaces between characters, and then introduces Vertical Projection to roughly locate the characters and their left and right borders. Hikvision algorithm guarantees the excellent application universality at the beginning.

2.2.2. FINE PARTITION

Since there are possible problems left by the rough partition such as one character separated into two or more, two characters combined into one, diverse character widths, and inter-embedded characters, Hikvision develops a fine partition algorithm with the most advanced technology, which is a core part of the ANPR technology.

- 1) To finely separate complicated characters problems such as one character separated into two, or two characters combined into one, the algorithm separates characters based on different preprocessed pictures (such as greyscale picture, outline drawing, etc.), compares the results, and selects the result with the highest confidence coefficient.
- 2) Hikvision's character detection algorithm is used to identify characters with unequal widths. As shown in the following figure, the characters marked with blue rectangle are the partition result that has eliminated the unequal width influence.



Figure 6 Partition Result of Characters with Unequal Width (Front Part)

- 3) The inter-embedded characters, such as the "7" and "4" in the following figure, are regarded as one character after the rough partition and affect the recognition accuracy. Hikvision introduces the Hikvision Block Analysis Technology to finely partition every character.

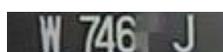


Figure 7 Inter-Embedded Characters

2.2.3. BILAYER PLATE PROCESSING

This technique uses a categorizer to distinguish the bilayer plate. If the plate is a bilayer plate, Hikvision has a special processing strategy that locates the minor layer (with fewer characters) based on the located main layer (with more characters) and completes the character partition.

In most cases, the main layer is located lower than the minor layer; however, in some regions, the positions of the main layer and the minor layer are reversed, as shown in the following figure.



Figure 8 The Main Layer is in the Upper Position

To maintain compatibility with both kinds of bilayer plates, an "internal adjustment

measure" is adopted: after locating the two layers of the plate, it will always start the partition from the lower layer. This measure can speed up the processing efficiency for bilayer plate.

2.3. CHARACTER RECOGNITION

Hikvision's character recognition algorithm is based on a machine learning neural network algorithm. Compared to the traditional recognition algorithm, it has advantages that it has a character authenticity identification module and supports various kinds of characters recognition, including Arabic numerals, English characters, Chinese characters, Korean characters, Thai characters, Japanese characters, etc. It works according to the below flow diagram.

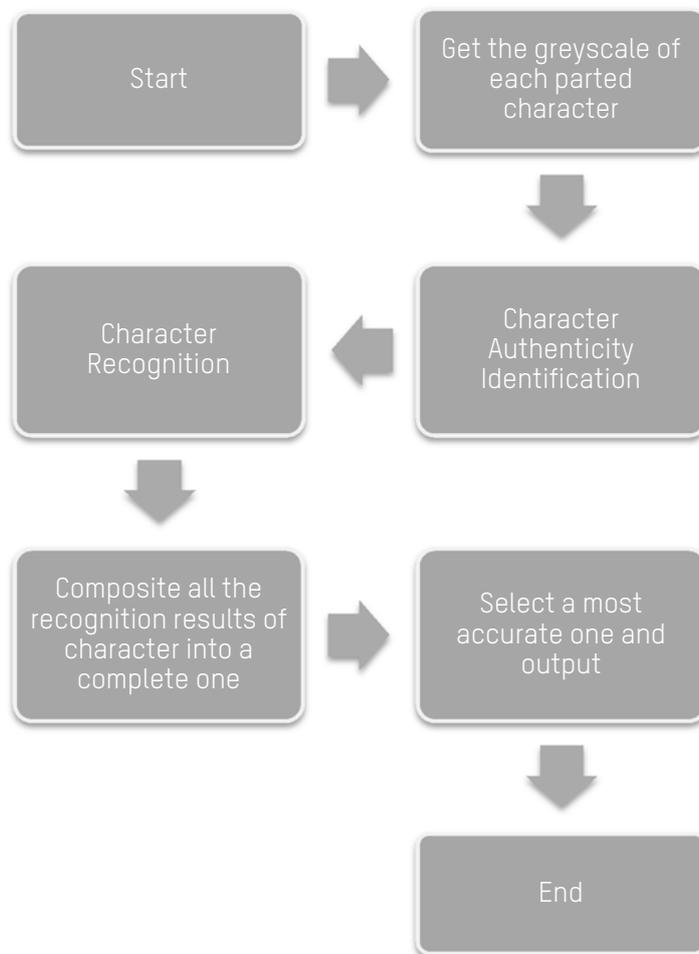


Figure 9 Character Recognition Flow

Because the Hikvision ANPR algorithm is suitable for the global application, many non-character may be separated in the partition process, such as the plate frame and heat dissipation area in the vehicle nose. To improve the recognition efficiency, the false information is filtered by implementing the character authenticity identification before character recognition.

3. APPLICATIONS

Hikvision ANPR technology features the most advanced machine learning algorithm and the image processing measure, and reaches extremely high accuracy. It has the following advantages:

- ✧ Small resource occupation;
- ✧ High recognition efficiency;
- ✧ Great capability: round-the-clock recognition and minimally affected by weather;
- ✧ Global application: supports Arabic numeric, English characters, and any other language characters.



Vietnam ANPR Application



Indian ANPR Application



Philippine ANPR Application



Macau ANPR

Figure 10 Hikvision ANPR Global Application Examples

Most of the traditional ANPR technologies, which depend a lot on the license plate color and structure, the accuracy rises and falls affected by the environment, are applied limiting by their disadvantages. And if there are multiple plate types in the application region, their recognition accuracy would greatly reduce.

Hikvision's ANPR technology, however, does not rely on specific environmental and regional conditions. Hikvision's advanced algorithms can recognize multiple plate types. Hikvision ANPR cameras satisfy global applications with recognition accuracy higher than 95 percent. Versions customized for specific region can reach 98 percent accuracy or more. At present, Hikvision ANPR cameras have been applied in parking lots, buildings' entrance and exist, etc. and are approved by many customers.