

HIKVISION License Plate Recognition Technology

The essential component of a sophisticated vehicle management system

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1. BACKGROUND

When employees can easily and securely park their cars and get to and from work, businesses run more smoothly. License plate recognition (LPR) makes this possible. It's a technology that's come a long way in recent years and it's the essential component of a sophisticated vehicle management system. Developed as a global technology, Hikvision's LPR technology can accurately identify Canadian and U.S. license plates, as well as license plates from other countries. This white paper explains how LPR works, and takes a close look Hikvision's R&D contributions to recent advancements in LPR.

2. KEY TECHNOLOGIES

Hikvision LPR technology is able to extract license plates from complex backgrounds, 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 diagram below.



Figure 1 - Plate Recognition Flow

2.1. PLATE LOCATING

Plate locating technology does not rely on plate color or character structure, and can locate mono-layer (single section) and bi-layer (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 first step is the rough-locating procedure. The camera looks at the contrast between plate characters and the plate background. 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

The camera image of a vehicle is often complex, containing several plate-like parts, such as vehicle wheels as shown in Figure 2. The second step is to filter out false plate information from the rough locating result. LPR does this 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 located by analyzing the discriminating features between it and the background, as shown in the following figure.



Figure 4 - False Plate Filtering Result

Lastly, the LPR technology finely locates the main section (the section that has more characters) of the multi-sectioned license plate. In the diagram below the main section is within the red frame. The Hikvision character detection algorithm post-processes the license plate to determine the border of the main section.



Figure 5 - Bi-layer License Plate

2.2. CHARACTER PARTITIONING

Once the plate locating feature finds the upper and lower borders of the plate characters, the next step is determining the left and right borders of each character. There are three common character partition methods, and they each have advantages and disadvantages.

- **Vertical Projection**

This technique finds the wave troughs by observing 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 must 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. In practice however, excessive "noise" in the image may degrade the regions of different characters and interfere with character partition identification.

- **Template Matching**

After using character partition methods such as vertical projection, template matching can be used to precisely locate the character position with the known character order structure. This effectively decreases character partition errors. However, since plate types vary worldwide, template matching is unreliable. U.S. license plates are one of the most complex license plates in the world, featuring not only numbers, letters and pictures, but also a unique structure.

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. Hikvision's character partition algorithm is suitable for LPR applications in countries around the globe.

2.2.1. ROUGH PARTITION

During the rough partition procedure, Hikvision first uses the CCL procedure to 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's proprietary algorithm guarantees highly accurate LPR from the beginning.

2.2.2. FINE PARTITION

There are potential problems left by the rough partition including: one character separated into two or more, two characters combined into one, diverse character widths, and inter-embedded characters. To address this, Hikvision developed a fine partition algorithm with the most advanced technology as a core part of its LPR 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 pre-processed pictures (such as grayscale pictures, outlined drawings, etc.), compares the results, and selects the result with the highest confidence coefficient.
- 2) Hikvision's character detection algorithm is used to identify license plate characters with unequal widths. Below, the characters marked with a blue rectangle show the partition result when unequal width influence is eliminated.



Figure 6 - Partition result of characters with unequal width (Front Part)

- 3) The inter-embedded characters, such as the "4" and "5" in the following figure, are regarded as one character after the rough partition and affect LPR accuracy. Hikvision introduced the Hikvision Block Analysis Technology to finely partition every character.



Figure 7 - Inter-Embedded Characters

2.2.3. BI-LAYER PROCESSING

This technique uses a categorizer to distinguish a bi-layer plate. If the plate is a bi-layer 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 below 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 bi-layer plates, an “internal adjustment measure” is used. After locating the two layers of the plate, the technology starts the partition from the lower layer. This measure can speed up processing for bi-layer plates.

2..3. CHARACTER RECOGNITION

Hikvision's character recognition algorithm is based on a machine learning algorithm. Hikvision's algorithm has several advantages over the traditional recognition algorithm, such as character authenticity identification module. It also supports various kinds of character recognition, including Arabic numerals, English characters, Chinese characters, Korean characters, Thai characters, Japanese characters, and more. It works according to the flow diagram below.

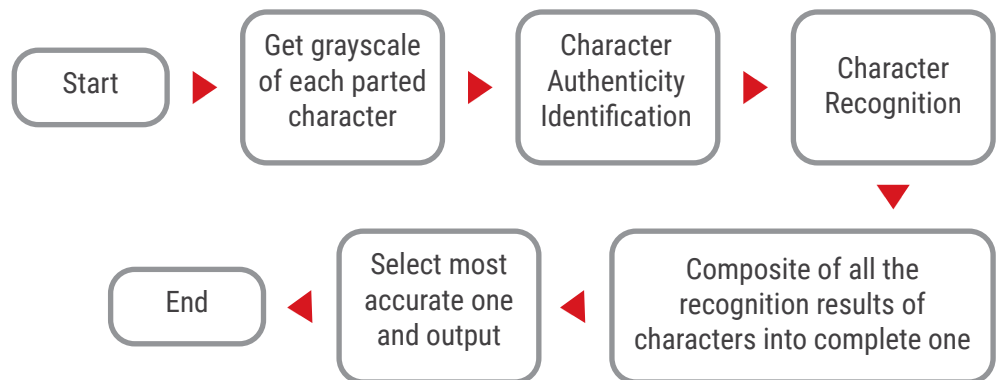


Figure 9 - Character Recognition Flow

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

3. APPLICATIONS

Hikvision LPR technology features the most advanced machine learning algorithm and the image processing measure and is extremely accurate. It has the following advantages:

- High Recognition Efficiency
- Great capability: round-the-clock recognition, minimally affected by weather
- Global application: supports Arabic numerals, English characters, and other languages



Canadian LPR Application



American LPR Application

Figure 10 - Hikvision LPR Global Application Examples

Most traditional LPR technologies depend heavily on the license plate color and structure. As a result, accuracy is highly dependent on the environment. And, recognition accuracy is greatly reduced if the application includes multiple license plate types.

Hikvision's LPR technology does not rely on specific environmental and regional conditions. Our advanced algorithms can accurately recognize multiple plate types. Today, Hikvision LPR cameras are used in parking lots, building entrances and exits in the U.S., Canada and around the world. With high reliability, Hikvision's advanced LPR technology is an essential element of a comprehensive security system for businesses, campuses, healthcare facilities and much more.

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