

Automatic License Plate Detection and Recognition in Thailand

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A license plate recognition (LPR) system with image sensors, which enables vehicle identification, plays a very important role in traffic flow control. In Thailand, chronic traffic congestion due to rapid motorization is a serious problem, and LPR can be one of the solutions. However, there are some technical obstacles to overcome such as the recognition of the Thai alphabet. We have developed a novel method that enables the LPR system to work well regardless of the plate format or alphabet. We conducted experiments using image data collected in Thailand, and obtained positive results with a plate detection rate of 94.6% and a character recognition rate of 92.0%. We will continue to improve the performance of the LPR system for practical use in Thailand.

Keywords: license plate, license plate detection, character recognition, Thailand, pattern recognition

1. Introduction

In recent years, chronic traffic congestion due to rapid urbanization and motorization is a serious problem in South East Asia including Thailand. Adequate traffic flow control, based on information collected with various kinds of sensors, like image sensors, is one of the solutions.

Among many ways of collecting traffic information, license plate recognition (LPR) with image sensors is very useful for travel time measurement because it enables vehicle identification without a special device. Therefore, many methods for license plate detection and recognition have been proposed. However, they tend to assume a specific format or use of Latin alphabet or Japanese characters, and are difficult to apply to license plates in many Asian countries like Thailand, where local alphabet is used on license plates.

We have developed a novel method for detection and recognition of various types of license plates⁽¹⁾. The method assumes neither a specific format nor a specific character system. In this paper, we examined the method with collected images of license plates in Thailand.

2. Methods

2-1 Outline of license plate in Thailand

Examples of license plates in Thailand are shown in **Photo 1**.

Outline of license plates in Thailand are as follows⁽²⁾:
General license plates

License plates for general cars are 15 by 34 centimeters in size, with a colored and embossed outline. The registration ID consists of two series of Thai letters followed by a serial number string up to four digits, from 1 to 9999. The province of registration is displayed in Thai under the registration ID. The colors of the text and the background differ depending on the type of vehicle.

Bus and truck plates

License plates for buses and trucks are 22 by 44 cen-



(a) General License Plate



(b) Bus and Truck Plate

Photo 1. Examples of license plates in Thailand

timeters. The registration ID consists of two digits and four serial digits, separated by a horizontal line. The word “THAILAND” is displayed above the ID, and the province of registration is displayed below the ID. The color of the text is black, and the color of the background is yellow or white.

2-2 Outline of the methods

Figure 1 shows the outline of the proposed method. First, plate detection process is performed on the input image, and character recognition process is performed on the detected license plate. These two processes are independent. The targets of character recognition were vehicle ID only.

2-3 License plate detection

Figure 2 shows the outline of plate detection.

Bag of Features⁽³⁾ based on Histogram of Oriented Gradient (HOG-based BoF) and linear support vector machine (SVM) were adopted for a detector. Robustness against illumination or environmental change can be achieved with HOG, and robustness against various types of fonts can be achieved with BoF.

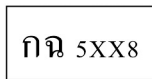
At the training phase, the study constructed a detector with a lot of positive and negative samples. These samples were selected randomly from the collected images.



(a) Input image

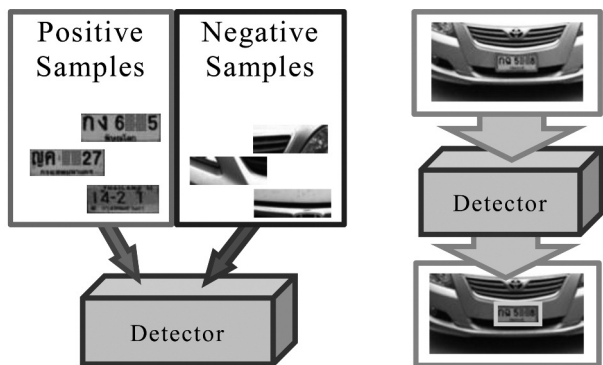


(b) Detected license plate



Recognition of the registration ID

Fig. 1. Outline of the proposed system



(a) Train detector with positive samples (images of license plates) and negative samples (images of other parts)

(b) Plate detection with the trained detector

Fig. 2. Outline of detector training and detection

2-4 Character recognition

Figure 3 shows the outline of character recognition. HOG-feature was adopted for character recognition.

At the training phase, we adopted generative training⁽⁴⁾. Training data for character recognition was generated from a high-resolution image of each letters (44 Thai letters and 10 Arabic numbers), and distribution of each letter in the HOG-feature space was then obtained.

At the recognition phase, each character is cut out from the image, calculated the HOG-feature vector, and recognized characters with the distribution in HOG-feature space obtained above.

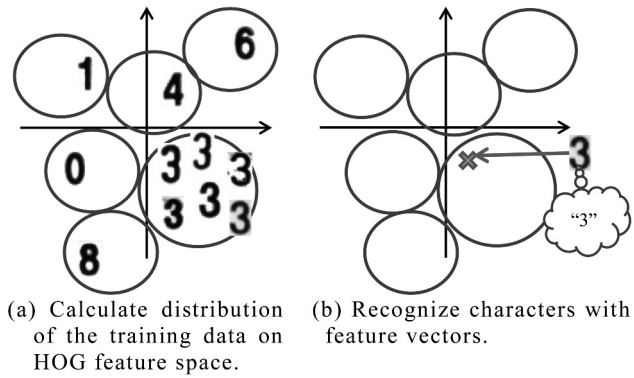


Fig. 3. Outline of character recognition. HOG feature space is described as a 2-dimensional plane for simplicity of explanation.

3. Experiments

3-1 Image data for the experiment

Image data sets used in the experiment were collected on the Expressway in Bangkok, Thailand. Examples of the collected images are shown in Photo 2.

Among these collected images, 18,674 images were selected at random. For images with license plate, size, position, and registration ID of the plate were recorded by hand.

In the experiment, license plates in the images were detected with the plate detector. If the tested image has no license plate, the right answer is “NO PLATE.”

After that, the registration ID on the detected license plate was recognized. As mentioned above, province names on the plates were not the target of this experiment.

3-2 Training

HOG-based BoF is used as a feature, and a support vector machine as a detector. As mentioned above, 3,000 images of license plate and 1,500 images of other parts of cars were randomly selected as a training data set.

The training data set for character recognition was generated from a high-resolution image of each letter (44 Thai letters and 10 Arabic numbers), considering the difference of fonts and conditions of dirt or damages. Although the fonts of Arabic numbers on general license plates and those on the bus and truck plates are different, training data were common in the experiment.

3-3 Detection and recognition

10,174 images with license plate and 4,000 images with no license plate were randomly selected as evaluation data.

First, license plates in the images were detected. After that character recognition was performed when the license plate was successfully detected.

4. Results

Terms about the results of the experiments are defined as follows:

- Success of detection: License plate is successfully detected for image with license plate.

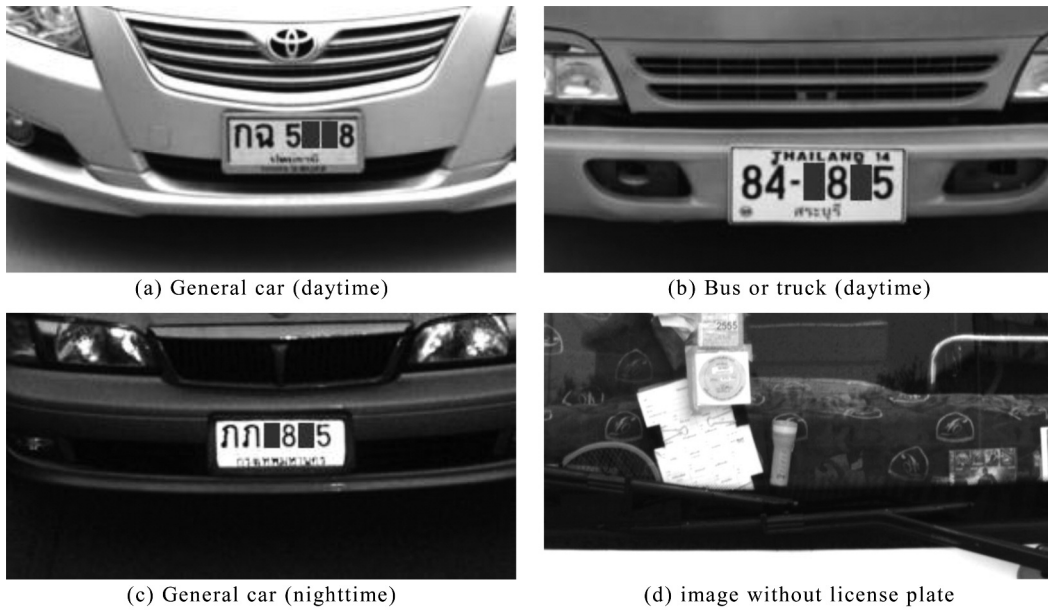


Photo 2. Examples of collected images

- Miss: License plate is not detected for image with license plate.
- False Alarm: Some parts other than license plate are detected as "License Plate."
- Success of Thai alphabet recognition: First part of the registration ID (Normally 2 Thai letters or 2 Arabic numbers) is recognized successfully.
- Success of Arabic number recognition: Latter part of the registration ID is recognized successfully.
- Success of all character recognition: All characters of the registration ID is recognized successfully.

Table 1 shows the results of license plate detection and character recognition. 210 of 4,000 images with no license plate had one or more false positives. Average number of false positives per image (with or without plate) was about 4.0.

Examples of the results of license plate detection are shown in Photos 3 to 5.

Photo 3 shows examples of successful detection.

Photo 4 shows examples of miss for images with license plate. Types of misses are detection failure of license plates of low luminance or plates with red background in the nighttime, or detection failure of license plates with surface damage or dirt.

Photo 5 shows examples of false positive for images without a license plate. All of false positives on images with



(a) General license plate (daytime)



(b) Bus and Truck plate



(c) General license plate (nighttime)

Photo 3. Examples of success of detection

Table 1. Results of license plate detection and recognition

Item	Total Numbers	Number of success	Rate of success	
License plate detection	10174	9627	94.6%	
Character	9627	Arabic numbers	9024	93.7%
		Thai alphabets	8932	92.8%
		All characters	8855	92.0%
License plate detection & All character recognition	10174	8855	87.0%	

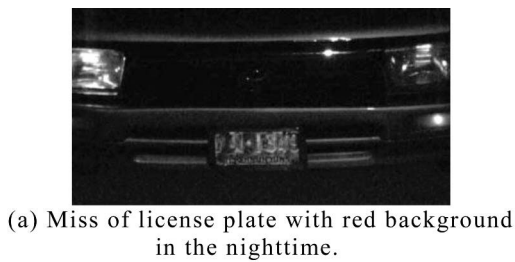


Photo 4. Examples of misses

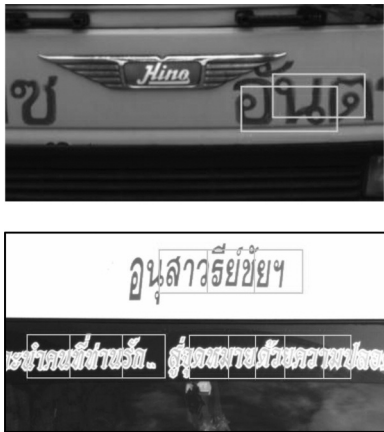


Photo 5. Examples of false alarm for images without license plate

no license plate were the detection of a character on non-license-plate objects.

Examples of the results of character recognition are shown in Fig. 4.

The processing time per image was about 300 ms (implemented on Windows 7 Pro 32 bit / Intel Core i-7 880 / C language).

5. Discussion

The results show that:

The combination of license plate detection with HOG-based BoF and character recognition with distribution in HOG-feature space is valid for license plates in Thailand, but the false positive rate is still high for practical use. Our method detects a license plate in the image as a “set of character-like curves.” Therefore, it can handle license plates regardless of their formats. However, as a side effect, it mistakenly detects non-license-plate objects with charac-



Fig. 4. Examples of the result of character recognition. The results with asterisk (*) are recognition failure, and characters with under bar are misrecognized.

ter-like curves. Therefore, it is essential to measure false alarms.

Character recognition based on feature vector distribution on HOG feature space enables flexible recognition, e.g. handles both fonts for general license plates and for bus and truck plates, and is valid for the Thai alphabet and Arabic numbers. Most of failures of recognition were caused by dirt or damage of license plates, and not by the fault of the method itself.

Our future works are as follows:

(1) Improvement of performance

At this time, the rate of detection or character recognition and the number of the false positives are not at a sufficient level. The performance must be improved for all the license plates including dirty or damaged plates.

(2) Computation cost

At this time, our method needs much computation cost. In order to transplant the LPR method from PC to a roadside device, the method needs to be optimized to fit the road-side device performance.

(3) Performance under extreme conditions

For practical use in Thailand, or other tropical countries, the study should cover more images under extreme conditions, like under heavy squalls.

6. Conclusion

This paper proposed a novel method for detection and recognition of license plates in Thailand. We performed a set of experiments and the results showed that the methods of license plate detection and character recognition are valid for license plates in Thailand. Performance improvement and evaluation of performance under extreme conditions are our future work.

7. Acknowledgements

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Technical Terms

- *1 Histogram of Oriented Gradients (HOG): HOG is an image feature value. An image is divided into multiple local regions, and a side-by-side vector of histograms oriented in the direction of the luminosity gradient of each region is calculated as the image's feature value. One characteristic of this method is that it is robust with regard to differences in position and variations in illumination.
- *2 Bag of Features (BoF): BoF is a feature value which describes a set of local features as a single histogram. It is very simple description, with information about places abstracted. Recently, it is used widely for object recognition.
- *3 Support Vector Machine (SVM): An SVM is a method of pattern recognition. In theory, it is the most efficient method for solving two-category classification problems and provides high identification performance when dealing with unlearned data.

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