# Detection Method for Different Types of License Plates

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Conventional license plate detection methods have a good success rate in detecting one or a few fixed formats, however, they may fail in some cases such as motorcycles in Japan and foreign vehicles across national borders. The authors have developed a novel method to detect different types of license plates. This method employs Bag-of-Features based on Histogram of Oriented Gradients, which enables the detector to identify characters' common curves on different types of plates. Moreover, this method reduces the computation time and false detection as used in combination with screening technology and edge distribution. The experiment results show that the method is effective for detecting motorcycle license plates in Japan.

Keywords: license plate detection, image processing, bag of features, Histograms of Oriented Gradient

## 1. Introduction

Many detection methods have been proposed for license plates of automobiles in Japan. In particular, methods based on the arrangement of characters [1] realize precise detection. The nominal detection rate of commercial plate detectors are more than 99%. One of the reasons of the high performance of these methods and devices is that the format of automobile license plates are stipulated by a national law, and is uniform throughout Japan [2].

On the other hand, the format of moped license plates varies in Japan as they follow the regulations of each local government. Recently, some local governments have adopted irregular forms or illustrations for license plates (**Photo 1**). Furthermore, outside Japan, automobiles with foreign license plates travel across national boundaries due to the liberalization of international traffic. It is necessary to detect and identify these license plates for accurate traffic measurement and other purposes. However, conventional plate detection methods, which target at certain fixed plate formats, cannot handle these foreign plate forms. Therefore, it is essential to develop flexible detection and recognition methods which can handle various formats of plates.

In this paper, we focus on the detection of different types of plates and propose a novel detection method. Furthermore, we report on the experimental result of license plate detection for mopeds in Japan.


**Photo 1.** Examples of moped license plates in Japan [3]-[5]

## 2. Outline of the Proposed Method

### 2-1 Feature vector and detector

Our method employs the Bag of Features (BoF) [6] based on Histogram of Oriented Gradient (HOG) as the feature vector, and a linear support vector machine (SVM) as the detector. BoF features can grasp common curbs included in the characters, especially figures, of plates. The linear SVM can be transplanted to real products using digital signal processors.

The detector is trained as follows:

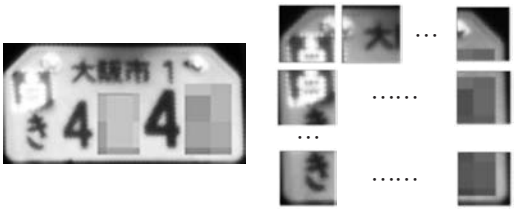
1. Divide training samples into blocks
2. Calculate HOG feature for each block
3. Cluster each block on the HOG feature
4. Create a histogram of weight (the sum of values of the bin of HOG contained in each block) for clusters
5. Train a linear SVM with the histogram described above as the feature vector
6. Combine the representative point of each cluster (described in 3) and the linear SVM (described in 5) to achieve the training result.

In actual training, we repeated the random selection of a subset of training samples and detector training for the subset. Finally, we picked the detector of the best performance for all the training samples.

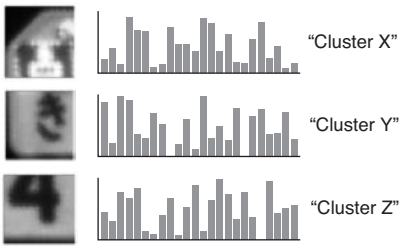
Based on the training method mentioned above, calculation of the BoF feature and detection are proceeded as follows (**Fig. 1**):

1. Divide the target sample into blocks
2. Calculate the HOG feature for each block
3. Determine the cluster of each block based on the HOG feature

4. Create a histogram of weight for clusters in the target sample
5. Determine the category of the target by the detector with the histogram described above as the feature vector



(1) Divide a target sample into blocks




(2) Determine the cluster of each block based on HOG feature


(3) Create a histogram of weight for clusters in the target sample

**Fig. 1.** Procedure of calculation of feature vector

(1) Target image

(2) Narrow the target area by inter-frame difference

(3) Narrow the target area by edge distribution

(4) Result of the detection by the detector

**Photo 2.** Outline of the detection process

### 2-2 Detection process

Fig. 3 shows the outline of the detection process.

First, the target area is narrowed down to the passenger of the moped based on the inter-frame difference. Second, the target area is narrowed based on the edge distribution. The computation of the BoF features requires high cost but reduces the entire processing time.

Finally, the target area is scanned by a linear SVM detector with the BoF feature, and windows judged as "positive" are the results of detection.

## 3. Experiment

### 3-1 Outline of the experiment

In the experiment, we examined tasks to detect moped license plates in images taken by a camera placed on the road.

Hexagonal- or rectangle-shaped license plates have been adopted by many local governments in Japan. The height of these license plates is 100 mm in common, but the width of hexagonal-shaped license plates is 200 mm and that of rectangle-shaped license plates is 170 mm [7]. Recently, license plates of other shapes have also been adopted by some local governments, but their size is within 100 mm x 200 mm.

The height of license plates in the test image was calculated from the y-coordinate because the cameras are

**Photo 3.** Example of target image

fixed. Moreover, the width of the license plates is limited to 2 values. Therefore, the height of the scan window was treated as a known value, and the image was scanned twice for scan windows with the width/height ratio of 1.7:1 and 2:1.

The test image sequences were the 3 sequences shown in **Table 1**. The images were taken by a cameras placed on the road. Some images contained automobiles, and others did not. The images of DAY 1 and DAY 2 were taken in the daytime, and the images of NIGHT were taken in the evening or the nighttime. The resolution of these images was 1920 x 1080.

The training dataset consisted of license plate images that were cut by an operator as positive samples and images that were randomly cut out of the moped bodies, except for the license plates, as negative samples. We adopt only the images cut out of bodies in consideration that scan windows which do not include moped bodies were excluded in the preprocess. The same detector was used for daytime and nighttime sequences.

In the experiment, the process was implemented with C language, and processed by a single core of Intel Core 2 Quad Q9550 (2.83GHz).

**Table 1.** Performance of detection in each test sequence

| | Number of frames | Number of license plates | Number of success detection |
|---|---|---|---|
| DAY 1 | 3542 | 93 | 92 |
| DAY 2 | 2807 | 65 | 65 |
| NIGHT | 2135 | 63 | 62 |

### 3-2 Results and consideration

When the scan window contained a whole plate, we concluded that the detection was successful, and when the scan window did not overlap with the plate, we concluded that the detection was a failure. The scan windows overlapping with the license plates of automobiles were not included in either successful or false detection.

**Table 1** shows the performance of detection in each sequence. The success rates of plate detection were over 98% for both daytime and nighttime, and the number of the false alarm was less than 8 on average. The process time for images with 1920 x 1080 resolution was less than 30 minutes per frame with a single core of Intel Core 2 Quad Q9550 (2.83 GHz).

**Photo 4** shows a sample of the detection result. The image on the left is the result without screening, and the image on the right is the result with screening. From these figures, we can see that screening can reduce false alarms.

The result shown in **Photo 4** has some false alarms around the plate. This is because BoF features are not suited for exact positioning, and overcoming this problem is our next objective.

**Photo 4.** Example of the result of plate detection
Left: without preprocess Right: with preprocess

## 4. Conclusion

Our experiment on PC shows high detection rates, and the result shows that the proposed method enables flexible and precise detection for various formats of license plates. It is necessary to examine the method in a real field.

The proposed method ensures the precise detection of automobile and mope license plates, and we expect to expand its application range.



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