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Detection of License Plate using Sliding Window, Histogram of Oriented Gradient, and Support Vector Machines Method

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Abstract. The license plate recognition usually used as part of system such as parking system. License plate detection considered as the most important step in the license plate recognition system. We propose methods that can be used to detect the vehicle plate on mobile phone. In this paper, we used Sliding Window, Histogram of Oriented Gradient (HOG), and Support Vector Machines (SVM) method to license plate detection so it will increase the detection level even though the image is not in a good quality. The image proceed by Sliding Window method in order to find plate position. Feature extraction in every window movement had been done by HOG and SVM method. Good result had shown in this research, which is 96% of accuracy.

1. Introduction

Automatic recording of license plate numbers is known as License Plate Recognition (LPR). LPR is usually used as part of the stages in systems such as parking systems, toll systems, traffic systems on offenses and others in [1]. To know the license plate of vehicle, required process of detection of object plate on vehicle. Vehicle license plate detection is considered the most important stage in the entire system LPR. Until now, a number of techniques have been proposed to find the license plate of the desired vehicle through visual image processing. There are several algorithms used to determine the location of the vehicle number plate on the image, such as the Part-Based Model (PBM) method and the Histogram of Oriented Gradients (HOG) in [2], edge statistics and mathematical morphology in [3], vertical projection method in [4], Haar-like cascade classifier and edge in [5], the authors [6] using artificial neural networks (ANNs) method to determine plate location by scanning sliding window, the authors [7] and [8] determines the plate location using SVM linear classification, genetic algorithm (GA) and Geometric Relationship Matrix (GRM) in [9].

Previous studies demonstrated using different algorithms to solve the problem of detection and vehicle license plate recognition. Especially the vehicle license plate detection, the algorithm used to be able to overcome the condition of the input image which is not desirable in the status of the natural environment, such as complex background and lighting conditions are not uniform on the image of the vehicle in [2] and [5], plate size in [9], perspective, shadow in [7], and different weather conditions. All these problems will be very complex if the detection plate is implemented on the android system because the android system in the mobile phone has limited computation.

This study proposes a method that can identify the location of a vehicle license plate using a mobile phone, and is expected to contribute to future recognize the identity of the vehicle and the owner of the vehicle based on license plate recognition in real-time. This study uses several methods such as the process of determining the location of the plate on the vehicle image by using the Sliding Window method and the Histogram of Oriented Gradients (HOG) method for feature extension by taking the texture form of the plate. While the Support Vector Machines (SVM) method classifies the image to determine whether the plate or not the plate so that the location of the plate can be determined. The detection of the position of the vehicle license plate on this image in the implementation on mobile devices based on Android.

2. Research method

The construction of an android-based vehicle plate detection system with Sliding Window method, Histogram of Oriented Gradient (HOG) and Support Vector Machines (SVM) in this research are as follows:
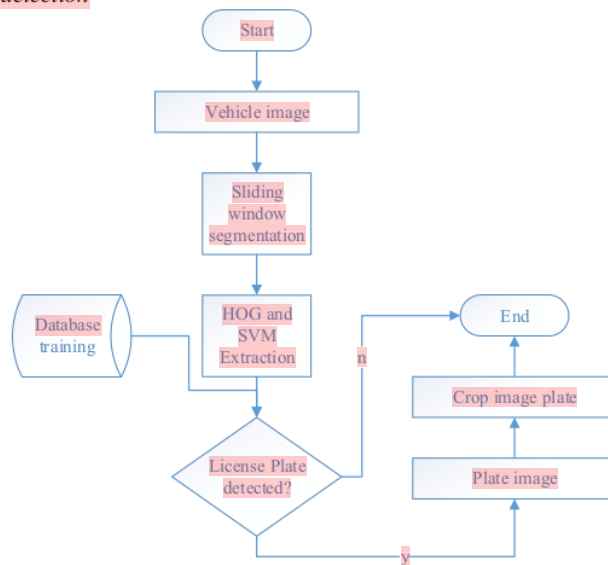
2.1. License plate detection

Figure 1. Plate detection process diagram

The plate detection process is done to locate the plate area on the vehicle image captured by the camera, this detection plate using Sliding Window method and HOG and SVM extraction. Furthermore, vehicle image in the process with Sliding Window method with the aim of finding the area / position plate. This process starts from the top left corner of the image with 16x8 window size, this window will move from left to right until the bottom right corner. The movement of each window will be extracted by HOG and SVM methods. Furthermore, the feature extraction that moves will be compared with the extracting of the training data feature and if the extraction of the mobile feature exists matching the extracted data training feature then the window will be marked as the plate area. After the plate area is detected, the next step the system will draw a square line on the area detected as a plate as shown in Figure 3. The area of the plate that has been given a square line will then be cut to get the plate part of the plate.

2.1.1. Input. The image that used as input is the image taken using the camera from android based mobile phone.

2.1.2. Sliding Window. In digital image processing the convolution process is the multiplication of convolution between the matrix of the origin image with the filter matrix or mask. The convolution operation is done by shifting the pixel convolution mask per pixel from the top left position to the lower right position which is often called the sliding window. The result of the convolution process is stored in the new matrix with the same coordinate position. In this study sliding windows method serves to determine the location of the plate on the image of the vehicle by sliding window to each pixel, with window size 128x48. Each shifted window will be cropped and then searched its features with the HOG method, the feature is matched with the features in the training database. This process continues until you find the location of the plate.

2.1.3. Histogram of Oriented Gradient (HOG). The Histogram of Oriented Gradient process requires several steps, including:
1.   Converting RGM to Grayscale image
2.   Calculating gradient value in every pixel.
The gradient of an image can be obtained by filtration with a 2-dimensional filter that is a vertical and horizontal filter. The first thing to do is convert the image in the form of grayscale to avoid having to consider the contribution of different intensities to each color field (RGB). The commonly used method is 1-D centered, with the following matrix: [-1, 0, 1] [10, 11]
Using partial derivative formulas for image function f (x,y)

a.   For x : $\frac{\partial f}{\partial x} = \frac{f(x+h)-f(x-h)}{2h}$ (1)

b.   For y : $\frac{\partial f}{\partial y} = \frac{f(y+h)-f(y-h)}{2h}$ (2)

We will get the values of x and y used to calculate the gradient [10, 11] :

a.   Magnitude: $R = \sqrt{x^2 + y^2}$ (3)

b.   Gradient Orientation: $\theta = arc\ tan\left(\frac{x}{y}\right)$ (4)

     Where x is the vertical gradient and y is the horizontal gradient.

3.   Create a histogram with 4 orientation bin.
     Images are divided into several regions with small spaces called cells. For each cell the local 1-D histogram will be accumulated or edge orientation on all pixels in the cell. The 1-D histogram cell-level combination forms a basic orientation histogram representation. Each orientation histogram divides the various angles of the gradient into fixed numbers in specified bins. The amount of gradient of pixels in the cell is used to vote into the orientation histogram. For example a histogram will be built distributed through 0° to 180° or 0° to 360° with a number of channels equal to 9 in [2] and [12]. Then for the vote in the histogram is as follows:
     a.   All gradients with large angles [0° - 20°] provide a vote for channel 1.
     b.   All gradients with large angles [20° - 40°] give a vote for channel 2.
     c.   And so on.

4.   Normalizes the value of each bin of that orientation
     Which takes the cell group and normalizes the overall contrast response. This is done by accumulating the size of the histogram of a group of cells called blocks. The result will be used to normalize every cell in the block. [2] states that the gradient arrangement in the HOG method produces the best performance in motor detection experiments and motor number plate test.

2.1.4. Database training. In this process the algorithm HOG and SVM will do the learning of the image which is then stored into the database. Prior to the process of vehicle plate image detection will

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be learning first. The results of the HOG and SVM learning will then be stored in the database with the * .xml format and used for the matching process.
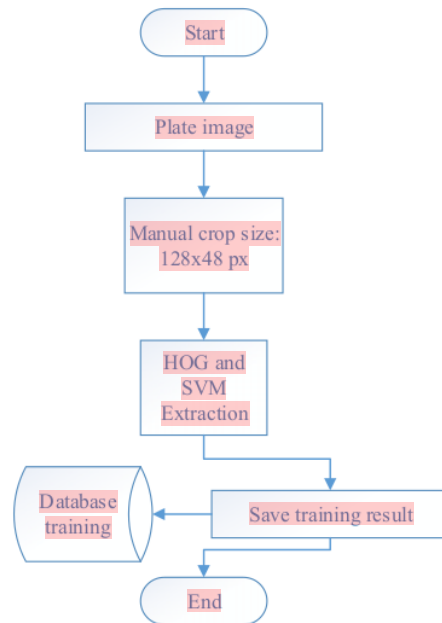

Figure 2. Training process diagram to gain database training

The image of the plate used in the training process is positive image and negative image. Determination of positive image and negative image very determine the result of vehicle plate location detection in [5].

3. Implementation

The image of the vehicle license plate is used as the test data is the image of 2-wheel vehicles and four wheel 350 images collected by using the camera of a mobile phone. Image data for data training using image data as much as 82 images, where for positive image as many as 39 images and negative image as much as 43 images. Intake of data by using camera mobile phone with distance of 1.5 meter for 4 wheel vehicle and 1 meter for two-wheeled vehicle. At the time of taking the image of the camera position against the vehicle plate must be perpendicular to the good lighting.
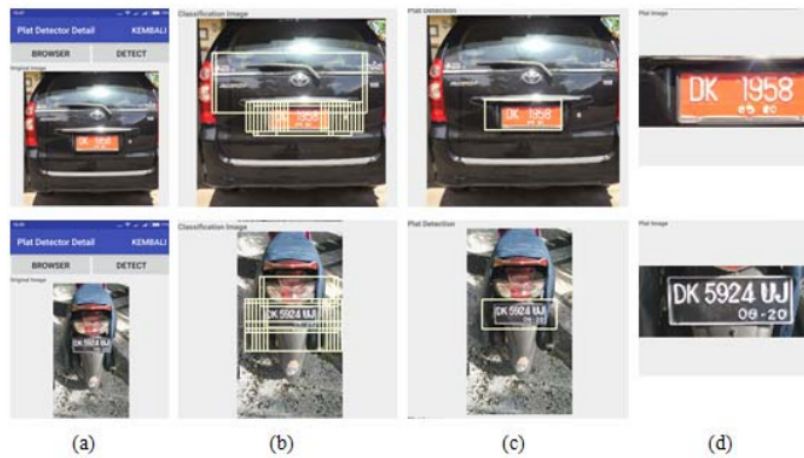
Figure 3. Plate detection (a) Vehicle images (b) Plate candidate (c) detecting plat position (d) cropping

The results of this study detection plate position on the vehicle showed very satisfactory results that is equal to 96%. The remaining non-platter test result is 4%, that the plate location is marked but the crop is negative image, as shown in Fig. 4.

Figure 4. Result Detection of non-vehicle plate (a) vehicle image (b) result of sliding window with multiple boxes on plate (c) result of plate detection and negative image (d) Negative cropped images

4. Conclusion

Detection of vehicle license plate position using sliding window method, histogram of oriented gradients and support vector machines on android-based mobile phone get very satisfactory result. The process of determining the location of the plate on the vehicle image by using the Sliding Window method then the Histogram of Oriented Gradients (HOG) method for feature extensions by taking the texture form of the plate. While the Support Vector Machines (SVM) method classifies the image to determine whether the plate or not the plate so that the location of the plate can be determined.

Accuracy results obtained by 96%. The remaining non-platter test result is 4% that the plate location is marked but the crop is negative image.

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