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Original Research Article

A NEW TECHNIQUE FOR LICENSE PLATE DETECTION USING MATHEMATICAL MORPHOLOGY AND SUPPORT VECTOR MACHINE

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Abstract: License plate localization is considered the cornerstone for any license plate recognition system. Its reliability and performance have a majore influnece on the whole license plate recognition system. In this paper, a new technique for license plate detection is presented. The first step is detecting the vertical edge using Sobel mask, and then the horizontal projection is applied to filter the edge image regions. Morphological operations and connected components labelling are used to get the candidate regions. Finally, support vector machine is used to examine the candidate regions and determine the license plate. Dataset downloaded from the internet is used to train SVM and test the proposed technique. This dataset contains 514 images of cars and vans. The images are captured in various illumination conditions, raining days, taken from different angle. Furthermore many of them have very complex background, shadow. In addition, many regions are similar to the plate region. Simulation results of the proposed technique show accuracy of 92.2%.

Keywords: Pattern recognition, computer vision, image processing, license plate detection, SVM, morphology operations.

1.0 Introduction

Intelligent transportation systems (ITS) become very important in advanced countries, One of the most important tasks of ITS is the recognition of license plate. In addition, the number of vehicles in all cities over the world is increasing rapidly, that makes the traditional management of traffic is very weak because it does not meet the current demands so build a robust system to recognize the license plate is very important. License plate recognition (LPR) system receives images from the camera, and then uses image processing and pattern recognition techniques to recognize the characters and numbers on the plate that identified the vehicle. The style of the plates is varied and differs from place to another that makes building a system that able to recognize all styles is difficult task. LPR systems consist

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of three essential steps 1- license plate detection 2- characters segmentation 3- characters recognition. License plate detection (LPD) is a very important step in LPRs because the other steps are based on. LPD method must overcome many difficulties to extract the plate successfully, for example of these difficulties (low resolution image - blurring image-low contrast – shadow - different position of the plate – existing of many regions that are similar to the plate… etc..). Many methods are proposed and many of them work well, but under many restrictions or conditions such that the distance between camera and vehicle are fixed, no complex background. In this paper, we proposed new method able to detect the plate in images that are taken with different distance, angle, different light condition, and have a complex background. The following sections are organized as follows: section 2 shows some recent related works. Section 3, diagram representing the general steps of the proposed technique and explanation for each step in Section 4. Experimental results are presented and conclusion is presented in section 5.

2.0 Related Work*:* Many methods have been proposed to detect license plate. In [1] vertical edges are detected using vertical Sobel operator then search for connected regions and filter them according to height and width ratio. The remainder regions are filtered by white and black ratio. [2] Sobel edge detector and morphology operations are used to connect the edges, then the aspect ratio is used to extract the plate. [3] Edges are detected using Sobel mask and erasing false regions based on edge density after that the regions are labeled and filtered using aspect ratio. [4] MSER is used to get candidate regions, and then filter these regions based on the summation of pixel, height-width ratio and scaling of the plate character region. Then removing the similar character regions is done, and the horizontal lines of the plate frame are determined by using the horizontal projection, vertical projection is used also to determine the vertical lines of the plate frame. [5] Method in this paper depends on detecting the edges using canny operator and sliding window to get ROIs then classifies the ROIs using trained SVM but the computational time is long because many interested regions are classified by SVM. [6] canny operator and Sauvola binarization method are combined to get binary image, then get the RoIs using CCA which are filtered later using some criteria. This method gives bad results with noisy images. In [7] canny operator and Hough transform are used to detect the plate. [8] It uses the edge detection and Hough transform to detect the frame of the plate, but locating the plate in this method depends on the plate is not tilted and the image does not have a complex background and contains only the half-front part of the car. In [9] Sobel edge detector is used to detect the edges and then filter unwanted regions using horizontal projection then extract the license plate depending on the aspect ratio and the color. [11] Vertical edges are detected, then edge density is used to find the candidate areas. The plate is extracted by filtering the candidate areas according to geometrical and textural characteristics.

3.0 The Proposed LPD Technique*:* The flowchart in Figure.1 describes in general the main steps in the proposed LPD Technique. In pre-processing step RGB image is converted into a grey image because the proposed technique does not need the color information, which make it able to detect any plate regardless of its color. After image conversion, vertical edges detection and image enhancement are done. In the second step, candidate regions are extracted using projection and morphology operations. Finally, classify the candidate regions using trained SVM. The following section discusses the steps of license plate detection.

3.1 Image pre-processing:

3.1.1 Converting RGB image into grey level image: usually the vehicle images are RGB

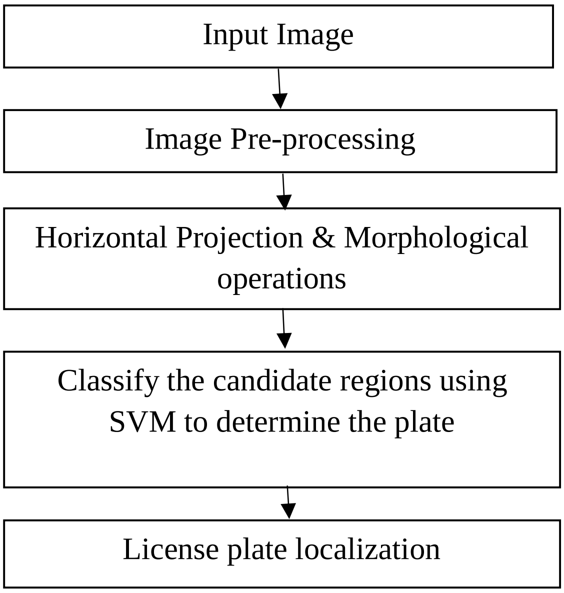


Figure 3.1: *The Proposed* Technique

3.1.2 Images:

We convert it to grey level image. the following equation is used to compute the intensity level of each pixel in the RGB image:

$$Intensity(i,j)=0.299*R(i,j)+0.587*G(i,j)+0.114*B(i,j) \quad (10).$$

3.1.3 Detecting the Vertical Edges

The most important feature of the license plate is characters existence, so edge detection gives a strong indicator of the plate region. There are many approaches that detect edges of an image such Canny, Prewitt, Laplace, Sobel ….etc. This technique uses Sobel operator to detect the edges because it is a simple and less sensitive to noise. The Sobel operator uses two masks one to detect the horizontal edges and the other for vertical edges .Only Vertical mask is used in the proposed technique because plate region contains more vertical edges than other regions of the car because of plate frame and the existence of characters and numbers.Figure.3.2 A shows the edge image resulted from vertical Sobel edge detection and Figure 3.2 B the used mask.

Figure 3.2 (A): *Vertical edge image*

-1	0	1
-1	0	2

Figure 3.2(B): *The used mask*

3.1.4 Edge Image normalization and binarizaton:

Image normalization or Contrast stretching is a simple technique used to enhance image contrast by stretching the range of image intensity values. We used it to enhance the edge image. Next step in this stage is Converting the enhanced edge image into a binary image using Otsu global threshold.

3.2 . Horizontal Projection & Morphological Operations:

- Horizontal projection: The first operation in this stage is finding the horizontal projection of the edge image. Horizontal projection is the summation of the white pixel in each row independently. Rows in the license plate region often have higher values in horizontal projection than other regions. For that, rows having values greater than T% of the maximum value in the horizontal projection are candidate regions and the other rows are eliminated by adjusting its values to zero in the edge image. This operation reduces the candidate regions.Figure.3.3 shows the result.

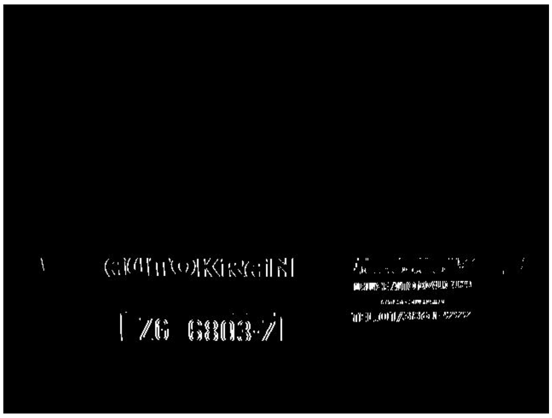


Figure 3.3: *Edge image after reducing* **candidate regions**

- Morphological operation:

Morphology operations are very important tool used to analyze image based on the set theory so it deals with the objects in the image as a set of pixels. Morphology operations can be used for many purposes such as: removing noise, image enhancement, image segmentation… etc. Dilation and erosion are the two basic operations in morphology.

Dilation basically extends the object, whereas the erosion shrinks the object. Dilation and erosion in this proposed system are used to determine the candidate regions as shown in the following sections.

- **Dilation**: rectangle-structuring element is used to dilate the binary edge image once at horizontal direction and another time at vertical direction, and then we get the common region.

Figure 3.4(A), Figure 3.4(B) and Figure 3.4(C) show the results. Many adjacent regions are resulted from the previous dilation operations as

Figure 3.4 (A): *Edge Image After Vertical Dilation*

Figure 3.4(B): *Edge Image after Horizontal Dilation*

Figure 3.4(C): *The common region s between image in Figure 4.A and Figure 4.B*

shown in Figure 4.B, these regions have to be merged because they represent one region. Therefore, another dilation operation should be applied again using rectangle-structuring element in order to merge the adjacent areas. Figure 3.5 shows the result.

Erosion: Erosion also should be applied using a line structuring element to erase the extra areas that resulted from the previous dilation operation or to eliminate small areas. The result shown in Figure 3.6. Many candidate regions are obtained as shown in Figure 3.6. It's difficult to determine which one is the plate depending on the aspect ratio or other geometrical characteristics because many regions have the same characteristics and the distance between the camera and the vehicle is

Figure 3.5: *The merged adjacent region*

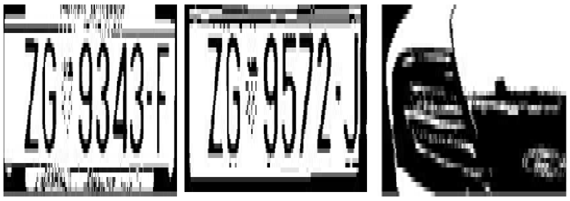
not fixed. Moreover, the plate region often connects to another part of the vehicle due to the illumination and signs so we use SVM to classify these regions.

3.3 License plate extraction:

- **SVM:** support vector machine is a classifier **used** to find the optimal separating hyper plane that maximizes the margin between the training data. Training data TD $=\{(x_{i,}y_i)\}$, i..N where $x_{i,}$ is a vector of binary value for a candidate region (positive region or negative region), $y_i \in \{0,1\}$ (1 is a label for license plate ,0 for non-license plate) .
- **Support vector machine training:**

To train support machine dataset is prepared containing 50 positive samples (plate) and 50 negative samples (nonplate) .In this technique, the SVM kernel function is linear kernel. Figure 3.7 shows some positive and negative samples used in the training process.

Figure 3.6: *Image after erosion*



A B C

Figure 3.7: A and B are positive samples, c is negative samples

4.0 Experimental result

Dataset downloaded from internet is used in training and testing stages (12). This dataset is challenging because it contains images with very complex background and contain many regions that are similar to the plate. Only 514 images that have single line plates are chose in this work. The proposed technique is tested using 464 colored images for car and vans captured in different (illumination condition- angle – weather-distance) and have a complex background. Each image resolution is 480 × 640. The accuracy of the proposed technique is 92.2% where detected 428 plates and fail to detect the rest images.

Evaluation of the proposed technique with other detecting techniques is difficult because all techniques were tested on unannounced dataset that contains images captured by the researchers. The result of testing the proposed technique shows that it is robust to locate the plate regardless of the position, angle, background, illumination and shadow of the plate. Figure.8 shows some example of the successful detection result.

5.0 Conclusion

A new robust technique for localizing the license plate has been presented. Car image passes through many steps until detecting the plate: In the first, the vertical edges are detected using the Sobel operator. Then, many regions are excluded using horizontal projection. After that, the edges are linked using morphology operations. Finally, the resulted regions are classified using SVM to determine the region representing the plate. Simulation results have proven the efficiency of the proposed technique.

Figure 8: *Example of the successful detection result*

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