Vehicle Logo Recognition Using Mathematical Morphology

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Abstract: - This paper presents a method for recognition of the vehicle logos from the vehicle images using mathematical morphology techniques. The gist is to use different morphological operations in such a way so that the logo of the vehicle can be identified accurately. The method makes the extraction of the plate independent of color, size and location of number plate. The proposed approach can be divided into different processes, which are, image enhancement, morphing transformations, filtering resultant images and extracting the logo from the objects that are left in the image. This algorithm can quickly and correctly detect the logo area from the vehicular image.

Key-Words: - Pattern recognition, mathematical morphology, tophat transformation.

1 Introduction

In the current information technology era, the use of automations and intelligent systems is becoming more and more widespread. The Intelligent Transport System (ITS) technology has gotten so much attention that many systems are being developed and applied all over the world. Vehicle logo recognition (VLR) can also be used in this context as "A trademark or logo is a distinctive sign which identifies certain goods as those produced by a specific enterprise" as defined by WIPO (World Intellectual Property Organization) [8]. VLR can find many applications in traffic monitoring system, including consumer (car buyer) behaviour, vehicle tracking, policing, security and so on.

Logo recognition consists of two steps, namely detection of candidate logo regions in the image or frame and subsequent classification of those regions as given in Hollander et al [7]. For logo detection, we search for homogeneously colored regions surrounding large intensity differences. For logo classification, we propose a novel method based on mathematical morphology. The most vital and the most difficult part of any VLR system is the detection and extraction of the vehicle logo as a logo can be a word, numeral, pictorial or different combinations, that directly affects the systems overall accuracy. The presence of noise, blurring of the image, uneven illumination, dim light and foggy conditions make the task even more difficult. In this paper we propose a detailed and novel method for accurately detecting the location of vehicle logos. The proposed system can work very accurately in almost any environment, time of day, and conditions.

The problem of logo recognition is being studied since the 90's. Image features that capture the essential traits of an object and are insensitive to different procedural changes are ideal for recognition or matching. The need for invariant image descriptors has long been recognized in computer vision [1], [3], it was even argued that object recognition is the search for invariants [3]. There exists a vast amount of literature on shape comparison but unfortunately the majority of the proposed methods are inappropriate for classes of objects as large and complex as trademarks[l], while car logos have not been exclusively studied which are the objects of interest to this paper. A search of the literature has found very few previous attempts to solve either of the problems of recognizing or matching logos. However, recently attempts have been made to solve the problem of matching or identifying trademarks using 2-D Fast Fourier Transform [2], Invariant moments[3], Hotelling Transform [6], neural networks [5], and retinal coding [4].

But it is argued that the moment invariants are not good image features [2], as they are sensitive to noise and suffer from information suppression, loss, and redundancy. Hotelling Transform is not invariant under image scaling, rotation and translation [6]. The entire exercise was done with an eventual aim of developing an efficient matching model for trademarks. The authors have made an attempt to critically analyze the experimental observations and have presented their views. All of the systems discussed above have some kind of limitations for example they are plate size dependent, color dependent, work only in certain conditions or environment like indoor images etc. The

method that we are proposing is independent of color, size, location and angle of the logo of the vehicle.

2 Proposed Technique

The proposed technique for the extraction of vehicle logos consists of the following four processes: Image enhancement including filtering, morphological transformations, morphological operations or post processing, resulting in the vehicle logo designate confirmation. We now discuss the above mentioned steps in detail:

2.1 Image Enhancement

In this process, we use methods that include adjusting the intensity of the image and reducing the contrast in the image. The technique used for intensity adjustment is known as histogram equalization. The contrast in the image can be reduced by several methods including the top/bottom hat transformations that are normally used for contrast enhancement. Secondly many images contain noise and are blurred that may be due to image capturing equipment. The noise removal algorithms and the de-blurring algorithms were also used in this process where required. Figs. 1 and 2 provide comparison.

Fig. 1. Original image

2.2 Hat Transformations

Hat transformations are used for contrast enhancement. There are two hat operations and are known as the top hat and bottom hat transformations [1]. Tophat operation is actually the result of subtraction of an opened image from the original one whereas in the case of bottomhat operation, it is defined as the closing of the image minus the image. The tophat operation suppresses the dark background and highlights the foreground objects. We see that no matter of what color the logo is, the characters (i.e., text and numerals) on the vehicle logo are usually bright colored and contrast the color of the logo, in some cases they may match i.e., car color and logo color. We will try to incorporate this feature in the later versions. So this operation highlights the characters and suppresses the irrelevant background. If we obtain the binary of the resulting image and remove very small scale features or components, we see Fig. 3 that only a few designate foreground areas are been left and most of the irrelevant objects have been removed.

Fig. 2. The result of intensity and contrast adjustments.

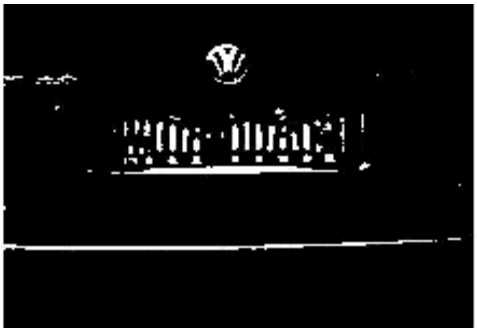

Fig. 3. Resultant binary image after hat transformation, and removing small features from the resultant hat image.

2.3 Morphological Operations

Mathematical morphology commonly refers to a broad set of image processing operations that process images based on shapes. There are several morphological operations but we use only dilation and erosion for the purpose of logo extraction. The subtraction of an eroded image from its dilated version produces a morphological gradient, which is a measure of local gray level variation in the image. We have used

the morphological gradient for the detection of logo designate area. First the image was eroded by a disk shaped structuring element. Then the original image was again eroded using the same structuring element. After that the eroded image was subtracted from the dilated version. This produces an image with very less designate areas for the probable vehicle logo. After this step change the resulting image into binary and remove the smaller components which are categorized as noise i.e., Fig. 4.

Fig. 4. Binary image after morphological gradient and noise removal.

2.4 Logo region confirmation

We observed that there were many horizontal lines which are present in the resultant combined image and which could possibly bring some error in the final results. So to remove those horizontal lines we opened the image with a horizontal line shaped structuring element and subtracted that image from the intersected image. This considerably removed some false designate areas such as the bumper lines or the horizontal lines of the front or rear lights. After that we dilated the image with a rectangular structuring element so as to combine the objects on the number plate into one object. Next we applied some checks and conditions which are based on the properties of the vehicle plate, for example the area of the logo, aspect ratio and the density of the region of the logo were checked for all the remaining objects in the image. The result by using these features was that components other than the probable number plate designate are deleted, and we are left only with the logo area. Lastly we calculate the bounding box around that object and get the coordinates of that bounding box, being the actual coordinates of the vehicle logo. Figs. 5 and 6 correspond to this resultant and later final image, respectively.

Fig. 5. Result of applying conditions like area, bounding box and aspect ratio.

Fig. 6. shows the final logoplate area detected in the image.

3 Experiments

Experiments were performed to test the efficiency and accuracy of the proposed technique. 50 color images were used for testing the technique. All the images being normalized to just about 640 x 480 because some images were double this size and also it is normal to use the size. The images were acquired from the highways, car parks, at different lighting condition (cloudy, sunny) and different kinds of vehicle (van, car). The images were taken of different color and variable sized number plates, also the images were irrespective of the angle and orientation of the camera. Also many images were acquired using the worldwide web. These results report a high accuracy rate of above 96%.

4 Conclusions

This paper describes an algorithm that allows the extraction of vehicles' logos using a hybrid of mathematical morphological techniques. The main advantage of the technique that we propose is the high accuracy of the technique that works irrespective of the

color, size, location, and angle of the logos. Therefore, this technique can be used effectively in any environment in any country. Although the technique is quite efficient enough to work very well in the real time environment but currently the technique proposed lays more emphasis on the accuracy of the overall system, while the some more work is to be done to make the technique more efficient. In the testing of the technique we used mostly plates containing English text and numerals, the authors hope to develop a technique further so that we are able to extract logos having other characters, for example Arabic, Chinese, mixed, etc. The authors hope to develop a vehicle detection system in which the VLR is a part. Also, future work is intended to improve the overall efficiency of the system so as to make it computationally more effective.

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