Vehicle License Plate Identification & Recognition

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Existing vehicle license plate identification and recognition systems are potent for either their accuracy or speed but not a combination of both. The algorithm proposed in this dissertation attempts to achieve this fine balance between the accuracy and speed that such a system must posses. The mathematical morphology operators of dilation and erosion are utilized to identify the region within an image which contains the license plate. Using the concept of color coherence vectors, an image recognition algorithm is presented which utilizes this extracted region and compares it as a whole to other images of license plates, in the database. The application developed for the testing of this algorithm works with an accuracy of eighty eight percent and an average processing time of two seconds per image.

Key Words and Phrases: Vehicle license plate recognition, color coherence vectors, mathematical morphology

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1. INTRODUCTION

The problem of vehicle license plate recognition is an interesting one and over the years has attracted a plethora of researchers and computer vision experts. The applications of such a system are vast and can range from parking lot security to traffic management. There are various approaches to the solution of this problem, such as texture-based, morphology-based and boundary line-based. This dissertation, presents a morphology-based approach for the identification of a license plate in the image of a vehicle. The recognition process deviates from the conventional approach of using Optical Character Recognition (OCR) systems and utilizes the concept of color coherence vectors [1]. Researchers have been proposed a variety of solutions for the problem of license plate identification and recognition in images. Researchers at Wroclaw University [2] have proposed a technique for the localization of

license plates that requires a connected component analysis of the YUV model [13] of the image. The application of the Hough transform [3,4 and 5] has also been partially successful in reducing processing times for segmenting license plates in an image. The utilization of enhanced edge-detection techniques [6 and 7] combined with others such as slope and projection evaluation is another interesting solution to this problem. To attain faster processing speeds some systems decide on a threshold for the size of the license plate and the character regions within them. Then using fuzzy logic and neural network algorithms [8,9and 11] the character regions are segmented and the characters within them are identified. A slightly different approach to the segmentation problem is the mean shift segmentation method [10]. It identifies several candidate regions within a source image and utilizes features such as rectangularity, aspect ratio and edge density to determine whether the identified region is a license plate or not. All of the above research works strive to maintain a correct balance between the accuracy of the algorithm and its speed. The morphology-based identification approach is highly accurate and the color coherence vector approach for recognition is extremely fast. A test application for the experimental evaluation of this proposed algorithm has been created using Microsoft Visual C# .NET. This algorithm and its experimental results shall be illustrated in detail in the sections ahead.

2. IDENTIFICATION OF THE LICENSE PLATE REGION

The first stage of this algorithm involves the identification of the region within the image wherein the license plate is enclosed. The basic mathematical morphology [12] operations of dilation and erosion have been utilized. Firstly, an original image similar to the one shown in Figure 1 is converted to monochrome using two different thresholds.

Fig. 1.The initial sample image

The results of applying this operation on the source image are shown in Figure 2 and 3. Each of these images is utilized for the further steps of dilation and erosion.

Fig. 2 Monochrome image with a threshold of 78 between black and white

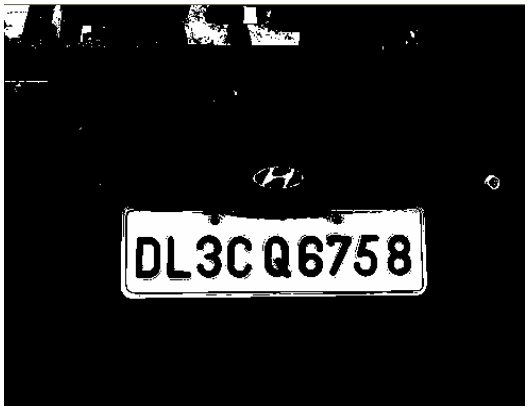

Fig. 3 Monochrome image with a threshold of 158 between black and white

Further, the image shown is Figure 3 is subjected to the dilation operation with a mask size of nine by nine and with white being the target color. The white regions in the source image are expanded marginally as a result of this operation, the results of which are shown in Figure 4.

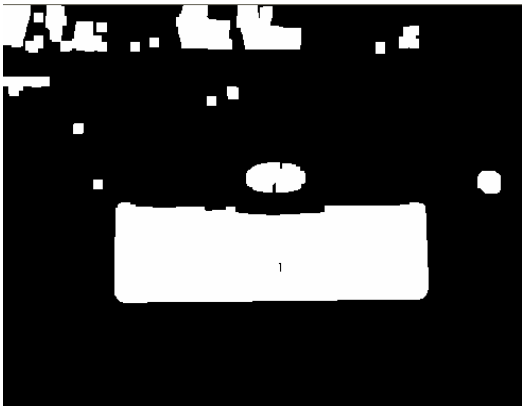

Fig. 4 Dilated image with a mask size of 9 by 9

Correspondingly, an erosion operation is applied to the image in Figure 2 with a mask size of 30 by 105 pixels. This operation decreases the size of the white regions and helps in maintaining the larger white regions and removing the smaller ones. The results of this operation are shown in Figure 5.

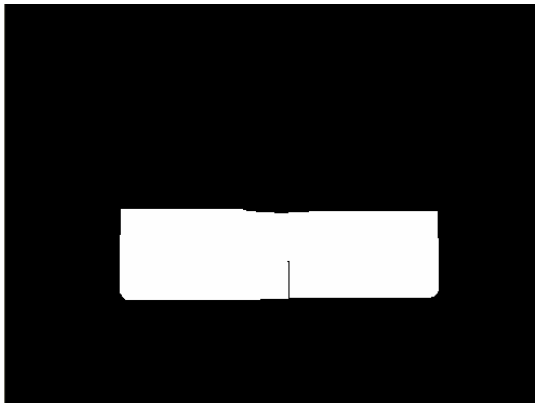

Fig. 5 Eroded image with a mask size of 30 by 105

After the preprocessed set of images has been prepared, the dilated image and the eroded images are together used to search for regions that are equal to the approximate size of the desired license plate region. Along with this aspect ratio, the contents of that region are also

examined to detect a pattern resembling a set of characters. The segmented region that best fits the above evaluation is then utilized for the next stage of algorithm. This proposed identification algorithm works successfully even if the vehicle has been aligned at an angle of 30 degrees on either side, with the camera. A few sample results of the identification stage on images with varying orientation are shown in Figure 6.

Figure 6. Sample results of the identification stage

3. RECOGNTION OF THE SEGMENTED LICENSE PLATE REGION

The optical character recognition technique has been frequently used for identifying characters in the extracted image of a license plate. However, the processing time and accuracy of this technique are questionable. This algorithm presented in this dissertation presents an extremely fast and accurate method of recognizing license plates. The algorithm can be termed as an illiterate one, in the sense that it does not extract the characters within the image but it recognizes the image as a whole. To build the initial database, images of the required license plates are preprocessed and their parameters are stored. During the recognition process these parameters are simply compared with those of the input image in constant time and the best match is retrieved. Due to its static complexity it is an extremely fast technique for image recognition and the process of parameter extraction for the license plate image is based on the use of color coherence vectors [1]. This technique divides the entire grayscale image into buckets, where each buckets represents a range of gray color values. This division of the image into buckets results in the segmentation of the characters from the rest of the unwanted background. Hence, during the comparison of these parameters the buckets representing the characters are compared to each other and the one which has the least overall error is displayed. Table 1 shows some of the successful and failed cases encountered during the testing of this proposed method.

Input Image	Best Match	Status
		Success
		Success
		Success
		Success
		Failure
		Success
		Success

Table 1. Sample results of the recognition algorithm

4. EXPERIMENTAL ANALYSIS

To test the accuracy of the proposed algorithm a test application was created using Microsoft Visual C# .NET. The database has a sample size of sixty images and several test cases with variations in the alignment, illumination and size of the license plates were tested. Forty seven out of the sixty cases were successful and thirteen were not. Most of the failed cases in the experiment were due to an improper alignment of the vehicle with the camera or due to

an erroneous segmentation of the license plate region. During the testing, the recognition algorithm worked in constant time and the identification algorithm had a variation of one to four seconds. Overall, the testing resulted in an accuracy of eighty eight percent and an average processing time of two seconds. Figure 7 shows a screenshot of the application utilized in the experiment.

Figure 7. Screenshot of the application

4. CONCLUSION

Earlier works relevant to the problem of license plate identification and recognition have been reviewed and the need for a system that balances accuracy and speed has been found. The algorithm proposed in this dissertation utilizes mathematical morphological operations of dilation and erosion to segment the region of the license plate in an image. Color coherence vectors are then utilized to derive the key parameters of the extracted region. These key parameters are compared to the database of parameters previously stored and the best match is displayed. The experimental analysis of the illiterate yet potent license plate recognition algorithm has resulted in an accuracy of eighty eight percent and takes an average processing time of two seconds per image. Hence, this algorithm has attempted to

strike a balance between the accuracy and speed that a license plate identification and recognition system must posses.

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