An Improved Vision-Based Surveillance System for Malaysia License Plate Detection

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Abstract - This paper introduces an improved vision-based surveillance system for Malaysian license plate detection. The system is based on the framework designed to detect a vehicle, extract the license plate area and segment its characters. The idea here is to build a real-time system that can achieve good performances in term of efficiency and processing time in extracting and segmenting Malaysian license plate. Through that challenge, morphological image processing techniques are used to extract the license plate and segment its characters. The result of the system in processing time will be compared with other license plate detection techniques in other countries.

Index Terms – Real-Time, Plate Detection, ROI (Region of Interest), preprocessing.

I. INTRODUCTION

Real-time vision-based surveillance system has been a challenge during these past decencies. In real-time environment, processes have to be fast and accurate enough to avoid delay on the image flow and all sorts of misidentifications. Therefore real-time surveillance systems are built to emphasize more in providing a maximum of accuracy in a minimum time interval.

This paper presents an improved vision-based surveillance system for Malaysian license plate detection. It includes real-time vehicle detection and license plate extraction algorithms that are built with an image processing library (OpenCV) configured on an open source development tool (C++). The applied algorithms are using a series of image preprocessing techniques along with some morphological image processing to detect moving objects, locate the vehicle license plate and segment the license plate characters.

II. EXISTING LICENSE PLATE DETECTION TECHNIQUES

Several techniques are applied to license plates in order to identify one or some of its features, and then extract them. Among those license plate’s features, there are boundary/edge (Shape), color, characters and size [1].

Zheng [2] uses edge detection techniques to extract the license plates. That technique consisted of identifying either horizontal edge, vertical edge or both as license plates usually have a rectangular shape.

Shi [3] uses color-based techniques to extract the license plate. Considering that the color combination of the license plate is unique and that combination occurs most of the time in a specific area of the vehicle, all the pixels in the input image are classified using the hue, lightness, and saturation (HLS) color model into 13 categories.

Character features can also be used to identify the license plate region. Based on this technique, Alegria [4] applied Hough transform algorithm to detect straight lines on the upper and lower side of binary objects, with same the aspect ratio, covering more than 30 pixels. The object will become a license plate candidate if two straight lines happen to be parallel, within a
certain range and the number of objects in between them is similar.

III. PROPOSED REAL-TIME LICENSE PLATE DETECTION

The proposed real-time license plate detection system operates based on three modules: motion detection, license plate detection and character segmentation, as shown in Fig. 1.

A. Motion Detection

Motion detection can be defined as the capability for a system to detect moving objects and capture the events. Its algorithms work by comparing an input video (set of frames displayed sequentially) to a reference image. Since the video loaded into the system was captured from a specific scene (with stationary camera), background subtraction is used for motion detection. A static scene model is selected on a specific region of the frame to act as background. The background, which also represents the region of interest (ROI), is usually selected from the first frame of the video. It is compared with the incoming frames in order to detect regions of movement. The result of the subtraction is thresholded to binary in order to eliminate noises. If there are significant differences between the current frame with the background frame, blocks of “1” (white) pixels would be noticed in the image result. The size of the white pixel blocks will determine whether there is a moving object to consider or not. The figure 2 and 3 illustrate background subtraction with and without moving objects.

B. License Plate Detection

License plate detection consisted of localizing the license plate area and extracted it for character segmentation. Since the Malaysian’s license plate characters are written in white color, the vehicle image captured was thresholded to show only the white area of the image. The thresholded image...
(binary) went under morphological processing techniques, where the license plate area was isolated and most the unwanted white blocks were eliminated. As video from a static camera that recorded a specific area was used, the approximate range size of the license plate was known as well as each character in it. Then, the license plate was localized by identifying all white blocks in the image and select the one within a given size range of license plate, containing number of a given size range of character. After the license plate was localized, the area is extracted from the original image for segmentation purposes. The Figure 4 illustrates the license plate image segmentation steps.

C. Image Segmentation

Image Segmentation consisted of localizing and extracting each character from the license plate image using the character contours technique [1]. In addition, noise removal was performed after extracting each character image. Noise removal consists of eliminating small white blocks shapes on each character image by turning them into black color. The Figure 5 illustrates the character image segmentation steps.

IV. EXPERIMENTS

The system efficiency was tested by running a sample of 5 minutes video captured Multimedia University entrance. The equipment used consisted of a camera (Logitech C300 Webcam) attached to a computer. This webcam had a 1.3-megapixel sensor for recording videos in resolutions of 800 x 600 pixels, able to capture 30 frames a second. The acquired images were transferred to a computer dual core with 2GB. The video sample captured 27 cars and 5 motorcycles.

Fig.5 Character Segmentation Steps

A. System Efficiency Results and Discussions

The testing results had shown 33 objects detected by the motion detection module, from 33 actual numbers of moving objects that passed through the ROI (5 motorcycles and one person). The result of the motion detection module testing is illustrated in the Table 1.

Among the 27 cars, from the 33 detected moving objects in the motion detection module, the license plate detection module was able to identify 23 license plates as shown in Table 1. Even though with a success rate 85%, the license plate detection module was able to detect only license plate, ignoring all non-cars moving objects detected earlier. That showed a certain integrity and coherence of the module system.

The 85% success rate of the license plate detection module could be explained by rays that reflect on the vehicles. As this technique used to locate the license plate was based on identifying the white characters on the license plate, the sunlight reflection on the vehicle were
generating white spot after the image is pre-processed. Those white areas interfered in the license plate detection since their size might be a value within the size range of the license plate.

Table 1. System Efficiency

<table>
<thead>
<tr>
<th>Module</th>
<th>Actual Number of License Plate</th>
<th>Number of License Plate Correctly Recognized</th>
<th>Success Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion Detection</td>
<td>33</td>
<td>33</td>
<td>100%</td>
</tr>
<tr>
<td>License Plate Detection</td>
<td>27</td>
<td>23</td>
<td>85.18%</td>
</tr>
<tr>
<td>System Success Rate (%)</td>
<td></td>
<td></td>
<td>92.59%</td>
</tr>
</tbody>
</table>

Another reason of the license plate detection success rate would be the presence of some dirt on some plates that turns the characters from white color and interferences like bar on truck. Those obstructions tend to make the license plates undetectable by the system.

B. Processing Time of the proposedSystem and Comparisons

The processing time of the license plate detection and character segmentation modules are illustrates in Table 2.

Table 2. System Average Processing Time

<table>
<thead>
<tr>
<th>Module</th>
<th>Average Processing Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>License Plate Detection</td>
<td>7.04</td>
</tr>
<tr>
<td>Character Segmentation</td>
<td>37.87</td>
</tr>
<tr>
<td>Total</td>
<td>44.91</td>
</tr>
</tbody>
</table>

The processing time of the method used to detect license plate happens to be fast enough. This proposed method in license plate detection was able to find a plate within 7.04 ms time average compare to some of the existing algorithms described in [1] (refer to Table 3.).

The license plate detection method, built for this system, was based on morphological image processing. This method happened to be fast because it didn’t take in account lots of parameters to identify the license. Malaysian license plates are known to be diversified in size, font and shape [5]; and taking in consideration all those parameters slows considerably the processing time to detect them. That is why the proposed method only focused on constant parameters of Malaysian’s license plate which are the black background and white characters. Thus, all the system needed to do is to identify all isolated white block within a range size of license plate, then select the one with a certain number of white within a range size of characters (refer to Figure 4 and 5).

Table 3. Average Processing Time of some License Plate extraction Methods

<table>
<thead>
<tr>
<th>License Plate Extraction Methods</th>
<th>Average Processing Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>License Plate extraction Using Boundary/Edge Information (vertical edges) applied on Saudi Arabian Plates</td>
<td>47.9</td>
</tr>
<tr>
<td>Hough transform and contour algorithm applied on Vietnamese plates</td>
<td>65</td>
</tr>
<tr>
<td>Block-based processing applied on Taiwanese Plates</td>
<td>75</td>
</tr>
<tr>
<td>License Plate Extraction Using Texture Features (scan-line techniques and the wavelet transform (WT)-based)</td>
<td>200</td>
</tr>
<tr>
<td>Color and fuzzy Aggregation</td>
<td>400</td>
</tr>
</tbody>
</table>

V. CONCLUSION

This system has proven to have many benefits as a real time vision-based surveillance, especially when it comes to a fast detection of the license plate. After the license was detected, its characters are segmented and put under optical character recognition (OCR) software called Tesseract for recognition. Even though this system records 85% success rate for license plate detection, there are still many rooms for
improvement since the system, often, fail to detect license plate image.

REFERENCES


