On the Automatic Detection System of Stop Line Violation for Myanmar Vehicles (Car)

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Abstract—Stop line violation causes in Myanmar when the back wheel of the car either passed over or reached at the stop line when the red light changes. A system for monitoring and recording incidences of red light violations at the traffic intersection is presented in this paper. As soon as the red light changes, the detection system starts and then grabs the video frame from the input video file to acquire the decision whether the car is violated or not. Software will be developed with the video files from the surveillance camera of the road in Myanmar in accordance with accepted rules. This system is intended to use for one sided way. The segmented license plate is extracted using the projection analysis and geometric features of License plate. Stop Line Detection is used Sobel edge detection and morphological operation from grabbing video frames and then calculated depending on the Y-coordinate location of the stop line and the License plate. If the location of the license plate is passed over the yellow line, it is defined as the violated car. Otherwise, the car is non-violated. This detection system should be performed in almost real time, watching cars passing the stop line at a street intersection in front of video recording device. In a real-life test environment, the developed system could successfully track 91% images of vehicles with violations on the stop-line in a red traffic signal.

Keywords: Stop Line Detection, Location, Segmented License Plate

I. INTRODUCTION

People focus the negative aspects of rules rather than the positive. Simply, the consequences for not obeying traffic laws take place personal injury, death, and damage to your vehicle or other property. All kinds of violations at a street intersection include red light running, speed violation, stop line violation and lane violation by tracking individual vehicles. According to an in-depth investigation of road accidents in Myanmar, 75% of traffic accidents are preceded by at least one traffic law violation. Traffic signals using time separation are aimed to reduce motor-vehicle crashes at intersections involving traffic congestion. Many low income countries have felt rapid growth in their motor vehicle blow over. Nowadays, the ever growing number of vehicles on the road fall out the crash statistics, and driving over the vehicle-miles exceed, and this situation is becoming a major concern of country authorities [1].

Figure 1: Statistics of traffic accidents in Myanmar

A major cause of such crashes is drivers disregarding traffic signals. Review of the police reported crashes found that running red lights and other traffic-control devices such as stop signs is the most common type of the accident, and the resident injuries more occurred crashing in the red light running, compared with other crash cases. Crashing reductions is the main way to slow down the red light running crashes at road traffic intersections.

One or more law enforcement officers monitor the traffic intersections for red-light violations that have been done in long time ago [4]. Enforcing traffic signal compliance using automatic monitoring system instead of the police officers can operate all the time of the whole day without interruption.

Since the 1970s Red light cameras, increasingly are being used in many foreign [7], to help communities enforce traffic laws by automatically photographing vehicles passing over the stop line when red light changes. Through the years, some minor variations occur, and automatic enforcement has been promoted to several types of violations and new technologies violations detection systems involved [5] [9]. The use of digital video recording is the most notable developments [4], the recognition and identification of a vehicle using image processing techniques. Even though certain countries have used photo-enforcement with some degree of success, traffic enforcement systems using photographic techniques have weak point that generally can be missed to capture when the vehicle reaches taking moment after changing of the red light. The detection system is invariably unable to provide a trigger point that is to ensure that consistent with the positioning of vehicles at the time of imaging is identical. Digital cameras are used, systems either require the availability of high-speed pricey processing to meet the demands of requirements. Thus, in this research, it has been thought out of a system which is
simple, cheap, reliable, and of course offers at least some fundamental advantages over the conventional automated systems. Here, stop line violation detection system has been used, which makes the system not only automatic but also flexible. It also makes the system simple to track the vehicle suitably for our nation’s road and also helps the system to keep in pace with the motion/running body. In course of the work, a dataset has been collected for the experiment, as discussed in section II. Section III describes the procedure of the system and includes the subsections III.A to III.C explaining the methods for adaptive background image generation, background subtraction and identification of stop-line and stop-line violation detection respectively. In section IV results of the experiment are shown and discussed. Section V gives the overall conclusion of the present work.

A. Outline of the Myanmar Vehicle License Plate

Standard LP contains Myanmar alphabets and numbers which are shown in Fig. 2. It is worth paying attention to two different plate colors while searching for LP in an input. Other types of vehicles, such as diplomatic cars and military cars, are not addressed since they are rarely seen. Color arrangements for the Myanmar VLPs are shown in Table 1.

![Myanmar License Plate](image)

Figure 2: Outline of the Myanmar License Plate

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Plate color</th>
<th>Character color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private automobile</td>
<td>Black</td>
<td>White</td>
</tr>
<tr>
<td>Taxi, Track, Bus</td>
<td>Red</td>
<td>White</td>
</tr>
</tbody>
</table>

Table 1: Myanmar Vehicle License Plate Specification

II. COLLECTION OF DATASET

The dataset for the current experiment is collected as a part of a demonstration project on Vehicle Stop Line Violation Detection system for a Government traffic monitoring authority of a major city in Myanmar. Surveillance cameras were installed at an important road crossing in Yangon at a height of around ten meters from the road surface. These are static CCTV camera and focus, fixed at a given orientation with the road surface. All the surveillance cameras were synchronized with the traffic signaling system such that the camera captures the video snapshots only when the traffic signal is turned RED. All the cameras were focused on the Stop-Line to capture back images of vehicles violating the Stop-Line on a RED traffic signal. The complete image dataset comprises of more than 50 surveillance video snapshots, captured over several times in an unconstrained environment with varying outdoor lighting conditions, pollution levels, wind turbulences and vibrations of the camera. 24-bit color bitmaps were captured through CCTV cameras with a frame rate of 25 fps and resolution of 240 x 320 pixels. Not all these video snapshots contain vehicle images with a clear view of license plate regions. For the current experiment, 200 images have been identified with complete license plate regions appearing in different orientations in the image frame.

III. PROPOSED TECHNIQUE

The overall traffic violation processing system of the proposed design is shown in figure 3.

![Traffic Violation System Diagram](image)

Figure 3: Myanmar Car stop line violation detection system

The controlling of traffic violation processing system mainly comprises three main modules (i) Motion Analysis (ii) License Plate Detection (iii) Stop Line Detection (iv) Decision making process. In first module, after the vehicle image is captured by the camera, it will be passed to frame grabber which captures the image based on the car’s speed driving along the distance for further processing by the system. Its main operations are intended to speed up. In second module, license plate is extracted. The elements (characters and numbers) in the extracted license plate are segmented by connected component and extraction method based on the geometrical features of the license plates and then checking the segmented characters using the projection analysis in detected region to ensure the exact result. Stop line location is detected using morphological operation and sobel edge detection. In the third module, the record is taken whether the car is violated or not.

A. Motion Analysis

Frame grabbing process base on the driving speed of the car (kilometer/hour) and the frame included in the video displayed time. The driving speed is supposed that 40 km/h. In Myanmar, traffic surveillance system uses Application Visualization System (AVS). Matlab cannot execute this format. It is converted to Matlab executable Audio Video Interleave (AVI) file format by using “Wondershare Ultimate Converter”. The driving speed is supposed that 40 km/h. The red light in traffic light signal is taken 30sec in one section.
The robust grabbing frame algorithm is used to accomplish with right frame grabbed. When the red light changes, it is grabbed the video frames in input video scene to get the accurate results as fast as possible. In present work, Motion analysis stage is necessary to take the input signal when the red-light signal changes. To acquire this, it is simulated the red button and it is assumed the starting of red light signal when red button is pressed. The grabbed pictures are used as the input image.

3600seconds=40000meters (40Kilometer/hour)
30seconds =333meters
333meters=3558frames
4.5meters (15feet) =48frames

Therefore, it has the 48 frames. It is grabbed one frame after jumping over the sequence of 10 frames. There are 4 frames last finishing one section of 30seconds after passing through this stage.

B. Proposed License Plate Detection Framework

License plate detection stage is the key step, which influences the accuracy of the system significantly. The vehicle license plate detection steps are the following:

1) Colour Analyse system

In the proposed method, the candidate regions are found by using RGB color model on the basis of using RGB thresholding. Firstly color image is classified as the individual color planes: red-plane, green-plane and blue-plane. Red or black color region is extracted using the predefined threshold value range:

For example: red-threshold=68; green-threshold=70; blue-threshold=72; white-threshold=255; black-threshold=0;

For black background plate, the threshold selective range is less than 50 in each color plane of red, green and blue. 

\[ \text{Black} = (\text{red plane} < 50) \& (\text{green plane} < 50) \& (\text{blue plane} < 50) \]

For red background plate, the limitation must have both greater than 15 by differencing the red-plane and green-plane and greater than 20 by differencing the red-plane and blue-plane.

\[ \text{Red} = (\text{red plane} - \text{green plane} > 15) \& (\text{red plane} - \text{blue plane} > 20) \]

After performing this step, connected components labeling (CCL) is used to scan an image and labels its pixels into component based on pixel connectivity. After labeling the spots, the next step can be done with labeling objects.

2) License Plate extraction based on geometric features

The possible candidate region is extracted using geometric properties from extracted color regions. Myanmar license plates have the dimensions 350 mm width and 162 mm height. Each plate has at most seven characters and at least three characters written in a single line. The dimensions of the plate have the most common size. All standard license plates contain Myanmar alpha-numeric characters, slash and digits. All standard license plates can have 30 characters of alphabetic Myanmar characters, followed by four or five numbers of digits. Under practical environments, the distance from the camera to vehicles and the inclined angles are constant. This fact can be used to locate or choose the plate among the candidate areas. All of the geometric features define the limit with the upper and lower thresholds. If the labeling object exist between these confine thresholds, it is extracted as a possible result. It is extracted the possible License Plates results used the following geometric features.

\[ \text{aspect ratio} = \frac{\text{width of license plate}}{\text{height of license plate}} \]

\[ \text{Box area} = \text{width of license plate} \times \text{height of license plate} \]

\[ \text{Frame area} = \text{row of frame size} \times \text{column of frame size} \]

\[ \text{extent} = \frac{\text{frame area}}{\text{box area}} \]

In the process of eliminating candidate regions which are not license plate, following criteria are considered:

- If the plate area is too large or too small related to the size of the image, it can be discarded.
- Normally plate background is black and foreground is white. In the candidate region, if only almost white pixels or black pixels exist, it can be removed.
- If the number of white objects (characters) inside the candidate region is more than 10 objects or less than 4 objects, it cannot be a real plate.
Pixel density of the license plate region must have the half of the pixel density of the whole of the frame size.

3) Projection Analysis

Projection analysis is applied to the image for specifying the plate location. Horizontal and Vertical projection that can be used to check labeled object is really license plate or not. License plate boundary is determined in the previous steps. This step is considered the objects in the license plate. The characters in the License Plate whether exist in or not. The neighborhood of each spot in the candidate region is analyzed and the spots are grouped using connected component labeling if there is another spot of the defined position in this neighborhood. The grouped spots is called target region. The projection technique in this paper is based upon the idea of projecting the image data onto the X and Y axis. By counting a component’s projection value, it is possible that are license plate and components that are other components.

Vertical projection (white pixels in each row)

\[ F(y) = \sum_{y=0}^{height-1} T(I(x,y)) \]

Horizontal projection (black pixels in each column)

\[ F(y) = \sum_{x=0}^{width-1} T(I(x,y)) \]

In projection stage, white color threshold \( T(P) \) is used to extract the exact result from the projected counting objects. White color threshold range is used two commands.

The case one for red-white pixels extraction in the license plate is

\[ White = (Red > 220 & Green > 140 & Blue > 140) \]

The case two for black-white pixels extraction in the license plate is

\[ White = (Red > 200 & Green > 200 & Blue > 200) \]

The resulted image after performing projection analysis stage is shown in Fig. 5.

4) Stop Line Detection

Firstly, the grabbed image is converted into grayscale image. And then filtering is made to filter the noise using imfilter command.

\[ \text{imfilter (grayscale image, sobel edge operator)} \]

\[ \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \]

Figure 6: Sobel operator for horizontal edge detection

Sobel edge detector is used to extract horizontal edge line. Dilation morphological operation is used to distinct the line area. The length of object greater than 290 is selected for line region. The result is shown in Fig. 8.
C. Decision Making

Extract the location of Y-coordinate of License Plate and the Stop Line. If the location of the Y-coordinate of License Plate is greater than the location of the Y-coordinate of the stop Line, it is the violated car. Otherwise, the result is non-violated car. The Y coordinate of License Plate is defined as threshold. In present work, the threshold value is 200 depending on the result of Fig. 9.

If Y-coordinate of License Plate>threshold Then Violated car
Else Non-Violated car.

IV. EXPERIMENTAL RESULTS

Experiments have been performed to test the proposed algorithm and to measure its accuracy. To evaluate the results, SLVDS (Stop Line Violation Detection System) can be calculated by using the following equation.

\[
SLVDS = \frac{Number \ of \ correctly \ detected \ Results}{Number \ of \ Total \ Tested \ Times} \times 100\%
\]

The system is simulated in MATLAB version (R2012a) for the extraction and segmentation of number plate. The video files total taking 17 hours are used for testing the technique. The video files are collected from RTAD (Road Transport Administration Department) at Nay Pyi Taw, Myanmar. The distance between the camera and the vehicle varied from 3 up to 7 meter. However, the proposed method is sensitive to the angle of view, physical appearance and environment conditions. The system cannot be used for all types of surveillance traffic watched videos: international. In a real-life test environment, the developed system could successfully track 91% images of vehicles with violations on the stop-line in a red traffic signal. The performance of the system is evaluated with a dataset of 200 images collected from 3 different environmental conditions.

Table 2: Experimental Results

<table>
<thead>
<tr>
<th>Total Video files</th>
<th>Capture images after passing Motion analysis step (Images)</th>
<th>Number of Correct detection</th>
<th>Percentage of Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>200</td>
<td>182/200</td>
<td>91%</td>
</tr>
</tbody>
</table>

V. CONCLUSIONS

A robust approach which considers different features of Myanmar car license plates to deal with more complex situations in real world is presented. A simple but efficient stop line violation detection system is implemented in this paper. The proposed method is mainly designed for real-time Myanmar Car stop line violation detection system. To measure the efficiency, this method has been tested over 50 video files. The new algorithm produces the higher accuracy and faster speed for VLP detection. The developed system will falsely detected, if input video has much noise which can cause the detection step not to be completely. The major limitations of automated license plate detection include constraints on when the image quite complex in color. To truly extract the plate area, at least the geometric features of the LP must have clear.

REFERENCES

[1] www.myanmarrtad.com, Road Transport Administration Department.