License Plate Recognition for Moving Vehicles Case : At Night and Under Rain Condition

Muh Ismail
Department of Informatics
Electrical Engineering Study Program
Hasanuddin University
Makassar, Indonesia
imuh77@gmail.com

***Abstract* — Research for the detection and identification of existing license plate focus on static image under different weather conditions. This research aims to detect and recognize the license plate on moving vehicle at night and under rain condition. The method used to detect license plate is Cascade Classifier with Local Binary Pattern (LBP) as a descriptor, top-hat transform for image enhancement, and recognizing character of license plate detected is using Optical Character Recognition (OCR) and Template Matching (TM). The testing process using 9 videos data with duration 30 seconds. The testing result that accuracy rates LBP OCR reach 77.42% increase 32.26% than without top-hat transform and LBP TM 64.52% increase 45.16% than without top-hat transform.**

Keywords—Video Processing; Image Processing; License Plate Recognition; License Plate Detection

I. INTRODUCTION

The increasing of vehicles in Makassar city is not in accordance with the capacity of road infrastructure. So it causes traffic problems, especially when in a crossroads that there is traffic light. One effort to reduce congestion in Makassar is to apply intelligent traffic light system [1], [2]. However, the system also needs to be supported by a vehicle monitoring system so that offence can be known in real-time. The identifier of the vehicle can be known by its license plate and become a challenge for intelligent transportation system, notably detection of license plates on moving vehicle conditions [3], [4].

In general, license plate recognition on moving vehicle in real-time have 3 stages. The first one, detect the license plate in a frame of video. Second, segment the character of the license plate in candidate region of the license plate. And the last, recognize the character of the license plate [5]. To maximize all of these stages, some research do not recommend using a neural network because it takes a lot of training samples and the size of image must be similar to others [6].

Wijetunge *et* al. use image processing techniques to detect license plates [7]. Image processing techniques used are vertical edge detection for detect license plate and hough transform to handle tilt license plates while identification using back-propagation method. Accuracy of license plate identification reached 86%. The data used is a static image. While research conducted by Pooya *et* al have already used video [8]. Data of research objects processed is under different weather and illumination conditions. The method used is the background substraction for extracting objects from background, edge detection for character extraction, and template matching for character recognition. Accuracy of this research reach 71,43%.

Worawut *et* al. used techniques are RGB Image to Grayscale Image, Grayscale Image to Binary Image, Edge Detection, Noise Reduction, Character Segmentation to extract all candidate characters and Template Matching to identify plates [9]. This research focuses on parking system so that the data is still limited only license plate image. Accuracy of this research reach 93.42%.

Similar researh has been conducted by Byung-Gil *et* al. In 2015, focus to detect multi-license plate in real-time and high resolution. Cascade classifier method is proposed to detect license plate with a resolution of 1,624 x 1,224, with the fastest average time less than 20 ms per frame [5].

From all previous works discussed above, most of them only focus to one vehicle in one frame and only focus to detect license plate in video. Moreover, all previous work still consider about night and under rain condition on moving vehicle in real-time which briefly in this paper.

The remainder of this work is organized as follows; In the second section, we present the proposed method. In the third section, we present and discuss the obtained result. Finally the paper is concluded in fourth section.

II. PROPOSED METHOD

The data has been recorded from the overpass, representing one of the main roads in the city of Makassar, namely Jenderal Sudirman street, with a height of the street ± 5 meters. The data has been recorded at night and under rain conditions at 7.00 pm - 10.00 pm (GMT +8). The camera used is a canon camera and an additional a tripod for stand of the camera. The camera is set to 1 meter for height, slope 30 degree, 1920 x 1080 px for dimension. To make efficiency the usage of memory in this work then the video data that has been recorded is divided into 30 second for each file. The training samples which processed in this paper are video data that extracted into frames.

In general term, this paper consists of three stages: 1. Detection of license plate by cascade classifier using Local Binary Patterns (LBP). 2. The character detection of license plate by image enhancement. 3. Recognize the license plate by OCR and Template Matching. Flowchart of system proposed for details in this research can be seen in figure 1.

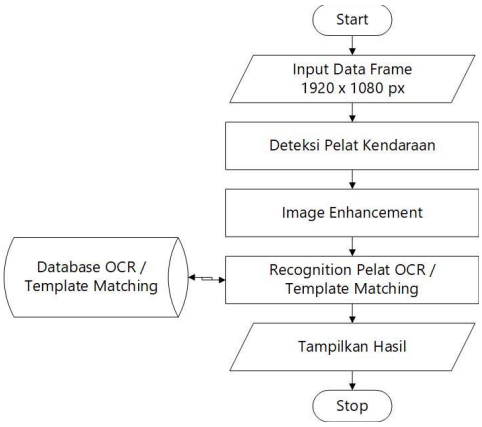


Fig. 1. Flowchart Stages of Proposed System

A. *License Plate Detection in Video*

License plate detection in video has been worked, start from detecting static object till moving object. One of the suitable methods used in complex cases, multi background, and multi color object is Cascade Classifier. LBP is one of the best descriptor and it has been widely used [10]. Some of all benefit using LBP are computational efficiency and able to detect different scale of object.

To make model of cascade classifier for classifying need training samples are positive samples and negative samples. Requirement of training samples are; 1. Set training positive samples as many as 1700 Region Of Interest (ROI) contained license plates of either Motor or Car. 2. Set training negative samples as many as 3400 Frames, where that there is no content of license plates in either frame or vehicle. 3. Set False Alarm Rate by value 0,2. 4. Number of Stages is set 20 to maximize training. Training samples can be seen as follow :

Fig. 2. Positive and Negative Image

The output of the cascade classifier training is a * .xml format file ready to use as a model of all license plates. To maximize the performance of the cascade classifier model, then for each frame in searching each of candidate plates filtered by a height range between 45 px and 70 px and a wide range between 150 px and 250 px. The following explanation pseudo code of cascade classifier filter implementation in this paper is :

```
insert frame 1080x1920x3 px
load model lbp
bbox=process frame by comparing model
countbbox=count(bbox)
for i=1: countbbox
    if ((bbox(i,:3)>=45) && (bbox(i,3)<=70) && (bbox(i,4)>=150) && (bbox(i,4)<=250))
        temp_bbox(i,:)=bbox
    end
end
print temp_bbox in frame
```

The following is an example output image that has been implemented into the cascade classifier :

a. Unfiltered Image b. Filtered Image

Fig. 3. Result of Detecting by Cascade Classifier

B. *Image Enhancement Stage*

Data extraction result of cascade classifier is a candidate region of license plate then performed image enhancement stages. Image enhancement stage does influence in recognizing the character of license plate. Here is the flowchart of image enhancement of this paper :

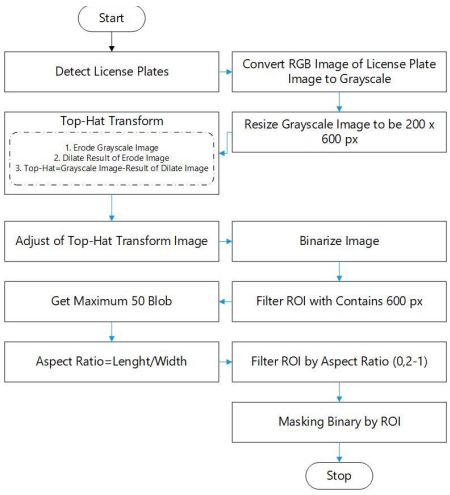


Fig. 4. Image Enhancement Stage

Implementation of image processing is conducted able to be seen as follow :

Fig. 5. Process of Image Enhancement : a. Extraction of License Plate; b. Convert RGB Image to Grayscale Image; c. Resize Image to be 200 x 600 px; d. Top-Hat Transform; e. Adjust Image; f. Binarize Image; g. Filter ROI with Contain 600 px; h. Aspect Ratio; i. Masking Image

In figure 5 show image enhancement by using top-hat transform which able separate between background and character of image. Case of night and under rain condition make the frame and image of license plate has colour almost white. This case make system difficult to recognize the character because background and character of image is connected. For example in figure 6(a) show the background and character are connected.

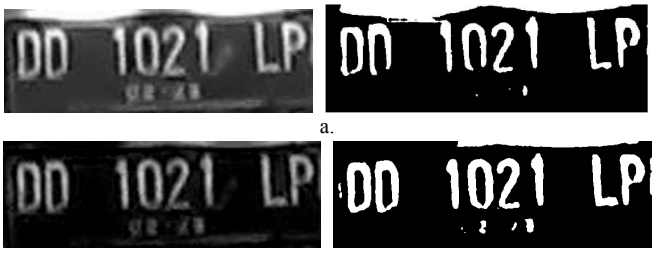


Fig. 6. Image Enhancement for Night and under Rain Condition : a. Convert to Binary image without Top-Hat transform. b. Convert to Binary by Top-Hat.

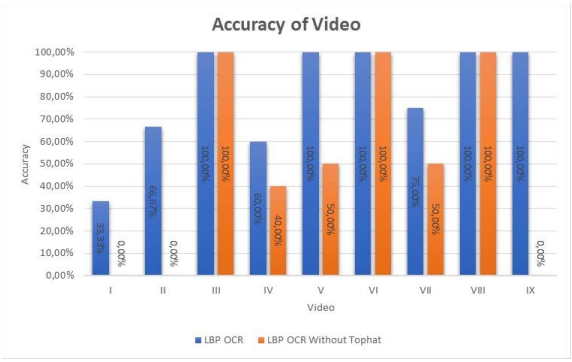
C. Recognition of Character License Plate.

Recognition of character license plate is the final step of this research. This research applies two method to recognize of character, that is by Optical Character Recognition (OCR) and Template Matching (TM). OCR used to recognize start from handwriting until digital images on computer vision application. The lack of OCR is difficult to recognize the text that has a lot of noise. While template matching used in pattern matching between image target and template to recognize the object. The lack of template matching is not able to adapt with rotation, scale and viewing angle is very poor [10]. Template of character in this research can be seen as follow :

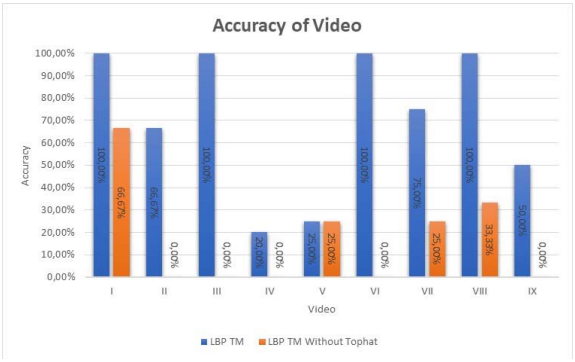
Fig. 7. Template of Character

III. Result and Discussions

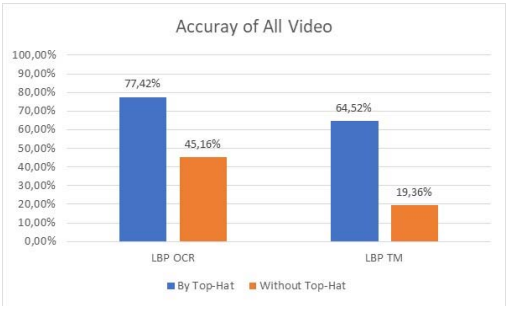
The techniques proposed in this paper tested with nine videos contain various of license plate. Video detected and recognized contains 30 seconds of each video. The results of license plate detection and recognition calculated for by means of two method : "True Recognition" and "False Recognition". If in one video, there is one type of vehicle and can be detected and recognized its text on the license plate correctly for all characters at least once during the vehicle appears in the video, then counted as True Recognition. Whereas if one type of vehicle never detected and recognized its text on the license plate correctly for all characters at least once during the vehicle appears in the video, it is calculated as False Recognition. The following accuracy of test results for detection and recognition of the license plate are shown in Figure 8 and in Table 1 shows the execution time results of each video which each video is 30 seconds.



a.



b.



c.

Fig. 8. Accuracy of Video: a. Accuracy of LBP OCR. b. Accuracy of LBP TM. c. Accuracy of All Video

TABLE I. Execution Time

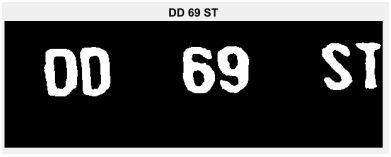
Video	LBP OCR	LBP TM
I	7' 59"	9' 48"
II	9' 8"	8' 53"
III	7' 6"	7' 25"
IV	8' 22"	6' 42"
V	7' 34"	6' 22"
VI	4' 54"	5' 29"
VII	9' 8"	9' 37"
VIII	7' 44"	6' 50"
IX	6' 4"	5' 18"

Video I in Figure 8(b) has 100% accuracy on the part of LBP TM because in this case the license plates have characters that are close to other characters. For example, when using OCR to

recognize, the "I" character when it tilt reads "1", the character "O" reads "0" or "8", and the character "D" reads "0" or "O" when the plate is tilt. So it can be concluded that in case of video I which is suitable to use is Template Matching for recognizing of license plate. In addition, there are also weaknesses when using Template Matching. As in video V in Figure 8(b), which is mostly wrong in the recognition of license plate. Because the technique applied in Template Matching is to divide into three license plate, they are : 1. The first of Bounding Box contains the letters. 2. The second of Bounding Box contains numbers. 3. The third of Bounding Box contains the letters. So in case of video V in Figure 8(b) is not suitable for template matching, because the license plates has many numbers "1" which is almost the same distance with each Bounding Box from the first to the third. This case causes the failure of the program, because each number "1" forms a Bounding Box or exceeds the amount of specified Bounding Box.

Several license plate image cannot be perfectly recognized because there is at least one letter of the license plate cannot be detected or recognized. In the others cases, the license plates are difficult to recognize due to license plate movement and uneven lighting. So the results of enhancing in terms of character extraction are similar to other characters. Here is one of the samples of True Recognition and False Recognition :

a. First Image



b. Final Image, Recognized as "DD 69 ST"

Fig. 9. True Recognition

a. First Image

b. Final Image, Recognized as "DD 11 SY"

Fig. 10. False Recognition

IV. Conclusion

License plate detection in this paper applies cascade classifier method, where the result does influence on negative samples and positive samples. The descriptor used to do detection are LBP. Image enhancement by using Top-Hat transform. Recognition of license plate by OCR and Template Matching. Accuracy of detection and recognition of license plates in this paper has achieved good results, especially detection by LBP and recognition by OCR and image enhacement by Top-Hat transform which reach 77.42%. The experimental results show that the system is not only able to detect many license plates but also able to detect license plates with multi-size. Implementation of image processing techniques such as Top-Hat that can solve the image with various lighting, and Aspect Ratio can filter Region of Interest which excluding candidate characters. As our future work, our research will focus in trying another descriptor.

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