2012 IEEE International Conference on Control System, Computing and Engineering, 23 - 25 Nov. 2012, Penang, Malaysia

Malaysian Vehicle License Plate Recognition Using Double Edge Detection

Norazhar Abu Bakar[1] , Mohamad Riduwan Md Nawawi[1], Abdul Rahim Abdullah[1], Aminurrashid Noordin[2], Zainolizam Musa[1], Oon Cee Xian[1]

[1]Faculty of Electrical Engineering, [2]Faculty of Engineering Technology
Universiti Teknikal Malaysia Melaka,
Melaka, Malaysia.
norazhar@utem.edu.my, riduwan@utem.edu.my, abdulr@utem.edu.my, aminurrashid@utem.edu.my

***Abstract* - Vehicle plate number is a unique combination of characters and numbers. Hence, it has been used in various application as personal identification such as for parking system identification, security monitoring system and etc. This paper illustrated the double edge detection technique in order to enhance the vehicle plate image, before character recognition process. Firstly, the vehicle image is captured, and then it will be re-sized and cropped until the resolution of image is 300x300. After the re-sized process, First Edge detection is applied to the image. Threshold of black and white are 59 and 60 respectively used to change the image into black and white colour only. Next, Second Edge detection is used to remove the unwanted image and only remain the plate number in white colour. MATLAB software is used in this experiment.**

***Index terms :* Plate, recognition, image processing, edge detection, LPR**

I. Introduction

License plate is a unique identification for every single vehicle. Hence, it has been used in various applications such as for security monitoring, access parking systems, private area identification and etc. Due to the benefit of using license plate as personal identification, a lot of research has been done to recognize the plate number automatically. Various technique of License Plate Recognition (LPR) is developed based on different techniques, applications and countries.

In general, the characters for vehicles plate number are arranged in two structures, either the characters are placed in a single row or in two rows. All plate numbers have the combination of alphabet and number. In Malaysia, the plate number is begin with alphabet and followed by number, except for the vehicles that registered in Sarawak, Sabah and Langkawi Island, which will end up with another alphabet.

The implementation of background colour for vehicle plate number in Malaysia is different with Taiwan [1], since the license plates in Malaysia only used two colours, black and white. The background colour of the plate number is black, and the font is white. Except for taxi, the plate background is white, while the font is in black colour. Since there are only two colours involved, the detection process of the plate number location become less complex. However, to clarify the types of the vehicle would be complicated due to no colour code used to differentiate the vehicle types like in Taiwan [1,2].

With various applications, different operation conditions, outdoor environment and non-stationary background are the major factors that mostly influenced the quality of the images captured, hence added complexity to the techniques needed [1]. The non-standard colours of black and white used for plate background and font as well as the aging plate number also contributed to the problems. To minimize the complexity of the technique, most of the researchers confine their operating environment such as limiting the process on day time or at indoor environment, limit the vehicle speeds, fixed the position of license plate at the vehicle, standard license plate structure is used, fixed illumination, and fix the distance between vehicles and camera [3,4,5,6,8,12]. For this project, there are two limitations will be considered. Standard of Malaysia license plate is used and the condition is on the day time.

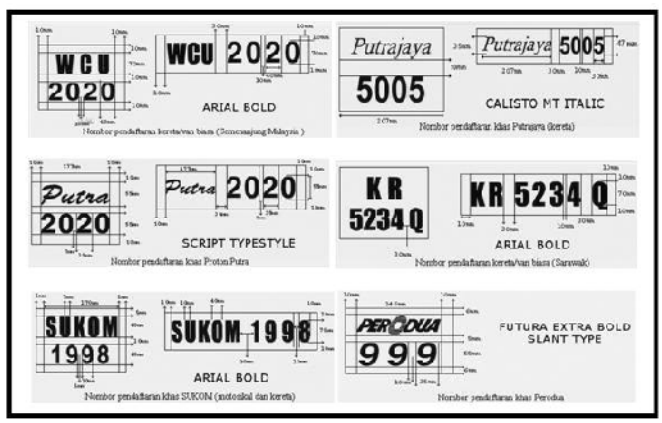

Figure 1: Standard Malaysian Vehicle Plate Number [2]

The LPR consists of two main processes; firstly, identify license plate location and secondly recognize the license plate number. In the first process, the exact location of the license plate is defined, so that only the selected area will be analyzed in the second process. It also helps in minimizing the processing time taken in the next process. Failure to identify the location of plate number will result complexity in identifying the characters of plate numbers and the worst scenario, the system is unable to recognize the character at all. It means, to get an exact location of plate number is a crucial process of LPR. Normally, location of license plate is determined based on the features of license plate such as license plate format, shape, symmetry, colour, texture, interval between characters, and spatial frequency [7,9,10,13].

In recognition phase, the character of the license plate is identified. Before the process of alphanumeric character identification, each character in the selected area is separated. After the separation process has been done, the character will be identified. There are several techniques have been used for the character recognition. Artificial Neural Networks, fuzzy, genetic algorithms, Markov's processes, and support vector machine are used in the recognition process [7, 8,9].

This paper is focused on determine the license plate location by using double edge detection technique based on colour features of the license plate. This experiment is restricted to daytime environment and standard license plate format in Malaysia.

II. THE PROCESS OF THE LICENSE PLATE LOCATION

A. *Basic Concept*

A flowchart for identifying the location of license plate is shown in Fig. 2. In this project, image of a vehicle is captured and loaded to the LPR system in RGB colour. Then, the image is resized to a standard resolution, Ny : Nx = 500:500, since the actual sized is large and not in the same resolution. After resized process is done, the image is cropped to 300 x 300 resolution based on the consideration that the license plate number normally located on that range. This process helped minimize the processing time taken when entered the filtering stage later on [10]. The next step is to convert the image from RBG to grey scale image before it is transformed to binary scale image. Then, image is filtered for second times and histogram analysis is used to identify the location of plate number. Finally after recognize the plate number location, each character is cropped and separated to each other. The result of this process is used in recognition stage.

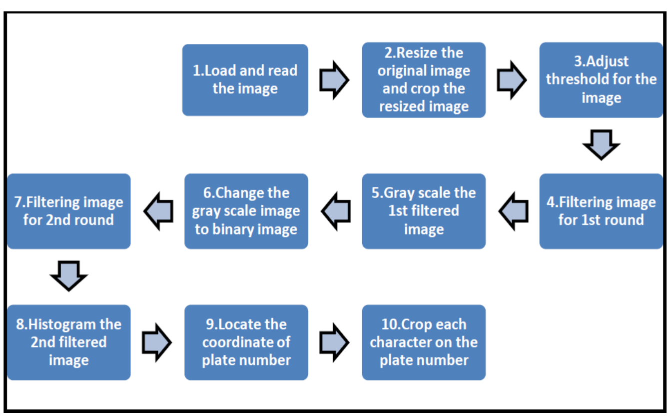

Figure 2: The flowchart for the process of the License plate location

B. *Filtering Stage 1*

The purpose of filtering at stage 1 is to convert the image from real colours into only two types of colour, either white or black. This process involves step 1 until step 4 as illustrated in Fig. 2. Before the filtering process, the original image is resized to 500 x 500 resolutions. Then this image is cropped again to 300 x 300 resolutions. Let the H-axis and V-axis is equal to 300 respectively; then the new Ny and Nx will be represented by:

$$Ny = (Ny - (Haxis - 1) : Ny)$$

$$Nx = ((Nx/2) - (Vaxis/2) : (Nx/2) + (Vaxis/2) + 1)$$

Figure 3 shows the original image captured by camera and Fig. 4 shows the image resulted from cropping process which the image is more focused on the location of license plate. The cropping process eliminates the unnecessary object on original image, and gives advantage in the next step.

Figure 3: The Original image

Figure 4: Image after the cropping process

Step 3 is to adjust the threshold of the image. The purpose of threshold adjustment is to do segmentation between foreground and background region of the image. The output image from step 2 is converted into gray scale image, and gray threshold (GTh) for the image is obtained. Then, threshold error (ThE) is set by

$$ThE1 = (GTh / 0.5)*100 ;$$

$$ThE = (0.5*ThE1) + 10 ;$$

For a case where segment has gray threshold equal or more than 0.6, then it will be adjusted by reducing the ThE value (New threshold = Original threshold – threshold error). Figure 5 shows the results obtained after threshold adjustment process.

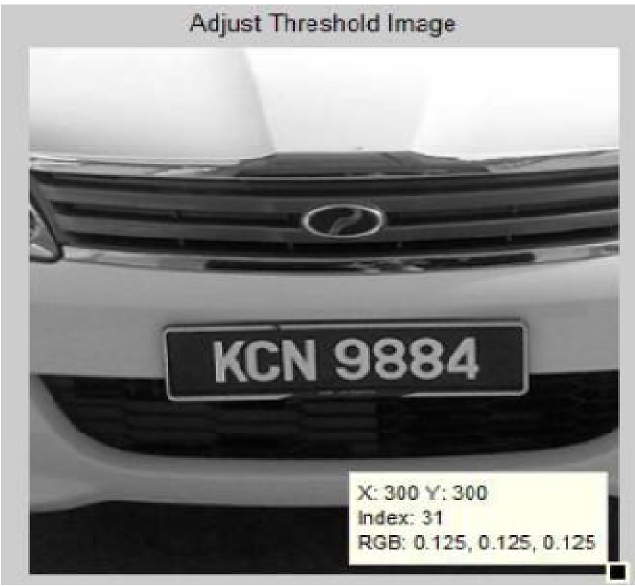

Figure 5: Result after threshold adjustment

Then, the image is filtered with colour edge detection where if the difference between three sequences pixel is more than 25, then change the pixel is changed into black colour (R,G,B = 0,0,0), otherwise remain with original colour as shown in Fig. 6. The RGB's brightness level is represented in decimal number from 0 to 255, hence the different combination values of RGB will give the different type of colours. In RGB image, white is represented by (R=1;G=1;B=1) and black is represented by (R=0;G=0;B=0). The filtering process is done from horizontal, and then followed by vertical. After that, the image is filtered again, but this time it is to change the pixel either in purely white (255,255,255) or black (0,0,0). Threshold value is used in order to separate between considerably white or black colours. In this experiment, threshold for black is set to 59, and for white is set to 60. In second filtering process, any pixel that have threshold value from 59 and less are converted to purely black (0,0,0), while pixel with threshold value 60 and above are converted into purely white (255,255,255). Figure 7 shows the results obtained after the second filtering process.

Figure 6: Result after filtering by using colour edge detection

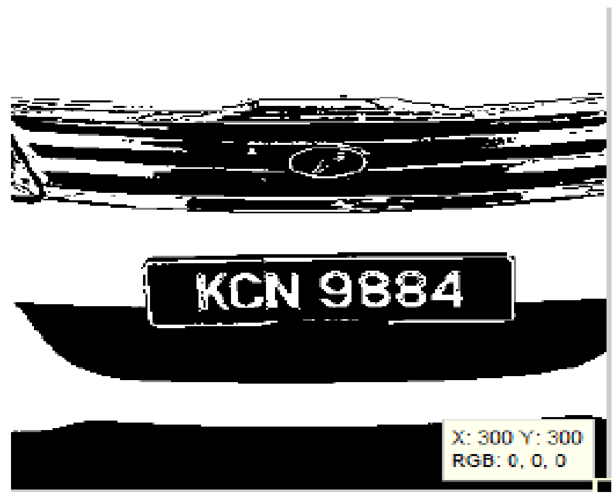

Figure 7: Result after using threshold filtering

C. Filtering Stage 2

Filtering at Stage 2 consists of step 5 until 7. The function of second filtering process is to remove the unwanted object around the plate number and the unwanted white spots in the image. Before the second filtering stage take place, the image in Fig. 7 is converted from RGB (Red, Green, Blue) colour to gray scale image. Then, the gray image is converted again into binary image, since it is easier to analyze in binary instead of in gray or RGB image. In binary image, the geometrical patterns and objects in the images could be identified easily since there are not cluttered with shading information. In binary image, only need to consider either 1 for white or 0 for black, compared with gray from 0 to 255. Figure 8 and Fig. 9 shows the results for gray image and binary image.

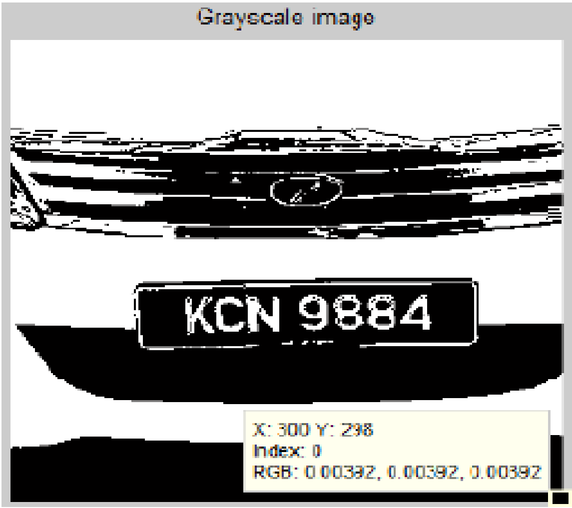

Figure 8: Result for grayscale image

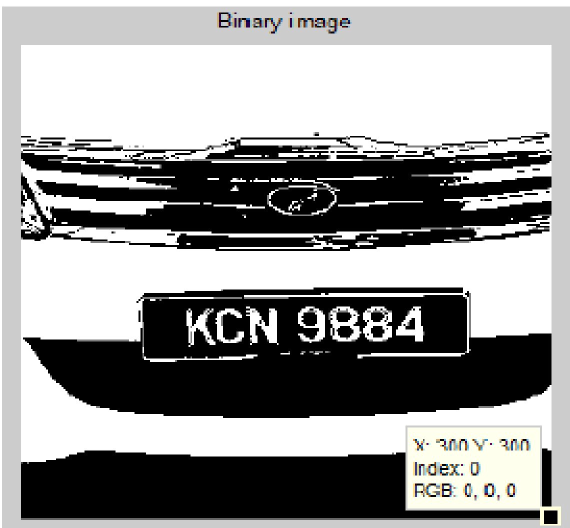

Figure 9: Result for binary image

After obtained the binary image, the filtering process is begun in order to remove the unwanted object and white spots. Since the size of Malaysian plate number is standard, so it's helpful to eliminate the unwanted objects and only remain the characters of plate numbers in white colour. The rectangular window is used in the first phase in order to remove all the unwanted objects included small white spots. To remove small objects in image, the rectangular with size of 3x10 structure elements is used, and any component less than 30 pixels in 4 related neighborhoods is removed. Furthermore, for unwanted larger objects, the instruction where if the white pixel is continuously long (in a range of 20 pixels and more), then it is changed to the black pixel. This technique is applied based on the consideration that the characters used for standard plate number must be less than 20 pixels. The possibility of longest continuous pixels is for character T, L and 4. Figure 10 and Fig. 11 shows the results for these processes.

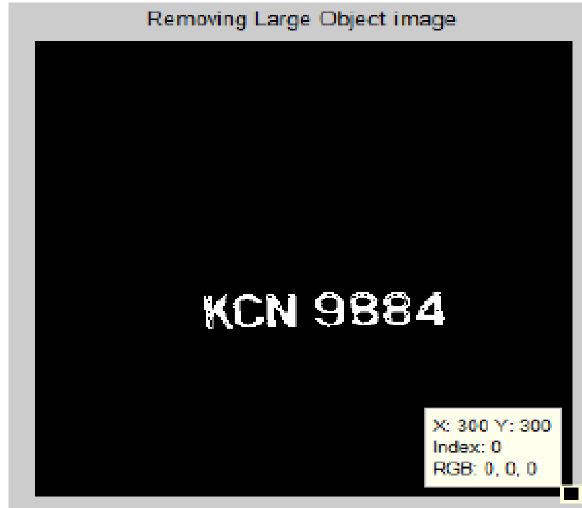

Figure 10: Result after removing large object

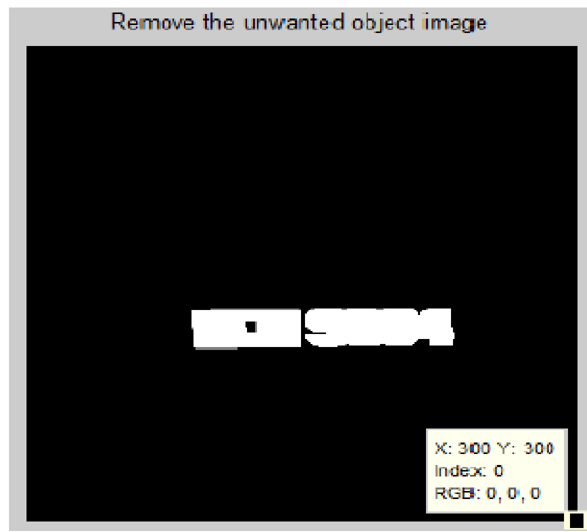

Figure 11: Results after removing white spots

D. License Plate Location

Step 8 to 10 is discussed to find the plate number location. Histogram analysis is used to identify the location of the plate number. In this experiment, the combination of vertical and horizontal histogram is applied, and the highest intersection between both histograms shows the location of the plate number. Figure 12 shows the results from the histogram analysis that has been done in this experiment. From the results obtained, the plate coordinate and position are determined. All the unwanted background is removed and only the plate number is remained as shown in Fig. 13. The final step is to separate each character. It is an important step before recognition process. Unable to separate each character accurately will cause difficulty when entering the recognition process. In this experiment, the function "bwlabel" in MATLAB is used to find the location of each character. If the binary in the image is continuously connected, then it is considered as one object or char. Figure 14 shows the results obtained after the process of plate number separation.

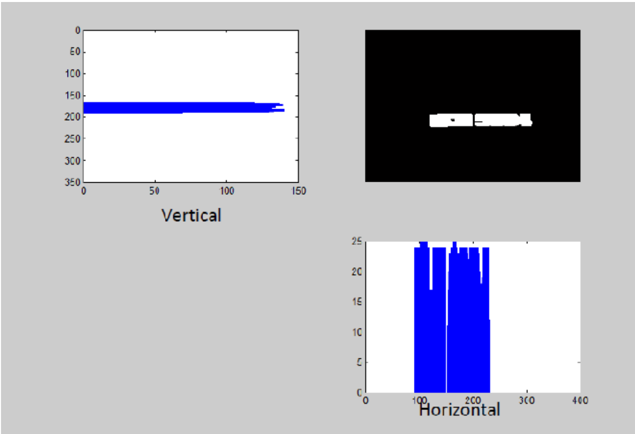

Figure 12: Result for histogram analysis

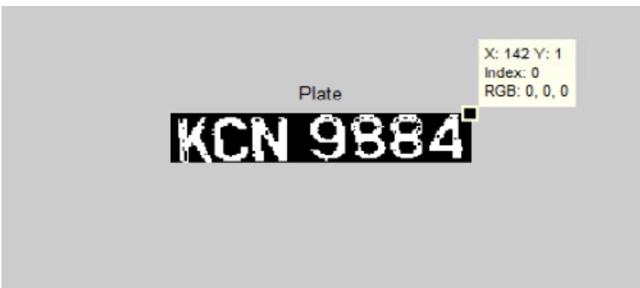

Figure 13: Result after plate number location founded

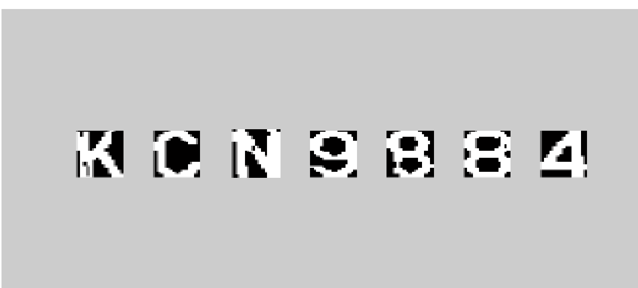

Figure 14: Final result obtained after character separation phase

III. CONCLUSION

This paper discusses about the implementation of double edge detections in order to find the location of the vehicle plate number. The First edge detection is applied in filtering stage 1, which is used to convert an original coloured image into two types of colours, either white of black. The second edge detection is applied in filtering stage 2. It is used to remove the unwanted object and white spot image in the picture. As a result, from 1000 experiments that has been performed (not discussed in this paper), 86% was successful, while another 14% failed. From observation and analysis that have been carried out, it shows that most of the failure is caused by the light reflection effects, which the plate number become too shiny and it seems like the plate number looks continuously connected to each other.

Finally, double edge detection technique is able to find the plate number location, however the illumination and light reflection effects need to be considered, since it will reduced the efficiency of this technique. For future research work, a technique on how to reduce the illumination and reflection effects will be carried out in order to improve the accuracy of this LPR project.

ACKNOWLEDGMENT

The authors would like to express acknowledgement to the researchers from the FKE and FTK, UTeM for the commitment and continuous effort. We are also very grateful to Universiti Teknikal Malaysia Melaka (UTeM), for their financial support.

REFERENCES

[1] Chang et al., "*Automatic License Plate Recognition,*" *IEEE Trans. On Intelligent Transportation Systems*, vol.5. no.1, March 2004.

[2] http://portal.jpj.gov.my/index.php?view=article&catid=7%3Ateknikal&id=24%3Aspesifikasi-no-plat-kenderaan&tmpl=component&print=1&option=com_content&Itemid=43&lang=ms

[3] D.M. Emiris and D. E. Koulouriotis, "*Automated Optic Recognition of Alphanumeric Content in Car License Plates in a Semi-structured Environment,*" in *Proceeding. Int. Conf. Image Processing*, vol. 3, 2001, pp. 50–53.

[4] P. Davies, N. Emmott, and N. Ayland, "*License Plate Recognition Technology for Toll Violation Enforcement,*" *Inst. Elect. Eng. Colloquium Image Analysis for Transport Applications*, 1990, pp. 7/1–7/5.

[5] G. Adorni, F. Bergenti, and S. Cagnoni, "*Vehicle License Plate Recognition by Means of Cellular Automata,*" in *Proc. IEEE Int. Conf. Intelligent Vehicles*, 1998, pp. 689–693.

[6] T. Naito, T. Tsukada, K. Yamada, K. Kozuka, and S. Yamamoto, "*Robust License-Plate Recognition Method for Passing Vehicles Under Outside Environment*," *IEEE Trans. Veh. Technol.*, vol. 49, November 2000, pp. 2309–2319.

[7] J. A. G. Nijhuis, M. H. T. Brugge, K. A. Helmholt, J. P. W. Pluim, L. Spaanenburg, R. S. Venema, and M. A. Westenberg, "*Car License Plate Recognition with Neural Networks and Fuzzy Logic*," in *Proc. IEEE Int. Conf. Neural Networks*, vol. 5, 1995, pp. 2232–2236.

[8] Siti Norul Huda Sheikh Abdullah,Marzuki Khalid and Rubiyah Yusof. Journal of *License Plate Recognition using Multi-cluster and Multilayer Neural Networks.* Centre for Artificial Intelligence and Robotics (CAIRO). Faculty of Electrical Engineering. Universiti Teknologi Malaysia .

[9] R. Parisi, E. D. D. Claudio, G. Lucarelli, and G. Orlandi, "*Car Plate Recognition by Neural Networks and Image Processing*," in *Proc. IEEE* Int. Symp. Circuits and Systems, vol. 3, 1998, pp. 195–198.

[10] Mohd Firdaus Zakaria et. al. *Malaysian Car Number Plate Detection System Bas on Template Matching and Colour Information* / (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 04, 2010, 1159-1164.

[11] Othman Khalifa, Sheroz Khan, Rafiqul Islam and Ahmad Suleiman. *Malaysian Vehicle License Plate Recognition.* The International Arab Journal of Information Technology, Vol.4, No.4, October 2007.

[12] Wisam Al Faqheri and Syamsiah Mashohor. *A Real-Time Malaysian Automatic License Plat Recognition (M-ALPR) using Hybrid Fuzzy.* International Journal of Computer Science and Network Security, VOL.9 No.2, February 2009.

[13] D. S. Kim and S. I. Chien, "*Automatic Car License Plate extraction Using Modified Generalized Symmetry Transform and Image Warping*," in *Proc.* IEEE Int. Symp. Industrial Electronics, vol. 3, 2001, pp. 2022–2027.