

Automated detection of vehicles license plate using image processing techniques

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ABSTRACT

The aim of this project is to design an Automated Detection of License Plate (ADLP) system based on image processing techniques. There are two techniques that are commonly used in detecting the target, which are the Optical Character Recognition (OCR) and the split and merge segmentation. Basically, the OCR technique performs the operation using individual character of the license plate with alphanumeric characteristic. While, the split and merge segmentation technique split the image of captured plate into a region of interest. These two techniques are utilized and implemented using MATLAB software and the performance of detection is tested on the image and a comparison is done between both techniques. The results show that both techniques can perform well for license plate with some error.

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1. INTRODUCTION

Nowadays as the lifestyle are keep on improving, the number of cars in Malaysia are increasing rapidly and become as an important facilities for the modern citizen to go to work, shopping, lectures and etc. In line with the increase in the number of vehicles in Malaysia, issues such as traffic jams and lack of parking spaces are increasing with less action to control the situation. As comparing between the number of car and number of parking space available, it indicates that there is lack of parking space [1]. This situation becomes more difficult in urban areas with high numbers of population. In the situation of no parking space available, some driver will do double parking as shown in Figure 1. The figure shows that the red car is parked outside the allocated parking space and blocking the blue car that park in the given parking space.

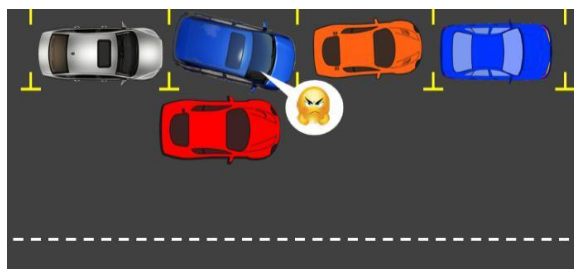


Figure 1. Illustration of double parking situation

In addition, the double parking can cause traffic jam and other traffic offense that might have implications on road users. Initially the road allows two cars to pass through at a time. However, with double parking, the road can only fit one car at a time. This reduces the traffic flow and causing the traffic jam. Therefore, a hybrid system known as Automated Detection of License Plate (ADLP) is proposed which uses Optical Character Recognition (OCR) and split and merge segmentation techniques to determine the individual character of number of the detected car, which is parked at the illegal area. Generally, the ADLP system takes input from the plate number by using cameras and recognise the alphanumeric characters using image processing technique. This technique is typically used in transportation scope in order to enhance the safety and mobility and also the productivity of advanced technologies [2, 3]. Basically, the OCR technique uses each character of the license plate and only suitable for alphanumeric. While the split and merge segmentation technique, split the area of image into a smaller area before merged it into a specific area of interest. These techniques are commonly used in toll payments [4], parking management [5, 6], road-traffic monitoring [7], security [8], crime identification [9] and etc [10].

2. LITERATURE REVIEWS

Qadri et. Al [11] propose a system that able to detect a vehicle and capture the image of vehicle by using segmentation and OCR techniques to trace the plate number and to identify the character. According to [11], the system is able to detect the plate number robustly without mentioning its accuracy. In addition, Rathore et. Al [5] propose a system using the same techniques with 99% accuracy of detection when the images are captured at fixed position that directly facing to the camera. Meanwhile, a research done by the S. Bhatkar et.al [12] develop a number plate detection system using Sobel Edge detection method. The system is successfully detected the edges and fills the holes with less than 8 pixels. This method is efficient due to less time consuming. Bhat et. Al [13] mention in their work that Sobel Edge method and morphological operation are able to predict the number of license plate in various shapes, sizes and different background colour.

Zhang et.al [14] propose a work entitled license plate recognition based on MATLAB by using gray-scale tensile, Log-Prewitt operator and self-adaptive median filter 7 techniques. The Log-Prewitt operator as mentioned in [13] is better than the Sobel method, while the self-adaptive median filter is the most practical methods to eliminate noise. Besides that, Ranglani et. Al [15] propose a technique consists of four levels of implementation, which are mathematical technique, thresholding (Otsu method), normalization (Hough transform) and boundary regional features and segmentation part. These 4 recognition levels use the template matching to recognize the characters of the license plate. The system is successfully function as required with 83.5% accuracy.

In this work, a hybrid technique that consists of OCR and split and merge segmentation techniques [16] are used to detect the number of license plate. The proposed technique is similar to the previous work done by [10], however, this work analysed the license plate in a few situations such as the distance and the angles of the license plate. Both techniques are widely used in the previous research because of the accuracy of the results produced. Basically, the OCR technique can function by itself but then it will encounter several problems that could be able to tackle by using split and obtained the accurate and successful results [17].

3. PROPOSED METHOD

This section reviews on the image processing methods that can be implemented for the detection of license plate which consists of OCR and split and merge techniques.

3.1. Optical Characters Recognition (OCR)

The OCR is an electronic process of changing of images into machine-encoded information. This is a general procedure to exchange the printed text into digital which allow the information to be edited, stored and displayed online [18]. Each of the characters obtained from plate number having the same size with the character save on database. The OCR technique uses template-matching algorithm to recognise each character. The character image is later compared with the database template save in the memory and the similarity of both information is measured [19, 20].

The similarity is measured using statistical method (correlation coefficient) and the most similar character is obtained before the number is predicted. The correlation coefficient is measure between a numbers of known images with the same size of unknown images to find the best match of image based the highest correlation coefficient value. There are 2 types of correlations, which are Auto-Correlation Function (ACF) and Cross-Correlation Function (CCF). The ACF involves only one signal and provides information of the signal in the time domain. However, the CCF measures the similarities between two signals. In this

work, there are 2 signal which are unknown input image and known template image, therefore the cross-correlation is used to measure the similarities of two signals.

Let $F_1(j, k)$ and $F_2(j, k)$ for $1 \leq j \leq J$ and $1 \leq k \leq K$ represent two discrete image denoting the image to be searched and the template respectively. The normalized cross-correlation between the image pair is defined as for $m=1,2,\dots,M$ and $n=1,2,\dots,N$, where M and N are odd integers.

$$R(m, n) = \frac{\sum_j \sum_k F_1(j, k) F_2(j - m + \frac{M+1}{2}, k - n + \frac{N+1}{2})}{\left[\sum_j \sum_k |F_1(j, k)|^2 \right]^{1/2} \left[\sum_j \sum_k |F_2(j - m + \frac{M+1}{2}, k - n + \frac{N+1}{2})|^2 \right]^{1/2}} \quad (1)$$

According to [18], there might be some error during the recognition due to the similarities of some characters such as B and 8, E and F, D and O, S and 5, Z and 2.

3.2. Split and Merge Segmentation

Split and merge segmentation technique aims to partition a digital image into multiple region to restructure image representation into a meaningful information which is easy to analyse. The image area is divided into smaller uniform areas and these smaller areas are again combined to indicate the area of interest [21-23]. There are 4 steps involve in split and merge algorithm which are (a) Divide any area R_i into four equal areas, (b) Divide the area continuously until there is no area left, (c) combine any two areas R_i and R_j for which $P(R_i \cup R_j) = \text{TRUE}$. Then (d) continue combining until there is no area left for combining [19].

The major disadvantages of split and merge algorithm is lacking of instruction on the selection of features, highly depending on limit values for both splitting and merging, as well as requires a large number of computations. However, by combining these two techniques, the system is able to minimize the disadvantages of each technique. Besides that, these techniques are much simpler than other methods and easy to comprehend.

4. PROPOSED ADLP SYSTEM

Figure 2 shows the block diagram of the proposed ADLP system, whereby the input image is captured using a camera based on Red, Green and Blue (RGB) format. The quality of the camera should be high in order to get the proper recognition of characters. Next, the license plate is obtained from the original image and focussing on the plate number. After completing the segmentation stage, the characters is detected using the template matching in OCR technique.

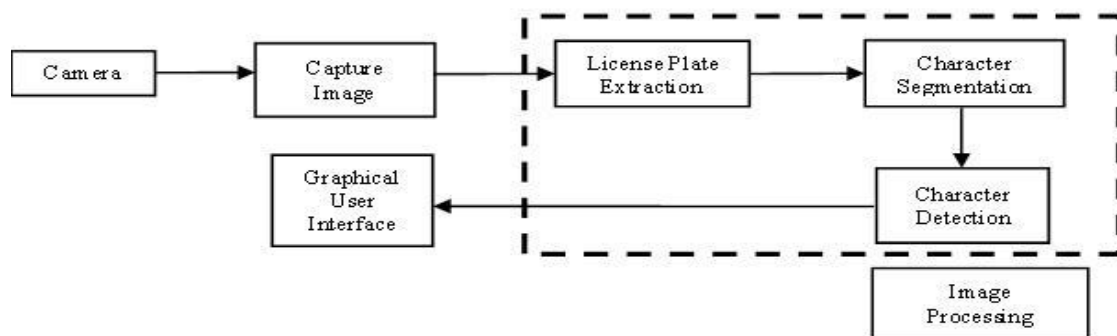


Figure 2. Block diagram of the proposed ADLP system

Figure 3 shows the flowchart of proposed ADLP system that is implemented in this work. The system starts with image acquisition, where a digital image is obtained through a digital camera or webcam. The system will be activated only if it is detected a car parking illegally at 'NO PARKING' zone or at the disable parking area. The captured image is later converted the existing RGB image into gray scale format using MATLAB software. In preprocessing stage, the noise on the image is eliminated, while the contrast or the features of the image is enhanced. The techniques involve in the preprocessing stage are gray processing, median filtering and license plate detection/extraction. Once the input image detection completed, the image is identify before the license plate can be extracted from its original image. In the

character detection and recognition stage, the license plate area obtained will be processed and divided into the smallest area in order to segmentise each of the characters. Finally, the output of character, which refers to the license plate number, will be shown on the Graphical User Interface (GUI) for user references.

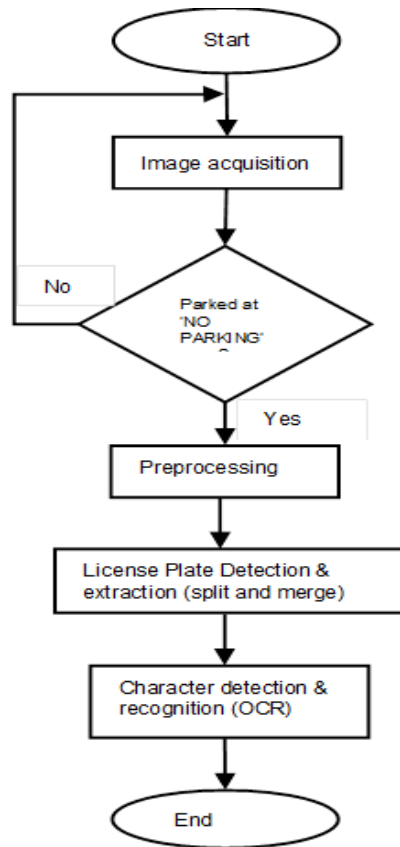


Figure 3. Flowchart of the proposed ADLP system

Since the proposed system is a combination of both techniques, the hybrid process is happened at the license plate detection and extraction steps, once the license plate is detected and extracted from the original image, the merge and split segmentation techniques triggered to merge and split them into a small region. The system continued detected each character on it then using the template matching in OCR techniques to recognize the characters on the license plate.

5. RESULTS AND ANALYSIS

5.1. Optical Characters Recognition (OCR)

Table 1 shows the results obtained using Optical Character Recognition (OCR) technique. From seven images, five images are from the license plates that are attached with the car body while the other two images are entirely the license plates. The system managed to detect the characters successfully except for the fifth images due to the darker image, which causes the characters are unidentified. While for the image of license plate only, the system is unable to recognize all the characters due to the character might be not matched with the template. Therefore, the recognition depends on the input image quality.

5.2. Split and Merge Segmentation

Table 2 shows the results obtained using split and merges segmentation technique. According to the results, the detection of license plate number is greatly affected by the distance between camera and target of the input image. If the input is at a certain distance from the camera and the fuzzy image is captured, therefore, the characters are difficult to be segmentised.

Table 1. Results of the Simulation using OCR

























Image of License Plate (input)	Character extraction	License Plate Recognition
		Successful Recognition
		Successful Recognition
		Successful Recognition
		Unsuccessful Recognition
		Successful Recognition
		Unsuccessful Recognition

Table 2. Result of the Simulation using Split and Merge






Input Image	Output Image	License Plate Detection & Extraction
		Successful
		Successful
		Successful
		Unsuccessful
		Successful but blurred
		Successful but blurred

5.3. Hybrid OCR and Split and Merge Segmentation

The results are analyzed based on the distance and the angle of the license plate [24]. Different license plate from above results has been used to show the relation of the factors with this technique. Table 3 shows the simulation results from the images of the license plate that are taken at various distances. The readings are observed for 10 times at each distance between 20 cm to 100 cm. This analysis is performed




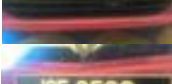

to determine the effectiveness of the proposed technique while detecting the license plate at different distances. From the results obtained, it can be seen that the system only capable to detect the license plate at the distance below 40cm, however the characters are not accurately recognized. The detection is unsuccessful for the distance more than 40cm due to the fuzzy image and characters are unable to be segmented.

Table 3. Simulation Results of the Proposed Technique based on Distance

Input image	Distance (cm)	License plate detection	Efficiency %
	20	JHY4032	85.71
	40	KY4	28.57
	60	Unsuccessful	0
	80	Unsuccessful	0
	100	Unsuccessful	0

The system is later observed in terms of five different angles of captured image as shown in Table 4. The images are captured at the angles of 22°, 45°, 90°, 135° and 157° degrees. The readings are taken more than 10 times at each angle. The results show the system is able to detect the license plate number only at 45°, 90° and 135° degrees. However, the detected license plate numbers are not accurate due to the character not segmented well, which leads to the system displays wrong characters on the screen panel. While the images taken at 22° and 157° degrees, are unable to detect the license plate due to the regions of image were failed to fill during extraction process.

Table 4. Simulation Results of the Proposed Technique based on Angle

Input Image	Angle (°)	License plate detection	Efficiency %
	22	Unsuccessful	0
	45	Y4	28.57
	90	JQF8A	57.14
	135	QF85	57.14
	157	Unsuccessful	0

6. CONCLUSION AND RECOMMENDATIONS

As the conclusion, the Automated Detection of License Plate (ADLP) system is developed to detect Malaysia license plate number using hybrid OCR and split and merge segmentation techniques. The performance of each technique has been analysed and a hybrid technique has been proposed which merge both techniques to get better performance. The system is considered successful to recognize and detect the input images, however there are some difficulties occur during the simulation stage whereby the proposed system is unable to detect the input due to certain reason such as the character not segmented well and the regions of image were failed to fill during extraction process. For instant, when the image of license plate number is fuzzy, the characters sizes on license plate number are small which causes an error during processing stage. The distance between camera and plate number also plays an important role to reduce the possibilities of error during processing stage. Future works can be done to detect the license plate number during nighttime [25] or raining day [26]. From the field test done, the system is unable to detect the input image in dark condition; therefore an improvement is needed on this factor, which could increase the efficiency of the system in future. A high-resolution camera also needed to produce a better image sample. Finally, by using the proposed hybrid technique, it is expected that the system is able to produce more accurate result for license plate number detection.

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