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Adaptive Bounding Box Searching Method Implementation for the Character Number Motor Vehicles Analysis

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Abstract:- Motor vehicle license plate detection system based on mobile is a motor vehicle license plate area detection system by using smart phone with windows phone operating system version 7.5. The pictures taken by smart phone camera are processed with high-pass convolution in order to get character objects on license plate. The outcome of convolution further is marking license plate's character candidates with adaptive bounding box searching method. License plate's character candidates obtained will be selected again to form a vehicle license plate. In this research 150 image samples were tested, where 50 images were tested with image taken distance of 1 – 1.5 meter, 50 images were tested with image taken distance of 1.5 – 2 meter, and 50 images were tested with image taken distance of 2 – 2.5 meter. From the research it was obtained that the highest success rate was at image taken distance of 1.5 – 2 meter which was 90%.

Keywords:- PCD, vehicle detection plate, adaptive bounding box searching

I. INTRODUCTION

The vehicle license plate is one of identification types of motor vehicle. The shape of vehicle's plate is in the form of metal or plastic piece mounted in motor vehicle as formal identification. The mounting of vehicle's plate usually mounted in the front or in the rear of the vehicle. Plate's numbers have certain serial numbers constitutes of special arrangement of letters and numbers integrated with the information of related vehicle. The arrangement of these letters and numbers in Indonesia is called police's numbers[8]. All the data is covered in motor vehicle registration letter which is the evidence document of vehicle ownership.

The progress in the field of computer technology brings about many benefits for humanity. One of it is in the field of digital image processing which is widely utilized as a technique in detection and recognizing an object in a digital image or in a digital video[7]. Motor vehicle license plate detection system is one of the applications in object recognition technique of an image[3].

The technology of portable computer currently is widespread in public such as smart phones. The processing speed of smart phone's microprocessor also is increasing significantly. Along with the development of portable computer's hardware, the development of operating system is also increasing rapidly. Motor vehicle's plate can be easily captured with common smart phone's camera so that is not required to use special equipment such as earth's surface image capture[5]. Motor vehicle's plate in Indonesia has standardized dimension constitutes of colour composition, length, and width of license plate so it is possible in detection of motor vehicle license plate[8].

The initial stage prior to the implementation of motor vehicle license plate detection is the image capture by digital camera on smart phone. To simplify the detection of vehicle license plate, the image taken using smart phone at least should be perpendicular with the vehicle plate object and using the specified distance, the capture of vehicle plate object image also should not be blocked or covered by other object. The detection will be difficult to conduct if inside the image there are a lot of writing objects similar to the writing on vehicle plate. The process of image or object capture from hand phone's camera also is instrumental in the detection of motor vehicle license plate[3]. Moreover, background color and vehicle plate's writing also greatly affecting the ease of vehicle plate detection. Based on the problem mentioned above can be formulated several issues as; how to create motor vehicle license plate detection system based on mobile, and how is the performance of motor vehicle license plate detection system based on mobile.

The objective of this research is to create a software system to perform a detecting or the searching of motor vehicle plate area on digital image obtained from the outcome of mobile device's photo in the form of smart phone which is widely available in public and can be done anywhere (portable). Moreover, the benefits that can be provided from the preparation of this this research such as the system that will be created is expected to be able to produce a motor vehicle license plate detection system based on mobile and performs a cropping on vehicle plate that being found, can be used as a stage of vehicle plate recognition system or plate recognition, and can be used to collect data of vehicle plate automatically from the result of smart phone's camera photo.

II. RESEARCH METHOD

The research method is conducted by using the image on motor vehicle license plate's object obtained with mobile camera of capture camera mobile device with the distance range of capture from 1 to 2.5 meter and perpendicular position to vehicle plate's object. The outcome of image obtained further subject to be tested such as resizing, gray-scaling, High Pass Convolution, binary thresholding, which will simplify in the detection process of motor vehicle license plate[3]. The searching process of vehicle plate location conducted by searching process of pixel by pixel which qualifies as a feature of vehicle license plate in order to obtain output cropping of motor vehicle license plate.

Considering the extent of existing problems then in this discussion will be confined several issues such as: The capture of vehicle plate image performed in the distance range that has been specified before that is from 1 meter to 2.5 meter and image capture should be motionless, so that will not produce blur or fuzzy effect. Vehicle plate that will be detected or searched should be facing perpendicular with smart phone's camera and is not blocked by the other object. Vehicle plate that will be detected is a legal vehicle plate from One Roof System Office, without changing physical form or modifying vehicle plate. The type of vehicle plate that will be detected is non public (personal) vehicle plate, and government vehicle license plate.

The analysis flow of the research conducted are: Problem defining of the application that will be made to increase the understanding regarding the issue. From this defining can be obtained several problem formulations and the data collection related to a system design and creation. Understanding of the occurring processes, so that a data modeling can be performed. The making of software which being implemented on desktop and running on mobile windows phone 7.5[5]. The testing for software which has been made to insert several data samples and try the software on several mobile Windows phone 7.5 devices. To draw the conclusion to find out the result of research and provide suggestions for the development of further applications.

III. RESULT AND DISCUSSION

License plate detection process is starting from capture image, resizing, gray-scaling, high pass, thresholding, character detection on test image, the marking of license plate's candidates, the selection of vehicle license plate, object cropping of vehicle plate and delivery process of plate image to the computer. Capture image process is conducted by using the camera on smart phone Nokia Lumia 710 Windows phone 7.5 devices[4]. Image resize is an image resolution changing process (height and width dimension) to be the desired resolution. Resize is performed due to the limitation of hardware resource on Nokia Lumia 710 device. Resize process is starting from opening and displaying test image on Picture Box with specified dimension (height = 335 pixels and width = 447 pixels). Test image has 3 (three) color spaces that is Red, Green and Blue. Image processing on 3 color spaces will consume a lot of hardware resources on a mobile device, therefore test image's color is altered first to be a grayscale image. Grayscale process is an average of the value of three color spaces of R, G, and B, so that the further process is enough to use one of those color spaces.

Detection of vehicle license plate is conducted by the searching of license plate writing's object in the image. The amount of white color in test image will make the searching takes a longer time, therefore a process is performed to sharpen only the edge of the object by using High-Pass method. The using of high-pass kernel in the picture above will make the outcome to be minus or more than gray limit (255), therefore the result of convolution by using high-pass kernel is made with minimum limit of pixel value at 0 and maximum limit of pixel value at 255.

In order to obtain binary image with value of 0 or 255, it is necessary to do thresholding to the grayscale image mentioned above. Thresholding process is conducted by means of altering pixel value smaller than threshold value to become 0 and the pixel greater than threshold value to become 255[1]. Thresholding process is crucial to do since the license plate detection process is conducted in binary image.

Motor vehicle license plate is containing letters and numbers. Character detection is performed by using reversed L filters. Reversed L filters will check horizontal position (first stage) if pixel value exists continued with checking vertical position (first stage) if in this position also pixel value exists then this position is the starting point of a character candidate. Furthermore to determine the height of character candidate by way of shifting the filter of horizontal section downward until pixel value is not found[3]. The final stage is to determine character's width by way of shifting the filter of vertical section to the right until pixel value is not found. Character's width in vehicle license plate certainly will not exceed character's height, if the width found exceeding character's height then this object is not license plate's character.

The marking of license plate's candidate is conducted by way of comparing ordinate position (Y) of the adjacent characters. As for the requirements that must be fulfilled among others: The difference of ordinate's (Y) character and adjacent character not exceeding from the specified value. The distance width between adjacent characters should not exceed 2 times of character's height. The plate's candidate that fulfills the requirements will be marked and recorded.

The selection of vehicle license plate's candidate is performed by way of comparing with legal vehicle license plate. Comparison process between test license plate's candidates and legal license plate is conducted with the stages as follows:

1. To calculate the pixel's height and width of motor vehicle license plate manually to obtain reference value.
2. Next stage is to calculate the height and width of each candidate found. The image of license plate's candidate number 1 has the dimension of height by 17 pixels and width by 20 pixels, whereas the image of license plate's candidate number 2 has the height of 13 pixels and width of 75 pixels.
3. Further stage is to calculate the magnitude of difference between legal license plate which processed manually and license plate's candidate obtained by the system.
4. The final stage is to determine the license plate's candidate. The defining of license plate's candidate is conducted by comparing tolerance value obtained in previous stage with tolerance threshold value of vehicle license plate. The greater the tolerance value of a license plate's candidate the greater the accuracy level as a license plate. The calculation performed in the previous stage, the size of license plate's candidate number 1 is not fitting with the size of legal license plate, where tolerance value of license plate's candidate number 1 is at 327, whereas license plate's candidate number 2 is closing to the size of legal license plate with tolerance value is at 13.2.

Cropping process is the final process in detection of motor vehicle license plate. Cropping process is conducted in accordance with motor vehicle plate's object coordinate. Vehicle license plate's object which lopsided or not aligned will do rotation process to align motor vehicle license plate's object. Rotation process of motor vehicle license plate's object is performed to align motor vehicle license plate's character. The magnitude of slope degree can be found by using trigonometric formulas[3]:

$$\boldsymbol{a^2 = b^2 + c^2 - 2bc\ cosA} \qquad \boldsymbol{cosA = \frac{b^2 + c^2 - a^2}{2bc}}$$

or

$$b^2 = a^2 + c^2 - 2ac\ cosB \qquad \boldsymbol{cosA = \frac{a^2 + c^2 - b^2}{2ac}}$$

or

$$c^2 = b^2 + a^2 - 2ba\ cosC \qquad cosA = \frac{b^2 + a^2 - c^2}{2ba}$$

Considering that the research's result data of license plate detection system is also used in motor vehicle license plate recognition system, then in motor vehicle license plate detection system based on mobile is provided with the process to deliver the image of motor vehicle plate to personal computer (PC). Windows phone does not provide file transfer protocol facility so that data delivery to computer is using socket facility provided by Microsoft[5]. The image of vehicle license plate's object which has been found is processed by cropping process, gray-scaling process, storing height data of a license plate, storing width data of a license plate and storing all the pixels' value on the image of motor vehicle license plate's object. Obtained data is converted to become text and sends to the computer using socket. Data received by the computer is rearranged to become a digital image to be stored. The following is the receiving process on personal computer. Recognition system of motor vehicle license plate further is processing the image to perform character recognition to the image, where the outcome of character recognition is stored in the form of text file. Simultaneously on the mobile device side is waiting for the text file to be downloaded.

A. The Outcome of System Testing

Threshold or test image threshold is a 2 colours image namely black and white. It is required 1 bit in memory to store both. Binary image is an image which already passed through pixel separation process based on gray scale degree owned. The forming of binary image requires gray limit value which will be used as a reference value. Pixel with gray scale degree greater than threshold value (T) will be given the value of 255 and in contrary pixel with gray scale degree smaller than threshold value (T) will be given the value of 0. The testing of motor vehicle license plate detection system is performed with 3 (three) threshold values (T) namely T = 96, T = 127, and T = 150. From test result the outcome is obtained as follows:

The outcome of each object's testing with varied threshold values (T) has different accuracies which impacting on the success of motor vehicle license plate detection. The magnitude of accuracy value not necessarily is a motor vehicle license plate. The accuracy of test result finds a minus value, due to plate's candidate is too much differed with reference plate's object. Accuracy value in the table above also contains "x" symbol, means that vehicle license plate's candidate is not found in test image, so that accuracy searching can not be done[3]. Figure 1 shows the average of values concluded by using threshold value of 127 and the distance of image capture from 1.5 to 2 meter it is obtained the largest license plate area that is at 90%. It is due to the distance of image capture from 1.5 to 2 meter, the distance between characters on vehicle license plate clearly visible and supported with threshold value of 127 making both the information of license plate's character object and background object not huddling each other. The distance of image capture from 1 to 1.5 meter with

threshold value of 96 making character object huddling with other character object and with background object, meanwhile the distance of image capture from 2 to 2.5 meter with threshold value of 150 making a lot of information in the image lost so that the marking of license plate's character is failed to be done.

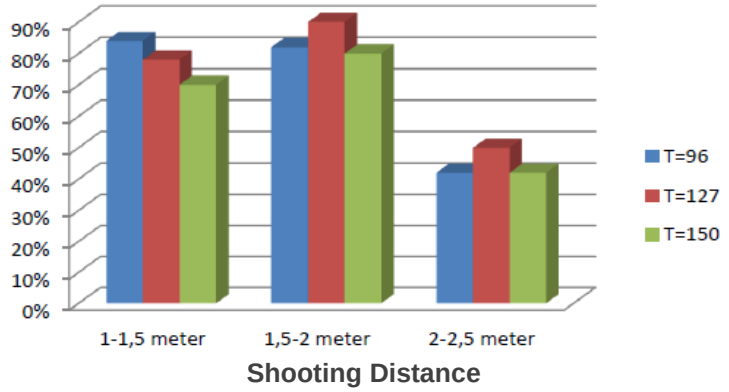

Figure 1. Comparison graphics of threshold values.

Character position on motor vehicle license plate's object obviously will not differ much with other character object. Position tolerance of each character will be crucial whether the group of such character objects constitutes vehicle plate's objects or not. Variation of values which used in this comparison is between 0 pixel, 5 pixels, and 10 pixels. The greater the tolerance value is, then the greater the difference of position's height gap between characters which being received as motor vehicle license plate's candidate. The test result of each object with difference value variation of character position's height has different accuracies impacting on the success rate of motor vehicle license plate detection. The magnitude of accuracy value is not necessarily a motor vehicle license plate. The accuracy of test result finds a minus value, due to plate's candidate is too much different with reference plate's object. Accuracy value in the table above also contains the symbol of "x", means vehicle license plate's candidate is not found on test image, so that the searching of accuracy can not be done.

Figure 2 can be shows the average of values concluded by using difference value of character position's height 5 and the distance of image capture from 1.5 to 2 meter it gets the largest license plate area that is at 90%. Difference value of character position's height 10 is making the non character object located next to the plate also joining to become vehicle license plate's candidate, so that when tested with reference plate, accuracy becomes exceeding tolerance limit. Whereas difference value of character position's height 0 requires each character candidate found is in parallel with other character candidates. The result of system testing with tolerance of 10%, 20%, and 30% is providing different accuracies. This tolerance value aims to compare the differences between test vehicle license plate's object with vehicle plate's object specified manually. The result of each object testing with tolerance value variation has different accuracies impacting on the success rate of motor vehicle license plate detection. The magnitude of accuracy value is not necessarily a motor vehicle license plate. The accuracy of test result finds a minus value, due to plate's candidate is too much differed with reference plate's object. Accuracy values in the table above also contains "x" symbol, means that vehicle license plate's candidate is not found on test image, so that accuracy searching can not be done.

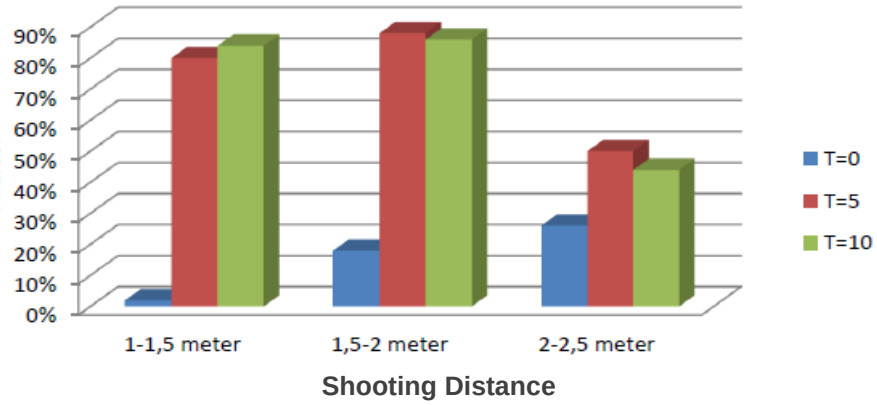

Figure 2. Comparison graphics of difference values of character position's height.

Graphics comparison in Figure 3 shows the average of values that concluded by using tolerance value of 30% and the distance of image capture from 1.5 to 2 meter it gets the largest license plate area that is at 88%.

Motor vehicle license plate's candidate found has different accuracy with other vehicle license plate's candidates, starting from 100% which means perfect (equal with reference plate) up to minus which means very much differed with reference plate. Tolerance value of 30% provides more leniency for vehicle license plate's candidate, can be assumed that accuracy value of license plate's candidate at minimum of 70% to be categorized as a license plate. Tolerance value of 20% is smaller than tolerance value of 30% leads to the accuracy of license plate's candidate to be below 80% and is ignored by system, so that if there is a license plate's candidate having accuracy below 80% it will not being processed further (failed), as well as tolerance value of 10% where the minimum accuracy of vehicle license plate is at 90%.

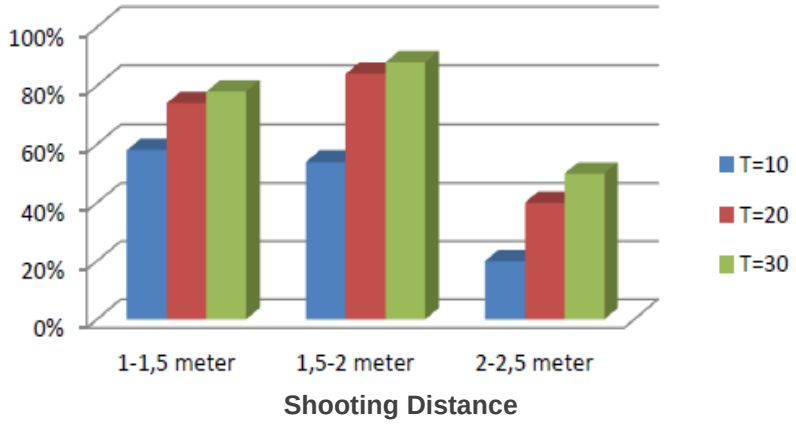

Figure 3. Graphics comparison of the system testing with values of tolerance and distance taking

B. Result Analysis

From several system testing that being conducted, can be concluded that some parameter values which being used are very instrumental in the system success to detect motor vehicle license plate. System testing that has been conducted by using good threshold value is at 127.

The value of T = 127 making character object on license plate is marked neatly, no more character candidate which being marked in the left and right side of vehicle license plate's object. Thus license plate's character object allows the mistakes or errors to be suppressed. Binary threshold value of T = 96 is seemed to leave a lot of pixels on test image so that making considerable character candidates for vehicle license plate, even objects behind vehicle license plate also marked as character candidates. Binary threshold value of T = 150 is seemed in the picture above too much eliminating character objects on the license plate, objects behind vehicle license plate also being marked because the object underlining being cut off due to threshold value being too big, so that the object which has the same criteria also being marked. Further system testing is to compare the variation of difference value of character position's height. The object's position in the motor vehicle license plate is not all being perpendicular. The tilt in vehicle license plate's object is impacting the difference in character position of vehicle license plate. Test result conducted by using value comparison of height differences of character position at 5 pixels shows the highest accuracy. From the graphic of test result above shows that with value comparison of height differences of character position at 10 pixels is less accurate. Excessive height differences of character position is making too much non character objects in the plate takes part to become vehicle plate's character object candidate, so that vehicle license plate becomes long.

Meanwhile by using value comparison of height differences of character position 0 requires each vehicle license plate's character to be parallel in order to get motor vehicle license plate area. The last system testing is to check tolerance value on license plate's candidate by way of subjectively (manual reasoning). This test is using the comparison of height and width of test plate compared to height and width of manually counted plate. From test result that has been conducted, with tolerance of 30% system accuracy is very high compared to tolerance value of 10% or 20%. It is due to tolerance of test plate's candidate obtained lies over 20% or the accuracy of license plate's candidate lies below 80% so that the system ignores it to be processed.

IV. CONCLUSIONS

Based on discussion elaboration and result analysis can be concluded several issues suc as; this research has successfully performing detection of motor vehicle license plate on the Nokia Lumia Windows phone 7 devices. The processes which being conducted in detection system of vehicle license plate consisting high-pass, binary process, character detection of motor vehicle license plate by using Adaptive size bounding box searching, searching for the candidate of motor vehicle license plate, comparing the candidate of license plate with reference license plate, cropping, and sending text data of vehicle license plate. For the best threshold

value to change an image to become good binary image is 127, the best magnitude of value for height difference of character position is at 5 pixels, and the best tolerance value of testing the candidate of vehicle license plate is 30%.

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