Vehicle Seat Vacancy Identification using Image Processing Technique

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***Abstract*— Image processing technology is very popular at present. It can be applied to various applications for detecting and processing the digital images. Face detection is a part of image processing. It is used for finding the face of human in a given area. Face detection is used in many applications such as face recognition, people tracking, or photography. In this research, face detection technique is used for detecting and counting the number of passengers in electric vehicle via webcam. The webcam is installed in electric vehicle and connected with Raspberry Pi 2 model B. When electric vehicle leaves from the station, webcam will capture passengers images in the seating area. The images will be adjusted and improved to reduce the noise which is done by software application. The images are sent to the server via 3G communication. Then, the server process the images by using face detection technology and counting the number of passengers in electric vehicle. The system obtains the maximum number of passengers in electric vehicle that process through the images then calculates the seat vacancy of the electric vehicle.**

Keywords—Face detection, Haar-like features, Morphological image processing, Contrast limited adaptive histogram equalization

I. INTRODUCTION

Nowadays, most people use public vehicle instead of personal car due to the rising of gasoline prices and traffic jams. Public company has been developing the system for displaying the position of the passenger vehicle for convenience of customers. However, those systems only indicate the position of the vehicle but not show the availability of seats in the vehicle. Customers will waste a time for waiting the next passenger vehicle and cannot manage the time travel or activities correctly. If customers know both of the position of the passenger vehicle and vacancy of seats, customers can use the time to other activities before the passenger vehicle arrives. Customers can plan their travel better.

In this research, the seat vacancy identification system is designed by using image processing technique. Webcam is connected with Raspberry Pi 2 in the electric vehicle for detecting the object on vehicle and sending the data to the server via 3G communication. This system use Open Source Computer Vision (OpenCV) to analyze and process the data then calculated the vacancy of the electric vehicle by using the maximum face detection data.

II. LITERATURE REVIEW AND RELATED THEORY

"Real-Time Integrated CCTV Using Face and Pedestrian Detection Image Processing Algorithm for Automatic Traffic Light Transitions", this research studies the traffic light for pedestrian that wants to cross the street. If the pedestrian cross the street they press the button and wait for traffic light. This system use CCTV instead the button and use image processing for detecting the face of pedestrian. If CCTV detects the face of pedestrian, the system will set the red light to show for 45 second. On the other hand if CCTV does not detect the face, the red light will show for only 30 second. [1] "Analyzing Impact of Image Scaling Algorithms on Viola – Jones Face Detection Framework", this research studies the Viola – Jones algorithm about the problem from low quality of the image and find the optimize solution from Viola – Jones algorithm. The system uses two methods to scaled image that are window scaling and image scaling. The image scaling has 5 techniques that is Nearest Neighbor, Bi-Linear, Bi-Cubic, Extended Linear, and Piece-Wise Extended Linear. The system uses 5 difference face database for comparing the performance of 5 different image scaling techniques. The system was developed by using C++, Visual studio 2010, and Open Source Computer Vision (OpenCV). They used confusion matrix that compose of True Positive, False Positive, and False Negative to evaluate the performance of each technique. From the result, they found that the analysis in format of the window scaling is better than image scaling. [2] "FACE DETECTION USING COMBINATION OF SKIN COLOR PIXEL DETECTION AND VIOLA-JONES FACE DETECTOR", this research studies the detection of the human skin. It uses a combination of two techniques that are a novel hybrid color models and Viola – Jones algorithms. Its purpose is to identify the object is human or not. The system is designed in MATLAB and use ECU face and skin database to evaluate the accuracy. From the result, this method has high performance more than another. When use this method with Viola – Jones face detector, it will be more efficient. [3]

A. Haar-like features

Haar-like features are a popular technique for detecting the face of human in the present. They are a method that has fast processing and high accuracy. The method is proposed by Paul Viola and Michael Jones in 2001. [4] Algorithms of Haar-like features are separating the image from input image to the sub-

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window and scanning for detecting the face. They use integral image technique for finding the summation of the pixel inside the image, and then use the detector that can change the size and the position for finding the difference of white and black areas. When finish from integral image process, the next step is calling Adaptive Boosting or AdaBoost. This process is the data classification by increasing weight to the classification of a face until the best face detected. Determine A_i is classification by i = {0, 1, 2, 3,…, n}, the process starts from A_0. The classification of A_0 may be less accuracy. If finish from the process of A_0, AdaBoost will increase accuracy of the classification and create the new classification that is A_1. This process will do continuously until the final classification A_n and end the process. The last step is Cascaded Classifier. This step separates the image to sub-window and check the sub-window for finding the face. If a sub-window is not a face, it will reject the sub-window. If the sub-window has a chance of having human face, it will go to the next classifier that increases the weight of classifier. This step will find the face from the sub-window until get the best of face detected.

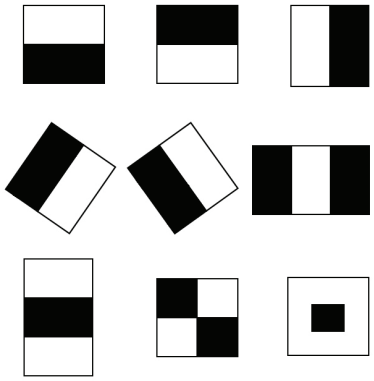


Figure 1: Type of Haar-like features

B. *Contrast limited adaptive histogram equalization or CLAHE*

Contrast limited adaptive histogram equalization or CLAHE is the process for increasing the image quality. This process is developed from adaptive histogram equalization. This method considers the data of histogram equalization in each of pixel of gray scale format. In the first step, this method finds average histogram value of the image. The method uses the histogram value that has higher than the average value to share to all pixels inside the image for equal histogram value. [5]

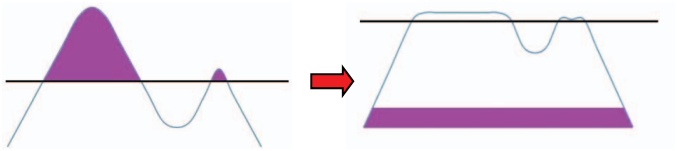


Figure 2: Contrast limited adaptive histogram equalization method

(A) (B)

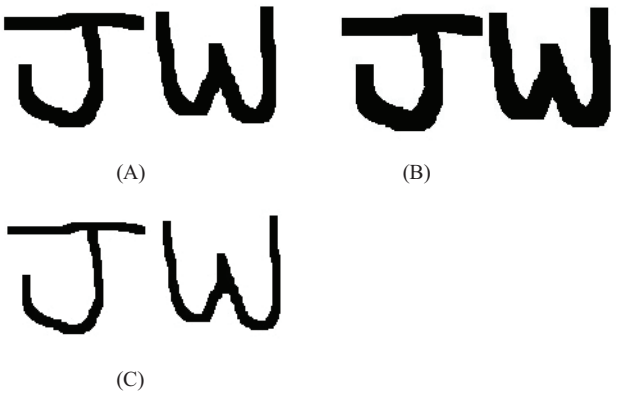
Figure 3: (A) Original image (B) The image from CLAHE process

C. *Morphological process*

Morphological process is the process for changing shape or structure of the image. The process use matrix data that comprise the binary values 0 and 1 for calculation. It is called structuring element. Morphological process has 2 methods that are dilation and erosion.

Dilation is a technique for adding the edge pixel of object. This technique creates the structuring element (set B), then use structuring element to scan the data of image (set A). When the data of image (set A) has some binary data on the image matching with structuring element (set B), the binary data of the image will change by using $A \oplus B = \{x \mid B_x \cap A \neq \emptyset\}$.

Erosion is a technique that is different from dilation technique. It reduces the edge pixel of object by using structuring element (set B) to scan the data of image (set A) same dilation technique. When the data of image (set A) has some binary data on the image matching with structuring element (set B), the binary data of the image will change by using $A \theta B = \{x \mid B_x \subseteq A\}$. [6][7]



(A) (B)

(C)

Figure 4: (A) Original image (B) Dilation method (C) Erosion method

III. METHODOLOGY

The devices that include webcam, Raspberry Pi 2 model B, and 3G module are installed in electric vehicle at the top-front of the electric vehicle. When the electric vehicle leaves from the station, the system will capture the image in the passenger seat area (1 image per 1 second) and send to the server by using 3G communication. The server processes the images that receive from Raspberry Pi in electric vehicle by using Open Source Computer Vision (OpenCV).

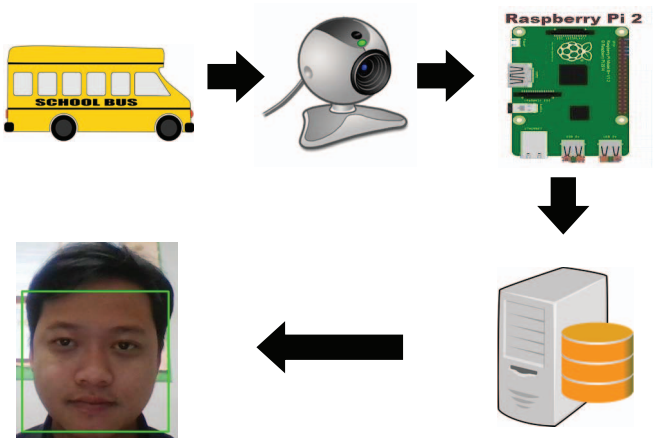


Figure 5: Overview of overall system

The system is divided into two parts. The first part is hardware. It installed and worked on the vehicle. The second part is program on the server. It is used for process the data from hardware. The system work is shown in figure 6.

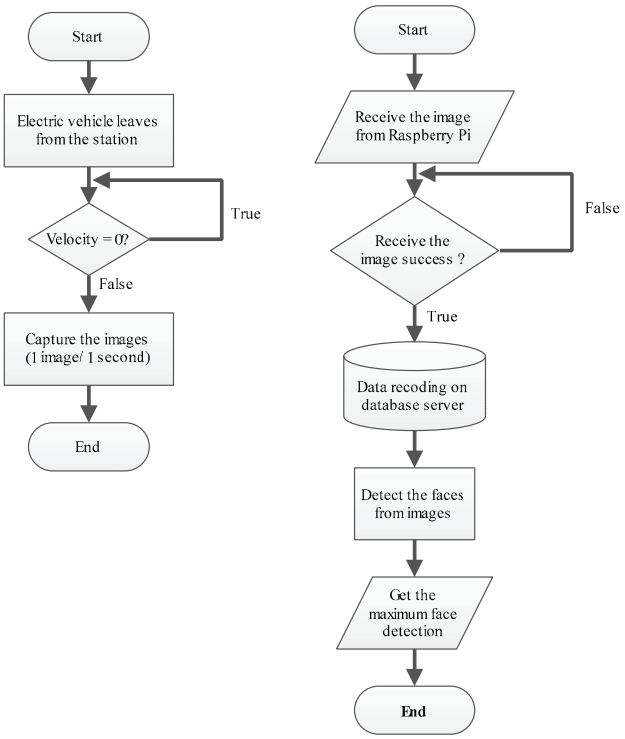


Figure 6: Program flowchart of the system in the vehicle and server

The program has processes to reduce the image noise. It uses method from Open Source Computer Vision (OpenCV). It is shown in figure 7.

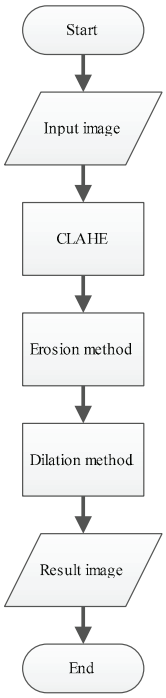
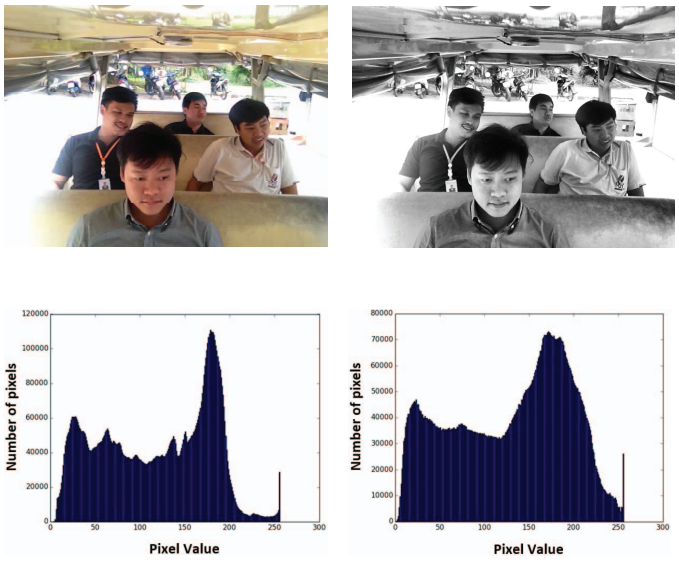


Figure 7: Reducing noise method flowchart

The program use contrast limited adaptive histogram equalization or CLAHE method. This step will adjust the histogram of the image for the appropriate value and change to grayscale format.



Original image CLAHE method

Figure 8: The comparison histogram of original image and the image from CLAHE method

When the system finishes adjusting histogram then the image noise will be reduce by using the morphological process. The image noise is processed by using the erosion method for removing unwanted pixel. Then, the dilation method applies after the erosion method to increase the edge pixel of the image. The result of the face in the image is clearer when compare with the original image (figure 9).

Figure 9: The comparison of original image and the final image result

In the last process, the system will use Haar-like feature algorithm for finding the passengers faces. The system will detect only the face of human by using the face shape. In each image, the result of passengers face detection is not equal. When the process finish, the system will give only the maximum number of the passenger face from all of the images. Finally, the system will use the maximum number of the face detection to subtract with the number of the electric vehicle seat and show the remaining seat of the electric vehicle.

Figure 10: Example of face detection

A. *Result*

The experiment use different number of passengers and experimental time. Three experiments are conducted. The passengers in electric vehicle are not equal in each round. In each experiment uses different number of images to evaluate the accuracy of face detection in electric vehicle. The result of experiment is shown in table I.

TABLE I.

The number of images	**Round 1**		**Round 2**		**Round 3**		**Accuracy (Percent)**
	N_P	N_D	N_P	N_D	N_P	N_D	
5	7	5	8	4	9	5	58.33
50	7	6	8	6	9	6	75.00
100	7	6	8	7	9	6	79.17
150	7	6	8	7	9	6	79.17
200	7	6	8	8	9	8	91.67
250	7	6	8	8	9	8	91.67
300	7	6	8	8	9	8	91.67

* N_P: Number of passengers; N_D: Number of passengers detected by face detection technique.

From the result, the number of images has an effect for face detection. If we use less images, the program will be low performance and accuracy. The program cannot detect the face because the face of passengers is not clear. This problem consists from environment around the vehicle. It makes the images too light or dark. If the number of image is increases (long capturing time), the movement of passenger face is increase as well. The program can detect the face of the passenger better because the program has a more chance to detect the passengers face from many images.

IV. Conclusion

Vehicle Seat Vacancy Identification using Image Processing Technique was designed and tested. Webcam and Raspberry Pi were installed in electric vehicle. When the electric vehicle leave from the station, webcam captured the images and send to the server by using Raspberry Pi and 3G communication. The images were sent completely. From experimental result (Table I), the number of images have a direct impact to the face detection result. If the number of images increases, the accuracy of face detection is increase as well. Because the system will has more chance to detect the passengers face from many images. The noises in images occur from environment inside and outside the vehicle such as the light and face blur. The system improve quality of images by using contrast limited adaptive histogram equalization and morphological process. The system can work well at 200 – 300 images data. It gives 91.67 % accuracy.

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