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Enhancement Face Detection using Viola-Jones and Multi-Block Local Binary Pattern

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Abstract *– The enhancement of face detection that using Viola-Jones and Multi-Block Local Binary Pattern (MB-LBP) features as a replacement Haar-like features in the Viola-Jones algorithm. Due to how important that face detection is for security purposes and potential commercial, this paper proposes a face detector that is able to detect rotated frontal images and high detection accuracy. The experiments prove that Viola-Jones and MB-LBP are recommended for face detection becauseViola-Jones, and Haar-like features only detect frontal image that rotates 0 degrees up to 16 degrees and 345 degrees until 360 degrees. Meanwhile, Viola-Jones and MB-LBP are able to detect rotated frontal images up to 360 degrees. This is due to the fact that MB-LBP is capable of capturing extra details on the image's structure and performs better than Haar-like features.*

Keywords – *Viola-Jones, MB-LBP, rotated frontal image, face detection, Haar-like features*

I. INTRODUCTION

The demand for face detection or recognition increase year by year due to security demand and potential commercial. Viola-Jones algorithm presented by Michael Jones and Paul Viola in 2001 is a detection framework with competitive real-time detection rates. There is various implementation of viola-jones in the different application according to the classism of extracted feature process and selection of the greatest features. Another learning-based that is effective for constructing face classifiers is support vector machines and neural network-based methods[1]. Traditional Haar-like features used in Viola-Jones contain a mass of redundant information. Viola and Jones propose a boosting-based detector as a breakthrough in face detecting research [2]. The benefit of boosting algorithm is a select limited number of distinct rectangle characteristics and compose an effective classifier [4]. The Haar-like feature is a simple feature that needs high-cost computation in test phases and training phases. These Haar-like features are basic but substantial, with thousands of rectangular features. The high number of elected features, the higher the estimation cost during the testing and training stages.

This paper presents an enhancement of Viola-Jones and Multi-Block Local Binary Pattern (MB-LBP) as face detection for rotated frontal images. The function of MB-LBP is to encode the areas that are rectangular by the LBP operator (local binary pattern). Also, calculate the integral image briskly and capture extra details on the image's structure compared to the Haar-like feature. Local Binary Pattern (LBP) features to compute a 3x3 neighborhood between pixels on a local scale; meanwhile, large scale structures that are prominent features of image structures are captured by MB-LBP features.

The entirety of the paper is written as follows. Section 2 is about the literature review of the previous study in face detection using a different method. Section 3 is about the methodology and the process of how the face detector is working. The result and discussion about this face detector are presented in section 4. As a final point, section 5 is about the conclusion and a few discussions for future study.

II. LITERATURE REVIEW

Viola-Jones was a fast and robust method for face detection developed by Jones and Viola, which technique relies on Haar-like features. The attraction of the Viola-Jones algorithm is incompetent detection speed while relatively high detection accuracy, equivalent to a much slower algorithm [5]. Also, Viola-Jones can reduce computation time and improve detection accuracy. Basic Haar-like in traditional Viola-Jones observes the dissimilarity between the average intensity of rectangle regions, which makes the Haar-like feature have some limit.

The Multi-Block Local Binary Pattern feature is encoded rectangular regions by LBP [5]. Rather than individual pixels, the MB-LBP computations were based on average block subregion values and are more robust compared to basic LBP. LBP features are unable to capture the object's most prominent feature. But, by collecting the subregion's micro and macro information, MB-LBP gives a more

comprehensive image representation, and integral images could be used by MB-LBP to compute very quickly. [7]

Table 1 below shows the analysis method that has been used in a previous study. The advantage and limitations of the method that has been used are also listed below.

Table 1: Analysis method previous study

Method	Advantage	Limitation
Dynamic and Global Haar-like features[6]	Supports quicker calculations and adds a different update of worldwide query patches.	
Enhance V-J for scale-invariant feature transform (SIFT) and inappropriate image for image duplicated [1]	The speed and accuracy of performance are better than the original V-J	Limitation of detection on certain rotation
Viola-Jones[7]	high accuracy in detecting the human-object moment	Need better light circumstances on the front face
Integrated form for image frame data representation in Viola-Jones algorithm[4]	Speed and effection of facial recognition algorithm increase and better	The inaccuracy in computing the brightness indicator for the informative region of the face is affected by head rotation.
HAAR-like features in a cascade boosting-based classifier [8]	With a simple basic training set, detect numerous sorts of items.	Due to its fewer positive updates, it does not do well in recall tests.
Enhance Viola-Jones face component detection with a histogram of oriented gradients (HOG) [9]	Combining several categories with a majority vote improved recognition accuracy. Exceptional accuracy in recognizing face components in a variety of pose-changing situations.	
Local Binary Pattern (LBP) [10]	The process take attendance by recognizing face faster, accurate and more reliable	Illumination of the environment, the movement of background and need enough light
Multi-Block Local Binary Pattern is a new collection of distinct rectangular characteristics (MB-LBP) [3]	MB-LBP is more discriminative and capable of capturing more images structure information. The MB-LBP has a smaller set of features. Thus it takes less time to train.	

III. METHODOLOGY

The component that is important in this research is the accuracy of detection on the rotated frontal images and the method that is suitable in order to give the high accuracy detection result. Many factors affect the accuracy and efficiency of the detection, an example, image background, poses, rotation of the image, noise in the image, and facial expression. This research was focused on rotating the image around due to the noise, and the image becomes blurry and makes the face detection process fail to detect faces correctly.

The methodology of this research is shown in Figure 1 below, containing 3 stages: (a) pre-processing, (b) Viola-Jones and MB-LBP operation, and (c) performance indicator. The detailed explanations of each stage are explained in the following sections.

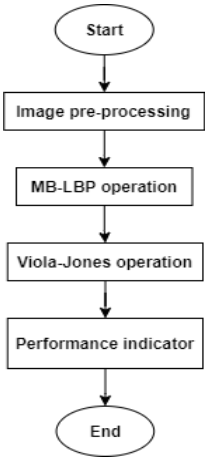


Figure 1: Methodology of face detection

A. Image Pre-processing

Image pre-processing contains three-part: (a) resize an image, (b) convert the image into grayscale, and (c) the rotation process. The original image or input image will be

resized into 250x250 pixels for better results of the detection. When the image is the size that is needed, it will produce a lower data size and hastens the processing or computation time. After that, that image will convert into grayscale because grayscale images do not need to use complicated and harder-to-process color images. The last of image pre-processing is the rotation process, which is the degree of rotation inserted by a user. The rotation process has been used to test the face detector in a rotated image. Figure 2 shows the flowchart of image pre-processing.

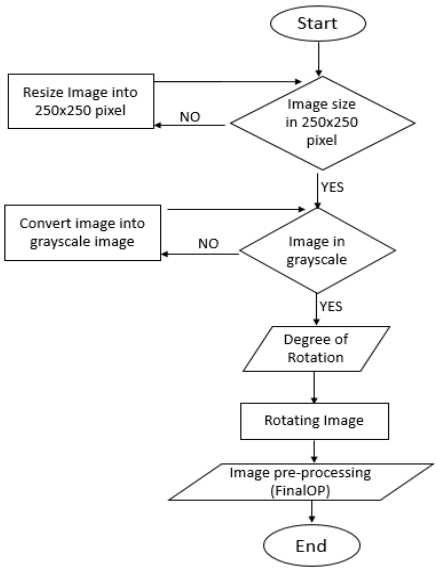


Figure 2: Image Pre-processing

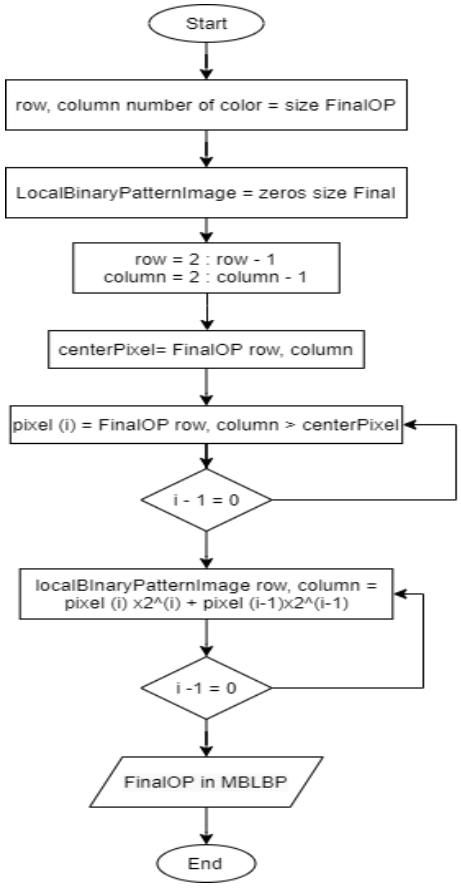


Figure 3: Flowchart of MB-LBP Operation

B. Face Detection Operation Process

The detection operation process used two types of features. The first feature is MB-LBP, and the second feature is Viola-Jones. The MB-LBP's feature extraction involves 7x7 pixels that process pixel by pixel. The technique comprises utilizing the window means, center pixel, or median thresholds to compare the center pixel of that window to pixels in the neighborhood. MB-LBP was chosen as image representation and classification because of the better recognition compared to another method such as using Mahalanobis cosine distance metric [3]. Viola-Jones algorithm is a common algorithm that was utilized for face detection and recognition. Viola-Jones can detect frontal image better than the face looking another side. Figure 3 shows the flowchart of MB-LBP. In process MBLBP, every row and column of extraction is the same as Final OP (image after preprocessing) before the extraction pixel by pixel. The center pixel of extraction is the same FinalOP as a threshold. The extraction of each pixel until zero pixels. Then, the total of MBLBP row and column is a total of pixel use this formula pixel (i)×2^7 + pixel (i-1)×2 ^7 until i equal to zero. The Final OP in MBLBP as a result.

Figure 4 shows the flowchart of Viola-Jones. Final OP (image after MBLBP process) convert in bit binary before the process of Viola-Jones cascade object detector. Then, the Final OP is cropped and in grayscale.

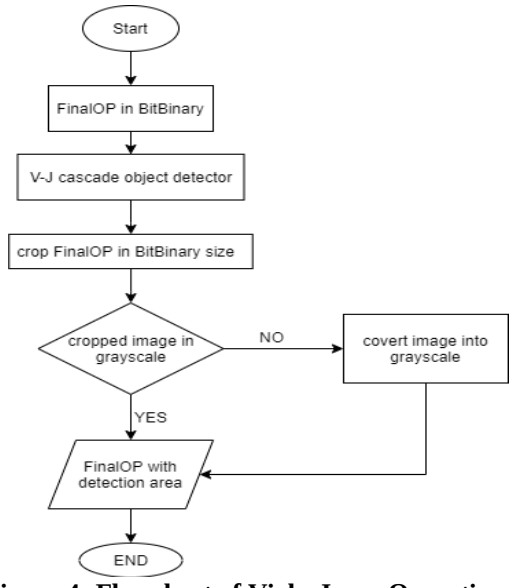


Figure 4: Flowchart of Viola-Jones Operation

B. Performance Indicator

The performance indicator that has been used in this experiment is a peak signal-to-noise ratio and accuracy rate. All the performance indicators were used to see the difference of the performance from the traditional Viola-Jones and the enhancement of Viola-Jones in face detection. The formula of peak signal-to-noise ratio (PSNR) is $PSNR = 10 \times \log 10\ (\ 256^2\ /mse)$. The formula of detection accuracy rate that uses is $Detection\ accuracy\ rate = [100 - (false\ positive/total\ test\ image \times 100)]$.

C. Development of Face Detector

This face detector develops using Matlab R2020b academic that can use for any application such as mathematical calculation, software design, and others. The frontal image that has been used for a rotated image is from Carnegie Mellon University (CMU) dataset, and the image can be in color or grayscale. Figure 5 below is an interface of the face detector that developed and has been used in this research.

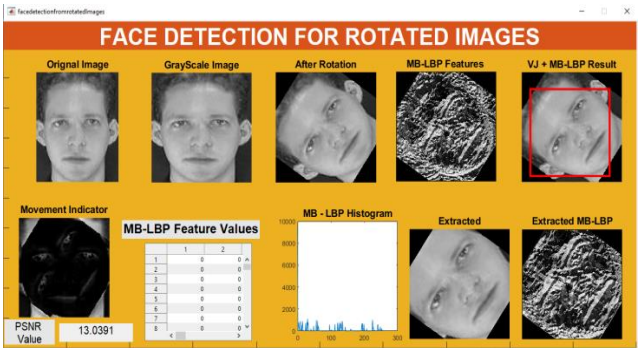


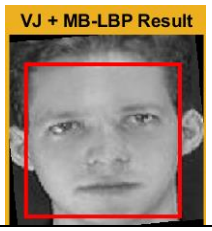
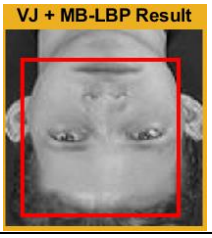
Figure 5: Interface of Face Detector

IV. RESULT AND DISCUSSION

In this experiment, using Viola-Jones and MB-LBP features in the face detector for the rotated image can detect faces at 0 degrees until 360 degrees, and the detection accuracy is 100%. Meanwhile, using Viola-Jones and Haar-like features in the face detector for the rotated image just can detect faces at a certain degree of rotations such as 5degrees, 16 degrees, 120 degrees, and that makes the detection accuracy only 30%.

Table 2 is an example of the result by using Viola-Jones and MB-LBP features in the face detector for the rotated image. Meanwhile, Table 3 is an example of the result by using Viola-Jones and Haar-like features in the face detector for the rotated image.

Table 2: Result Using Viola-Jones and MB-LBP Features

Rotation of Image (degree)	Viola-Jones and MB-LBP features	PSNR Value
5		19.2517
60		13.1515
120		14.147
180		17.3004
240		13.7904
300		13.4583

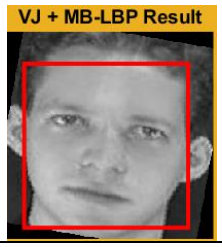
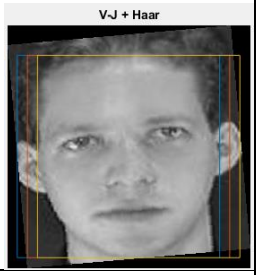
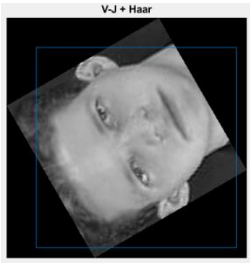
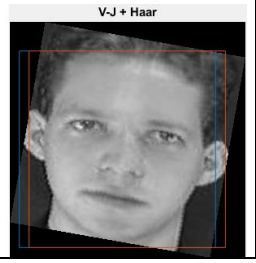
350		16.6015

Table 3: Result Using Viola-Jones and Haar-like Features

Rotation of Image (degree)	Viola-Jones and Haar-like features	PSNR Value
5		9.6258
60		6.5754
120		8.5415
180		9.5025
240		6.8514
300		6.7715
350		8.3007

V. CONCLUSION

The result show this enhancement of Viola-Jones and MB-LBP feature in face detector can detect face better compared to basic Viola-Jones andHaar-like features in face detector. More information regarding image structure can be captured using these features. And make the training process easier. Future work for this experiment, the face detection that been used not limited to frontal image only. Also, improve in the development of the face detector be more simple and effective.

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