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Evaluation Method of Real-Time Face Detection

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Abstract

Object detection is one of computer technology using image or video. Face detection is closely related Image processing and computer vision are used to detect several objects including human faces, landscapes, cars, etc. Face detection algorithm aims to confirm if an image has a face as the object in it. In this study, face detection uses several methods, namely the Eigenface method, the Fisherface method, and the Local Binary Pattern Histogram (LBPH) method. This study used 10 different subjects. The test was carried out 15 times using each face detection method with constant distance. The face detection process in this study was simulated using JupyterLab. The result showed that LBPH method obtained the highest level of accuracy in between comparison among Fisherface method and the Eigenface method. The accuracy of the LBPH method is 93.90%, while the Eigenface method is 85% and the Fisherface method is 53.33%. Differences in face detection accuracy were found due to the low level of lighting in the room and the use of accessories on the subject.

Keywords: Face detection, image processing, Eigenface, Fisherface, Local Binary Pattern Histogram (LBPH).

INTRODUCTION

Computer vision technology is now commonly used, including as an identification process. There are several parts of the human body that are used for identification process, such as eyes, fingerprints, or faces. The face is the part that is easier to recognize [1]. For recognizing, the face is detected by computer technology that digitize a human face in an image. Face detection is commonly used for various purposes such as biometric recognition, gender classification, human-machine interaction, etc [2][3].

There are many face detection methods that are used to find the faces. After the face detection, the process continues to the face recognition. Face recognition identifies the face from image or videos, and matches the face from database to describe whose face it is. Face recognition uses an algorithm to detect human faces from human parts such as the face, eyebrows, nose, or eyes [4]. After the algorithm detects the face area, it will apply additional tests to confirm the detected object.

Algorithms need to be trained using lot of data sets such as positive and negative images. It is used to improve the accuracy of face recognition. The level of accuracy of face recognition in images would be influenced by several factors, such as poses, facial expressions, facial position and orientation, skin color, use of accessories such as glasses or hair ties, lighting conditions, and the resolution of the captured image.

In this study, several methods could be compared facial recognition methods. There are three different method, such as the Eigenface method, the Fisherface method, and the Local Binary Pattern Histogram (LBPH) method.

THEORY

Haar Cascade

The face detection adopted Viola and Michael Jones method [5]. The method used two kinds of images such as image with faces inside it and image with no faces to test. The features are extracted to calculate the average pixel ofeach image. There are three features such as line, edge, and center-surround features shown in Figure 1. To train the images, used many classifiers to accurately determine the values [6]. Features are obtained by finding out the difference value between the average dark area pixel and the average light area pixel value [7]. The visual objects are rectangular modifications that are more suitable for visual recognition tasks [8].

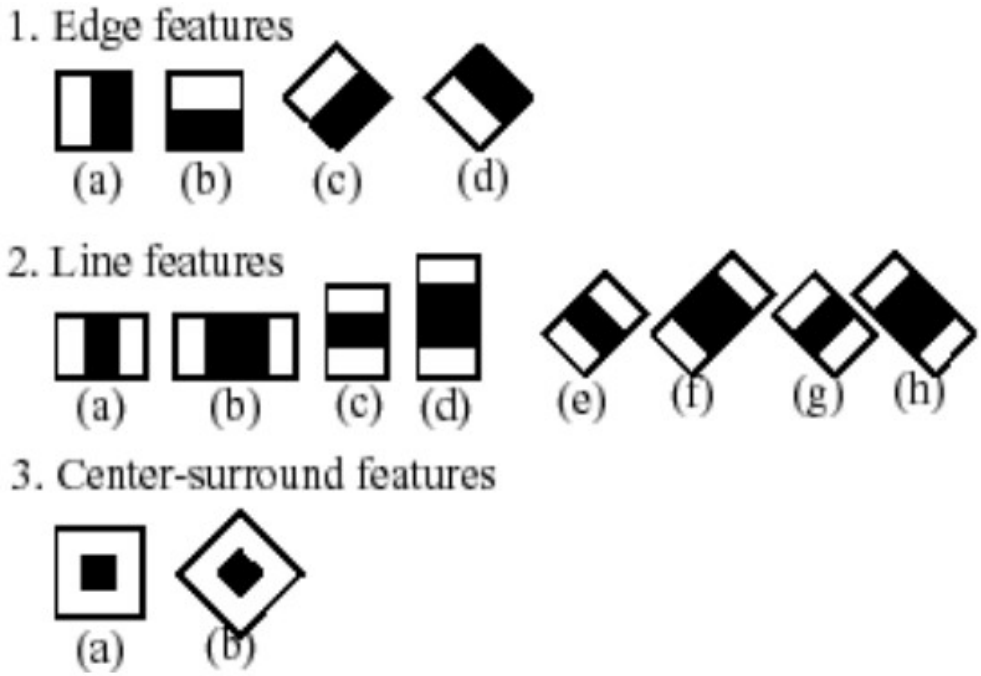


FIGURE 1. Haar Features [6]

Eigenface

Eigenface is the name of a set eigenvector that used in the computer vision for face recognition. Eigenvector is the result of mathematical calculations from Principal Component Analysis (PCA). The eigenface method used PCA to extracted out the original images [9]. PCA is considered the highest difference in the matrix. The algorithm transforms images into set eigenfaces from the images of training. After the images are transformed, every image of training is calculated and stored in the vector.

Fisherface

The fisherface method builds on the main concept of eigenface technique [11]. The basis of fisherface used Linear Discriminant Analysis (LDA). LDA works by finding a linear subspace which that lengthen the separation of the two pattern categories [12]. LDA using labels to reduce the dimension and to recognize patterns. It maximizes the ratio between class scatter and matrix. Therefore, different light conditions in the image would affected the classification using the LDA technique. The pattern of recognition image is shown on FIGURE 3.

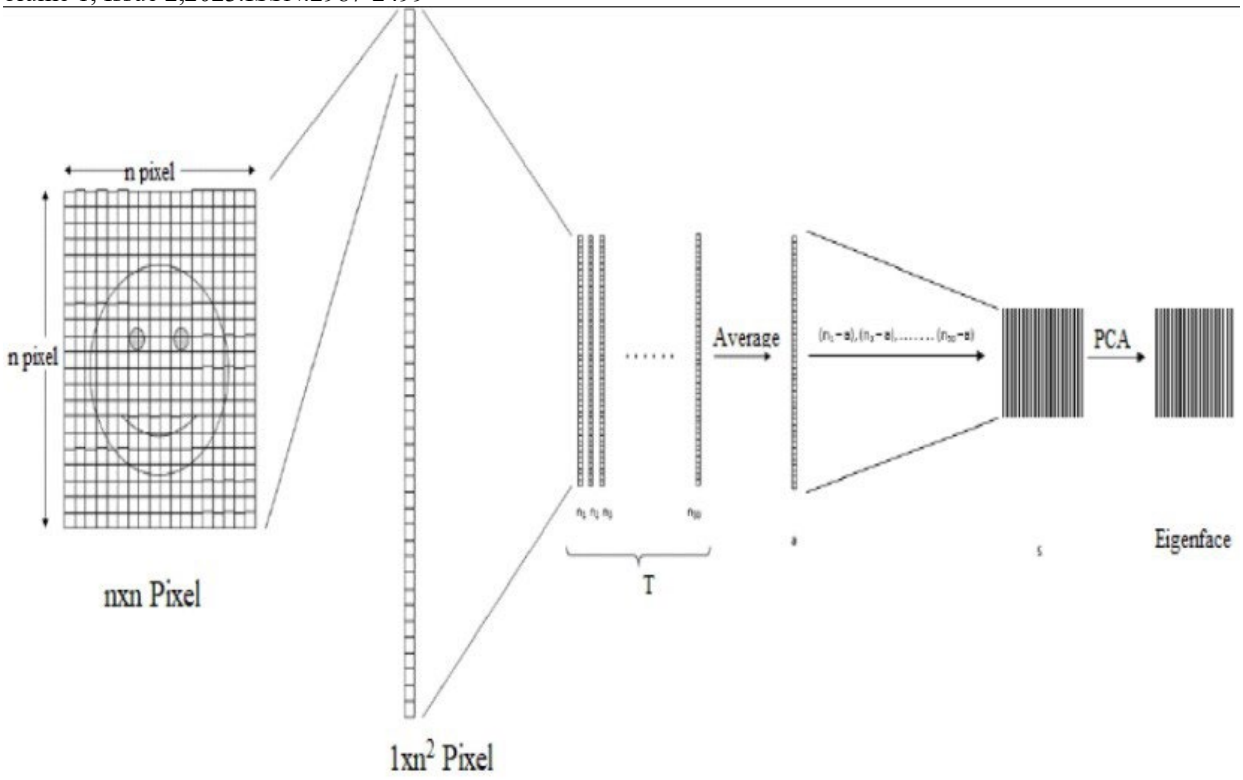


FIGURE 2. PCA Calculation on Image [10]

FIGURE 3. Pattern Recognition Image [6]

Local Binary Pattern Histogram

The local Binary Patterns (LBP) method is designed to analyze the grayscale image. The LBP operator generates labels for image pixels by blocking 3 × 3 system. The middle value of the block considered as the threshold. Each of the edge pixel is compared to the middle value. If the edge pixel higher than middle value, the result is 1. On the other hand if the edge pixel lower than middle value, the result is 0. This comparison result in binary number as shown in FIGURE 4. Each of edge pixel The result of binary number could be arranged as a decimal number which is called texture descriptor. The texture descriptor of the histogram used is 2^8 = 256 different labels [13].

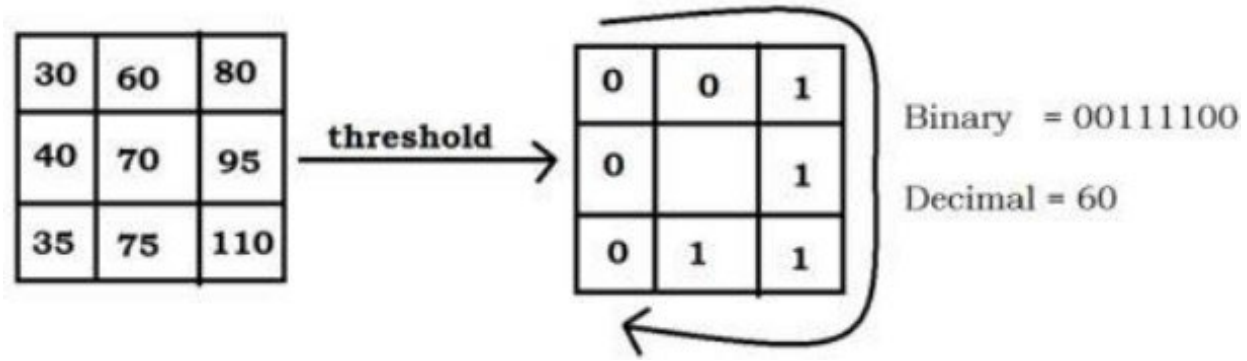


FIGURE 4. LBP Operation [13]

METHOD

The input is face images. Then the process is continued to the features extraction. Output of these features extraction is accuracy value. There are three features extraction methods, Eigenface, Fisherface, and LBPH methods. The accuracy of these feature extraction results would be analyzed. The process was simulated using JupyterLab. The FIGURE 5 shows the block diagram of this method.

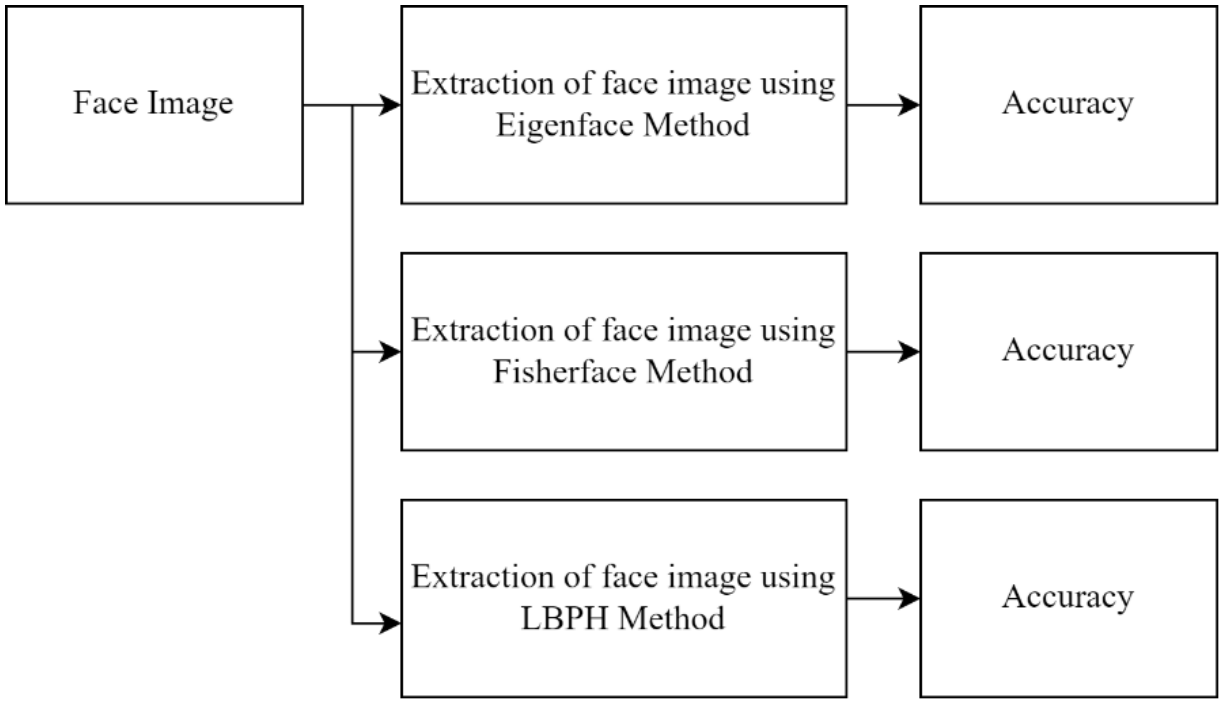
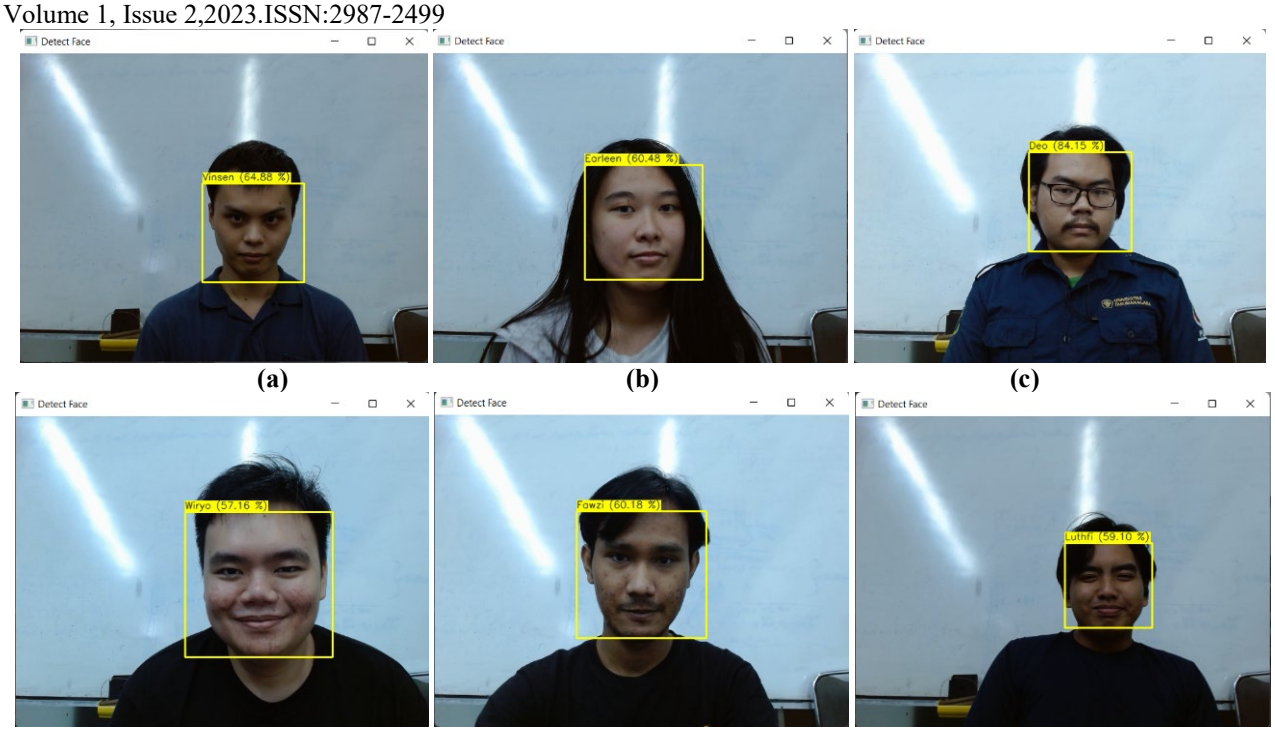


FIGURE 5. Process of Recognition

RESULT AND DISCUSSION

Data was obtained by using a Logitech C922 webcam in the laboratory of Electrical Engineering, Universitas Tarumanagara. Research has been conducted with 10 subjects at a constant distance. Each subject has 100 images and face images were detected real time. The comparison of training data and testing data is 80:20.

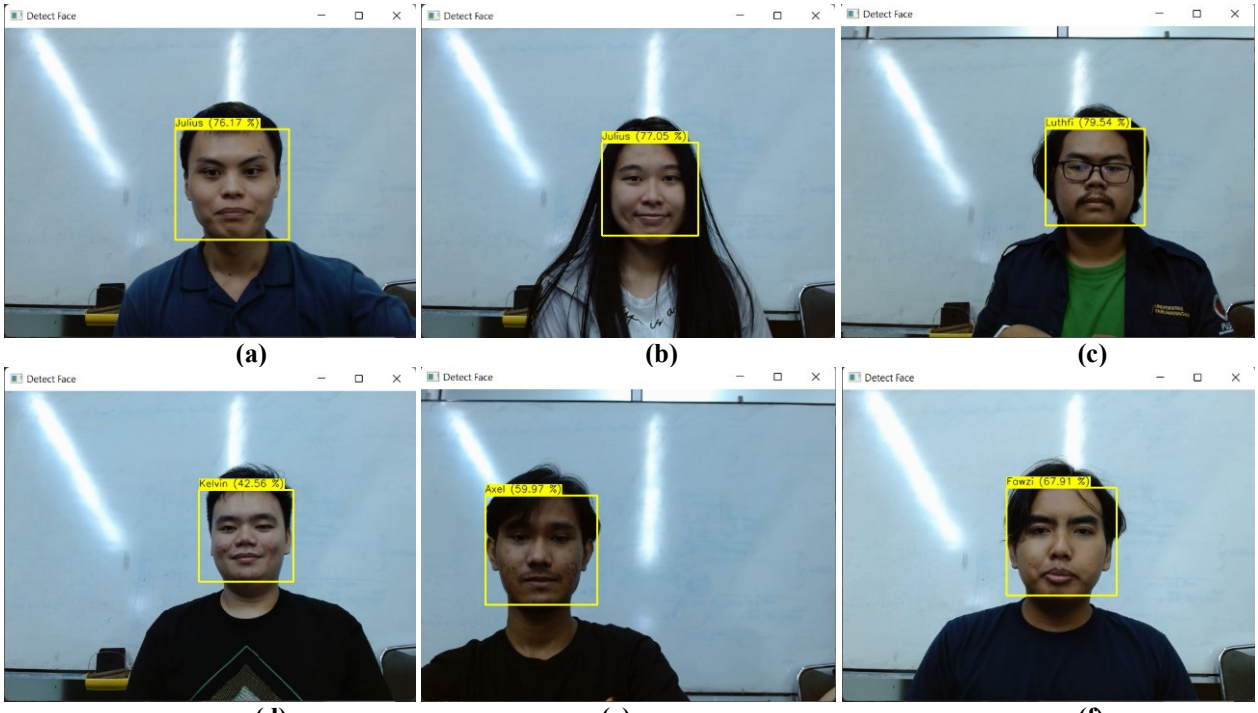


(a) (b) (c)

(d) (e) (f)

FIGURE 6. Example of Successful Real Time Tests

The result of detected faces were squared and showed the label of the face with its name and level of confidence. The successful identification is shown by label of the subject correctly matched to the database. FIGURE 6 shown the example of successful identification. The unsuccessful identification is shown by label of the subject incorrectly unmatched to the database even it has same squared as the successful identification. The example of unsuccessful identification shown in FIGURE 7.



(a) (b) (c)

(d) (e) (f)

FIGURE 7. Example of Unsuccessful Real Time Test

TABLE 1 shows the accuracy value of each subject with three different features extraction methods. Each subject has 15 images for testing data. There are differences in the accuracy value shown in each method. It was found that for some subjects the Fisherface accuracy value was smaller than the other methods. Meanwhile, the accuracy value of LBPH was higher than the other methods.

Based on TABLE 1, FIGURE 8 showed the average accuracy value. Accuracy is affected when the subject uses accessories, different angles of face, and light conditions. The highest accuracy value was obtained in the LBPH method with average accuracy is 93.90%. This is because the LBPH method able to extract features when the light intensity of the room is low.

TABLE 1. Accuracy Value

Subject	Accuracy Value		
	Eigenface	**Fisherface**	**LBPH**
1	100%	66%	100%
2	53%	20%	53%
3	86%	46%	100%
4	86%	46%	100%
5	100%	40%	100%
6	46%	93%	93%
7	100%	60%	93%
8	86%	20%	100%
9	93%	66%	100%
10	100%	73%	100%

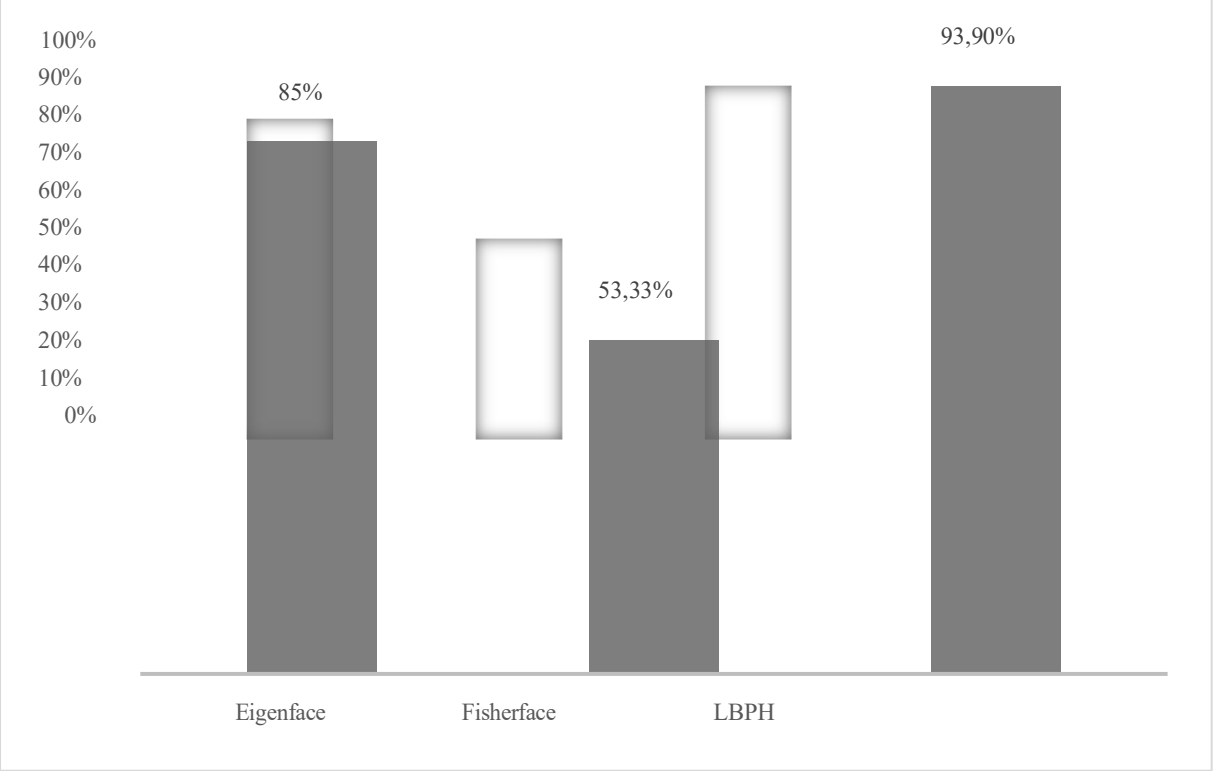


FIGURE 8. Average Accuracy Value Real Time Test

CONCLUSION

Based on the results of the real time testing, the percentage of success for the Eigenface method is 85%, the Fisherface method is 53.33%, and the LBPH method is 93.90%. The LBPH method has the best real time testing accuracy. Accuracy value affected by angle and accessories. These recognition could be expanded for databases online system.

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