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Realtime Face Recognition System with Viola-Jones and Local Binary Pattern Histogram (LBPH) Method

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ABSTRACT

The face is one of the body parts that a detection system can detect. This is what underlies the existence of face detection. One technology that uses face identification is biometric identification. The Viola-Jones method determines whether an object is a face by extracting features in a face image and classifying it to decide whether or not it is a face. However, the Viola-Jones method has the disadvantage that it can only detect human faces. This research will combine the Viola-Jones method to recognize human faces with the Local Binary Pattern Histogram (LBPH) method. The result is that the system can detect and identify up to two human faces facing forward, sideways, up, and down for the database. An accuracy calculation is also added to measure the accuracy of face recognition after the database is retrieved and trained. This average percentage of correctness is taken from comparing the predicted face to be recognized with the face that will be recognized. The result will be compared again with the number of photos taken during the recognition process and multiplied by 100%.

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1. INTRODUCTION

The face is its own identity, allowing humans to distinguish themselves from others. The face is also one way to identify human identity [1][2][3]. The human face has various unique characteristics that determine its identity, ranging from differences in the shape of the nose, eyes, mouth, and so on. In the case of human twins whose faces look very similar, several characteristics will distinguish their identity [4][5][6].

The face is one of the body parts the detection system can detect. This is what underlies the existence of face detectors. One technology that uses face identification is biometric identification [7][8]. Face recognition technology is now very sophisticated and is applied in almost all sophisticated systems that manage images and photos, including social media sites such as Facebook and Google Plus that can recognize human faces and predict the name of the owner of the human face [9]. The modern technology was

developed from several libraries already in general circulation. For example, OpenCV (Open-source Computer Vision) [10][11][12].

Bisogni et al. (2023) said biometric recognition, or arguably biometric identification, is the automatic recognition of a person seen from the uniqueness of characteristics and physiology such as fingerprints, face, retina, and others, or can also be seen from his behavior [13][14][15]. Face detection is a crucial initial stage in the face recognition system for the biometric identification process. Face detection can also be used to search for or index facial data from images or videos containing faces of various sizes, positions, and backgrounds by observing facial patterns such as the eyes, nose, and mouth [16][17][18]. The ability of the face detection and recognition system is obtained from how the system learns from the examples given, which can also be called training [19]. The training uses the active learning method, which is used to reduce the use of extensive data during the training process. The accuracy of the face detection and recognition system is highly dependent on the amount and type of sample data used during the training process [20].

Some research has been done on face detection and face recognition systems. In research [21], the face recognition process is carried out with several facial images that will be optimized to reduce dimensions. After extraction using PCA (Principal Component Analysis), the level of similarity between the face image from the test data and the face image from the training results of the face image from the database can be calculated using the distance method. The difficulty of extracting facial images using PCA is transposing the mxn size matrix to 1xn, and the level of similarity from the reduction and extraction results using PCA average is 77.59 for Canberra distance. In Research [22], Complete Kernel Fisher Discriminant (CKFD) is one of the face recognition application methods, which depicts Fisher Discriminant Analysis (FDA) and Kernel Principal Component Analysis (PCA). The first advantage is that the algorithm implementation can be divided into 2 phases, namely Kernel Principal Component Analysis (KPCA), which is added with Fisher Linear Discriminant Analysis (FLDA) so that the results are stronger. The second advantage is that CKFD can improve training results by creating two categories of information. The disadvantage of this method is that it cannot recognize the input face image if the head size does not match the size of the face image in the database. In research [23], face detection and face recognition can be solved using classification algorithms or methods, including the Support Vector Machine (SVM). SVM is very good at overcoming classification problems, but this SVM method can only be used on linear data types. In another study [24], a face detection system that modifies the Viola-Jones method with the Python programming language method uses Haar features for decryption. Adaboost and Integral Image are combined to search and filter feature values and form a Cascade Classifier that detects faces, testing using K-fold cross-validation and obtaining accuracy results of 90.9% for face images and 75.5% for non-face images. Then, in research [25], two methods were combined for the face recognition system: the Haar Cascade Classifier method for face detection and the LBPH method for labeling a person's face. The result is that the system can detect and recognize faces and display a person's name according to the registered face, and the success rate of this system is 88.42%.

Based on some of these studies, this research will experiment with modifying the Viola-Jones method. The Viola-Jones method, which can only determine whether an object is a face or not, will be modified to recognize the person's face. The modification of this method will combine with the Local Binary Pattern Histogram (LBPH) method, where the technique will help label the pixels in the image data to help in face recognition. The expected result of this research is that the Viola-Jones method is useful for face detection, while the Local Binary Pattern Histogram method functions for face recognition.

2. RESEARCH METHOD

This research begins by conducting a literature review on face detection and face recognition along with the methods used based on Python through national and international journals, the internet, and books that can be used as a reference for this research. After that, the problem identification process is carried out on how to make the Viola-Jones method label the pixels when the training dataset is carried out so that the result data during face recognition can recognize a person's face and name. Therefore, the Local Binary Pattern Histogram method is added, which can label the pixels. Then, testing the combination of the Viola-Jones method with the Local Binary Pattern Histogram (LBPH) method will be carried out using Python-based visual code. If the program does not work or an error occurs, an evaluation will be made on the error located in the program. Furthermore, if the program has been running correctly and produces the desired dataset, it will proceed to the image capture and conclusion stage, as shown in Figure 1.

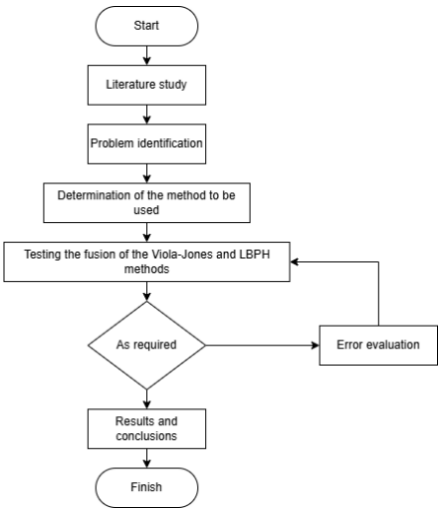


Figure 1. Flowchart of research design

The flowchart of face detection, data training, and face recognition is shown in Figure 2. The first step is to run the data retrieval program and enter the ID number and name. Then, the face image will be taken and stored in the database. After that, the training program will train the face data, and the average histogram of each ID will be stored. The training result file will be stored in the database. The first face recognition process is to enter the prediction ID to be recognized. The program will call the training results of the ID histogram and match the histogram of the face being recognized. Then, the average percentage accuracy value will be calculated. If the value of the average percentage accuracy is 0%, then there is an error in the first-time data collection, which affects the training results. However, the system can recognize the face if the average percentage accuracy value is above 0%.

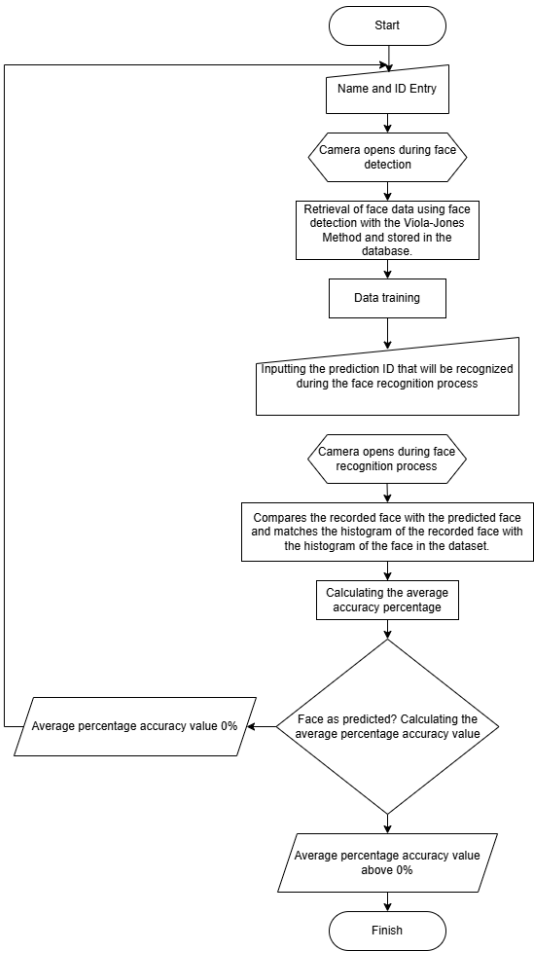


Figure 2. Flowchart of face detection, training data, and face recognition

In testing the face detection and recognition system, the results will be obtained in real-time using a webcam connected to a laptop to detect, retrieve data, and recognize faces. This test aims to modify the Viola-Jones algorithm, which will be combined with the LBPH algorithm so that the Viola-Jones algorithm can recognize faces from data that has been trained based on Python. Before the test begins, face data will be stored in the database as data obtained from taking photos taken in real-time and inputting the ID and name of the face.

Face sample data used in this study are 15 faces. Face data is taken from as many as 500 images to improve recognition accuracy. The data retrieval process is done by detecting using a camera in real-time. Then, the face data will be stored in the database, as in Figure 3. Furthermore, so that the face image can be extracted, the data is trained. Testing will be done by scanning the recognition of each face.

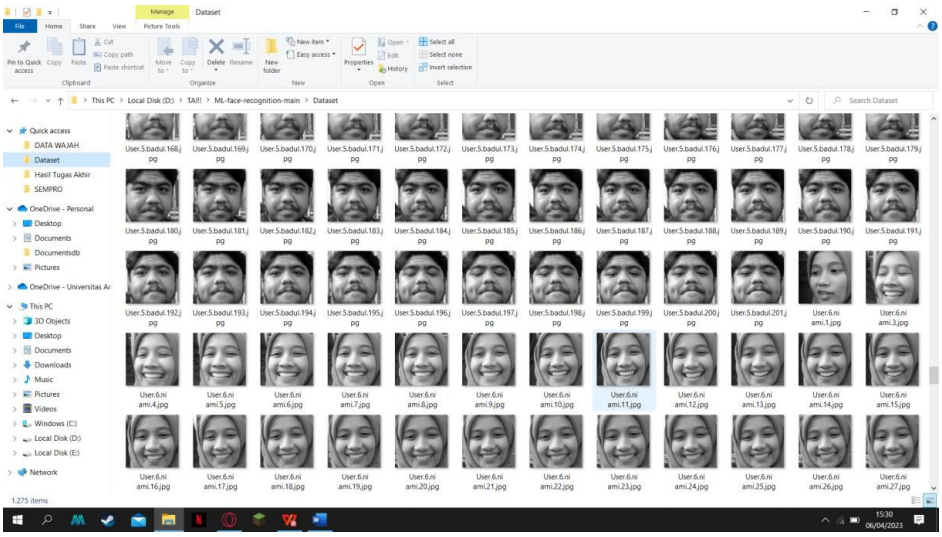


Figure 3. Face image database

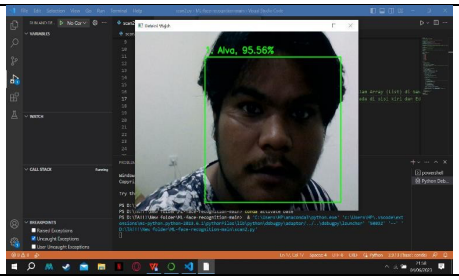
To simplify the calculation of the accuracy of the reading percentage, before scanning the face, the ID that has been taken will be inputted into the program to be compared with the face to be scanned. For example, in the face recognition program, Alva's ID (1) and Ani's ID (2) are inputted, and when recording the face for the recognition process, Alva and Ani must be in the camera layer where Alva must be the left of ani so that the system can compare the original and predicted conditions. The accuracy value of the average percentage of truth will be calculated from the number of correct obtained from the comparison between predictions and real-time readings, which will be divided by the number of readings that will continue to grow during the recognition process and will be multiplied by 100%.

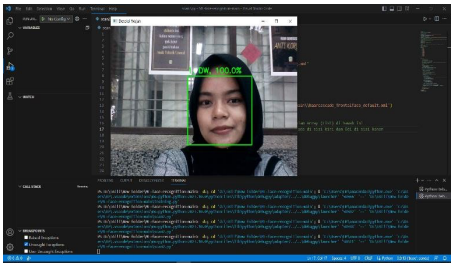
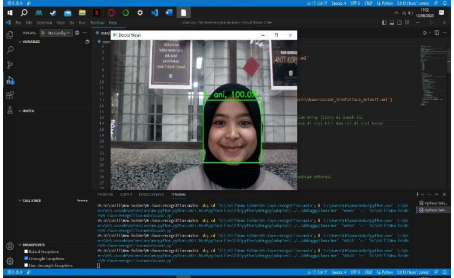
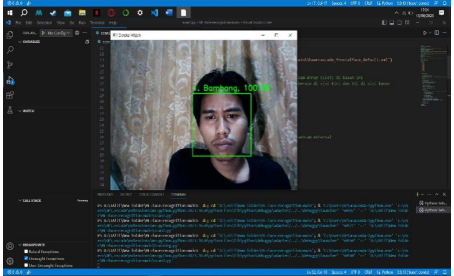
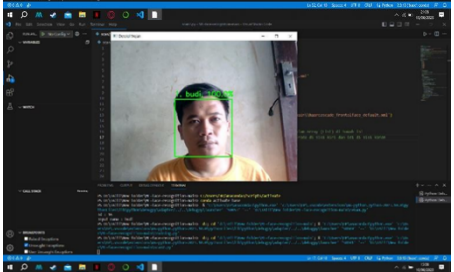
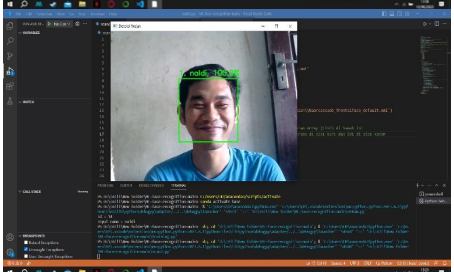
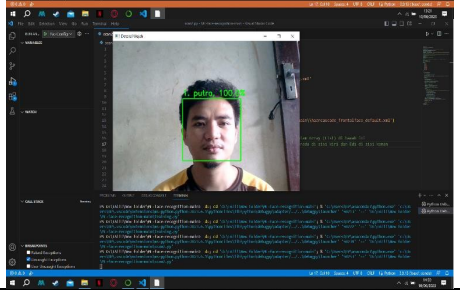
3. RESULTS AND DISCUSSION

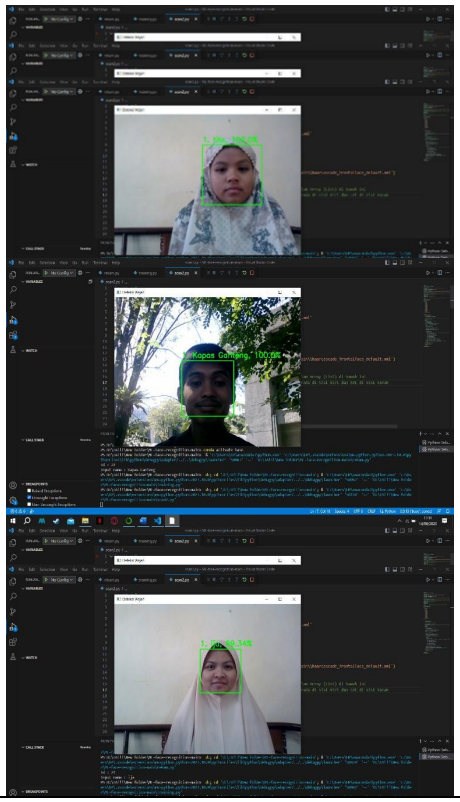
3.1. Single Face Detection Testing

This first stage of testing will be carried out to detect one face from each subject whose facial data has been taken. Testing to show the face recognition process of one face object and how the average percentage truth value. The test results of face detection and recognition are shown in Table 1.

Table 1. Single face recognition detection result

Label name	Picture	Accuracy percentage
Alva		95,56%

DW		100%
Ani		100%
Bambang		100%
Budi		100%
Naldi		100%
Putra		100%

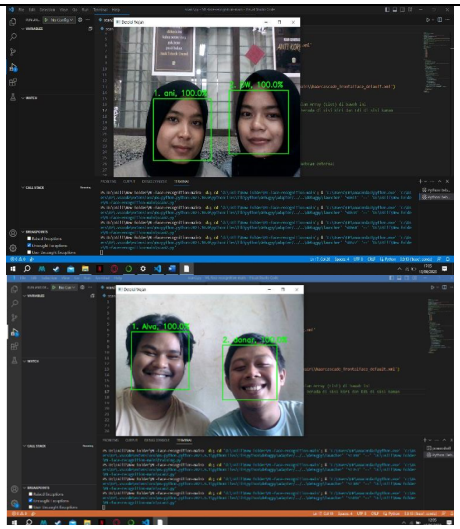
Tita		100%
Kapas		100%
Ija		99,34%

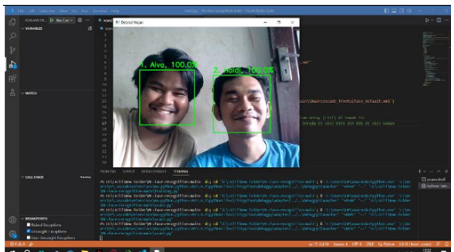
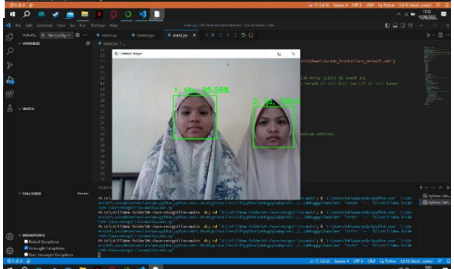
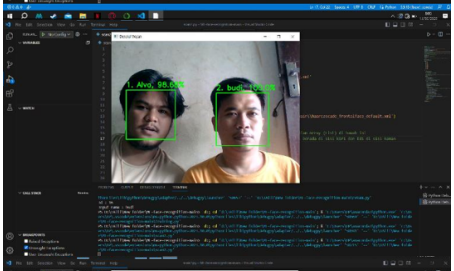
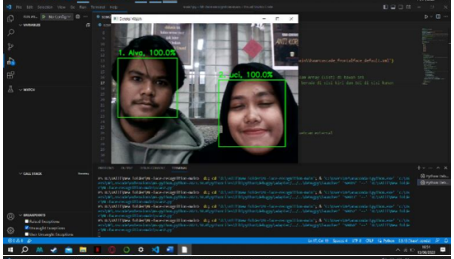
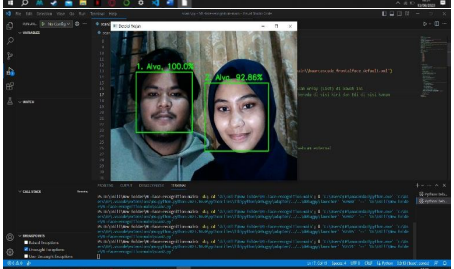
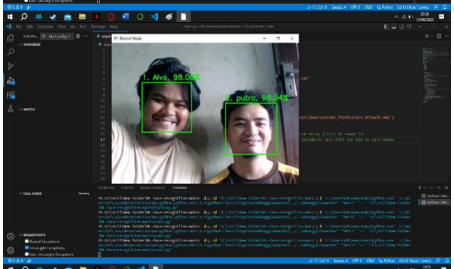
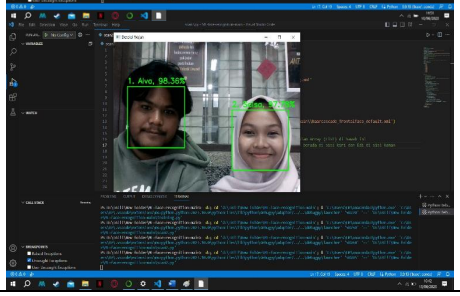
The test results in Table 1 show that almost all face recognition results are nearly 100% accurate. In contrast, only two experiments get accuracy results below 100%, namely in the detection of Alva's face, which gets 95.56%, and the detection of Ija's face, which gets 99.34%.

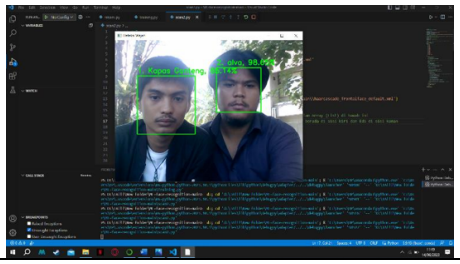
3.2. Two-Face Detection Testing

The second test will be carried out by directly detecting the recognition of two faces at once. This proves whether the system can recognize more than two faces at once. This test also displays the accuracy of face recognition obtained by the system, as shown in Table 2.

Table 2. Two-face recognition detection result

Label name	Picture	Accuracy percentage
Ani and DW		Ani: 100% DW: 100%
Alva and Danar		Alva: 100% Danar: 100%

Alva and Naldi		Alva: 100% Naldi: 100%
Tita and Ija		Tita: 100% Ija: 100%
Alva and Budi		Alva: 98,68% Budi: 100%
Alva and Uci		Alva: 100% Uci: 100%
Alva and Aurel		Alva: 100% Aurel: 92,86%
Alva and Putra		Alva: 98,08% Aurel: 98,04%
Alva and Salsa		Alva: 98.36% Salsa: 97.78%

Alva and Kapas		Alva: 98,65% Kapas: 85,14%

Based on the test results in Table 2, it is found that the Viola-Jones and Local Binary Pattern Histogram (LBPH) methods can detect two faces at once with almost 100% accuracy, whereas only in some tests that get less than 100% accuracy, namely in the 98.08% Alva face test and 98.04% Putra face. Then, in testing, Alva's face was 98.36%, and Salsa's was 97.78%.

3.2. Analysis of Test Results

Based on the experimental data, the face detection and recognition design system with the Viola-Jones method and the LBPH method works well in one- and two-person face recognition detection experiments. In the first experiment, using one face object runs smoothly with an average percentage accuracy from the lowest 95.56% to the highest 100%. In the second experiment, using two face objects continuously runs smoothly with a not-too-high average accuracy percentage from the lowest 85.14% to the highest 100%.

The average percentage truth value difference is due to the average value retrieval system used. The system proves that the average correct value is obtained from all the readings. The system works by comparing the correct readings predicted by the system and the total number of face readings in progress and multiplying by 100%. The percentage obtained will prove how much the average correct value of face recognition readings is from the predictions that have been inputted. The ongoing process during program execution will affect the average correct reading value. This causes the accuracy value of the average percentage of truth to be low and the unfocused face object at the beginning of the reading.

Lighting conditions and the distance from the face to the camera are also very influential. Although light intensity and distance are not calculated in this research, the lighting must be good enough for detection and recognition. Data converted into grayscale form will significantly affect the data training process because dark areas cover the facial features to be learned. Too much distance will also affect the pixels that affect the pixels that have been labeled by the LBPH method.

4. CONCLUSION (10 PT)

The Viola-Jones and LBPH methods used in the face recognition system continuously work well to detect and recognize faces as desired. The results in the first experiment using one face object produced a high percentage of average value accuracy, where the lowest accuracy was 95.56%. At the same time, the results in the second experiment using two face objects produced a lower accuracy percentage than one face object, namely 85.14%. The average percentage value's accuracy difference is due to the average value retrieval system used. In addition, lighting conditions and the distance of the facial object to the camera are also greatly affected. In future research, it is expected that in the recognition process, it is advisable to provide a limit on image capture so that the accuracy value obtained in each experiment is more valid. Then, in calculating the average percentage accuracy value, it is advisable to use another calculation logic that aims to prove accuracy from another point of view.

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