Attendance System Based on Face Recognition System Using CNN-PCA Method and Real-time Camera

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***Abstract*— One of the developments in computer vision is the research on human face recognition. One of the implementations of the human face recognition system is used as an attendance system. The attendance system uses faces as objects to be detected and recognized as a person's identity and then stored as a face database. The process of matching face image data captured by the camera with face images that have been stored in the face database will result in face identification of the object faces captured by the camera. The face recognition-based attendance system in this study uses a hybrid feature extraction method using CNN-PCA (Convolutional Neural Network - Principal Component Analysis). This combination of methods is intended to produce a more accurate feature extraction method. The face recognition-based attendance system using this camera is very effective and efficient to further improve the accuracy of user data. This face recognition-based attendance system using this camera has very accurate data processing and high accuracy so that it can produce a system that is reliable and powerful to identify human faces in real-time.**

Keywords— face recognition-based attendance system, hybrid feature extraction, CNN-PCA, real-time camera

I. INTRODUCTION

An attendance system using a camera-based on a face recognition system has been developed by several researchers to produce a face attendance system that is accurate and able to store a large-scale face image database. The design and manufacture of facial attendance systems using cameras are very useful effective and efficient to further improve the accuracy of user data and is useful for the high mobility of users who use it. Facial attendance system using a camera is very safe and accurate for detecting users because it has a more accurate data process and high accuracy so that it can produce a system that is reliable and robust to identify human faces to be used as a time attendance on attendance machines.

Research on Face Recognition for human interests has been carried out, especially for various interests such as security systems, surveillance, General identity verification, Image database investigations, Criminal justice systems, "Smart Card" applications, Video indexing, Multi-media environments and Witness face reconstruction [1]. According to [1], based on data acquisition methodology, Face Recognition is divided into 3 categories, namely Face Recognition Method based on image intensity (Intensity Image), a method that works based on video sequences and Faces Recognition Method which requires other sensors such as 3D Information and infra-red image (infra-red imagery).

There are two categories in intensity mages -based Face Recognition, feature-based and holistic face recognition. Feature-based face recognition based is a face recognition method that processes input images to identify and to extract features of faces such as nose, mouth, eyes, etc. then calculate the geometric relationships between these face points thereby reducing the face input images to geometric features vectors. The initial face recognition research based on feature-based was conducted by [2], that study uses the Geometrical Features and Template Matching method in identifying a person's face. In that study using the integral projection feature extraction method and the classification method used is the Bayesian Classifier.

The next feature-based research using the SOM (Self Organizing Map) method conducted by [3], in contrast to research [2], in this study the feature extraction method used is the feature mapping method using SOM (Self Organizing Map), while the classification method The method used is the MLP (Multi-Layer Perceptron) and Nearest Neighbor method . The method used is able to identify faces well compared to previous methods. The next face recognition research that uses feature-based method is conducted by [4], this study combines feature extraction methods using Mixture Distance and Euclidean Distance classification methods.

Another intensity-based Face Recognition the holistic face recognition. This holistic approach to face recognition tries to identify faces using global representations, namely describing them based on the whole image and not on the local features of the face alone. The simplest holistic approach is to represent the image as a 2D array of recognition and intensity values is resulted by comparing the direct correlation between face input and all other faces in the database. The initial face recognition research using a holistic approach was conducted by [5], this study used a feature extraction method using the eigenfaces method and classification methods in determining face identification using distance from space face measure.

Face recognition research that uses the same extraction method is also carried out by [6], but the classification

method used is Euclidean Distance. [6] conducted a study of Face Recognition using multiple cameras. This study uses the Cylinder Head Models (CHMs) methodology to detect faces in a subject that is detected using multiple cameras. To recognize faces, the eigenfaces method uses an average of half the face to reduce the effects of errors during transformation. The average-half-face is used during the process of scanning and unwrapping CHM to 2D face images. This method can be used and works well to recognize faces with an accuracy of up to 94.4%.

The next holistic -based face recognition research was conducted by [7] who conducted face recognition research using ICA (Independent Component Analysis) as a feature extraction method and Distance Measure as a classification method. Then followed by [8], in this study face recognition was done by combining the Locality Preserving Projections (LPP) method as feature extraction and Euclidean Distance as the classification method. This study uses Locality Preserving Projections (LPP), face images are mapped into several subspaces for the analysis process. This LPP method is used to retain local information and to determine important parts of the detected face structure. This LPP method is different from the PCA and LDA methods which generally use the Euclidean Distance method for the classification process. The method used in this research can reduce several variations of illuminations, changes in light, facial expressions and various types of different poses. This research states that PCA, LPP and LDA can be obtained from different models of graph. The Laplacian method used in this study is compared with the Eigenfaces and Fisherfaces Method and based on the experiment results it can be proven that the Laplacian method proposed in this study can produce good facial recognition and produce a low error or error.

Further holistic -based face recognition research was carried out by [9], [10], [11] and [12]. The four studies used the same feature extraction method, PCA (Principal Component Analysis), while for the different classification methods used, [9] used the Artificial Neural Network (ANN) classification method, [10] used the Neural Network classification method, [11] using the Error Back Propagation Neural Network classification method and [12] using the Support Vector Machine (SVM) classification method . Several previous studies on facial recognition are still constrained by the problem of variations in illumination lighting on the face object captured by the camera. This condition causes facial recognition to be less than the detected object.

In this study, the preprocessing method for images that will be processed using a compilation method development of the RGB - grayscale and resizing process, then using the addition of the histogram equalization method and the addition of contrast and brightness level adjustment methods to anticipate variations in the illumination of the image used. Some of the additional methods are intended so that the image that has been processed can be a high information value that can improve facial recognition to be more optimal.

Some related research has been conducted by researchers before, so this study used a method face recognition using a hybrid feature extraction method using CNN-PCA. This face recognition method is then used as a reference for making a face attendance application using a camera.

II. Research Methods

In this research, the development of a face recognition model as a face attendance machine using a hybrid feature extraction method using CNN-PCA was built using a combination of face detection and face recognition framework model using real-time cameras that function as a face detection tool and human face identification. The stages of the facial recognition process that will be carried out consist of the processes performed on data acquisition, face detection process, preprocessing, feature extraction process, and classification processes can be seen in Fig. 1.

The camera that used in face detection process is performed using face detection based on the Viola-Jones from the OpenCV package. Face detection is done by a camera to take face images of objects taken. The image taken from the camera lens is a raw image containing a background image and a face image. In this face detection process is carried out the process of detecting and searching for facial features in the camera image, which at this stage the system recognizes patterns as faces or not. The face image detected in the background image produced by each camera lens is marked by the position of the region of interest (RoI) coordinate point of the face image which is the location point and the size of the RoI face image produced. Normalization or preprocessing is a process that result a face image that has detected on process of face detection.

In this normalization phase, a combination of several face image processing models is used. We used the cropping method, resizing, RGB-Gray, and using histogram equalization as a contrast-brightness adjustment to optimize the facial recognition. The preprocessing method is used to improve the sharpness of the image to anticipate several variations in illumination that commonly appear when capturing facial images.

In this research, a face database is stored resulting from the 2D-3D image reconstruction process to result a face database that is used in the face recognition process. The 2D to 3D image reconstruction method is expected to make a strong contribution to face detection and recognition so that it has high accuracy and fast face recognition computing. This study uses an approach to develop a 2D image reconstruction model to 3D using the Convolutional Neural Network (CNN). The CNN method is used to produce 3D face images from 2D face images. The next step is to combine the vector shape and texture to produce a correlation point on the new face image that has similarities with the initial image used. The results of the process of combining vector shapes and textures from 3D face images are then processed using a database for the face recognition process. The 2D-3D image reconstruction process using CNN as shown in Fig. 2.

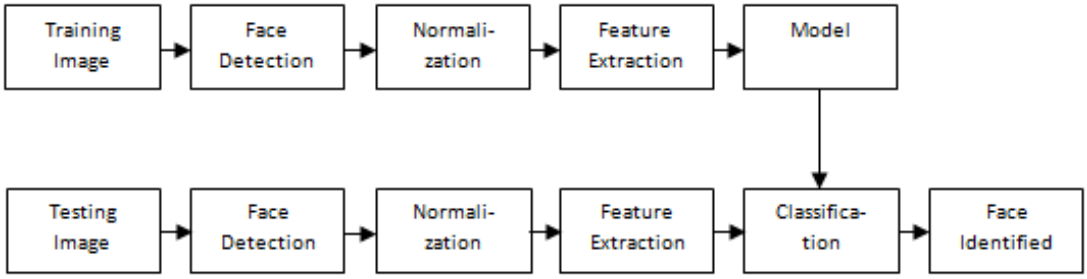

Fig. 1. Stages of the process of facial recognition

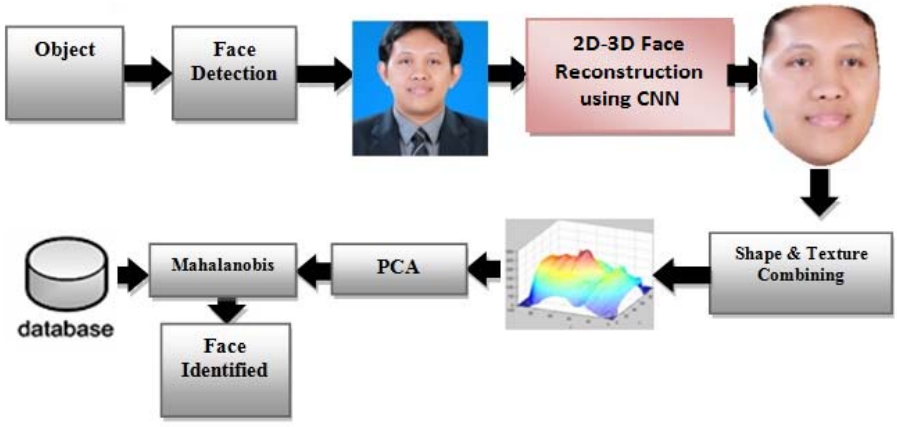

Fig. 2. 2D-3D image reconstruction process using CNN

2D-3D image reconstruction using CNN can be generated using equation (1) [13,14,15] .

$$S = \acute{S} + U_d.\alpha_d + U_e.\alpha_e \quad (1)$$

S is the 3D face output, Ś is the average face size, U_d is the main component of the 3D face image, α_d is the identification vector, U_e is the main component of training in 3D images and α_e is the parameter vector.

In this study, we use feature extraction method namely principal component analysis (PCA). PCA is used to reduce dimensional of face image resolution. The principal component analysis is used to convert a large variable data into a form of representation of other smaller variables.

We use the Mahalanobis distance method as a method of classification. The Mahalanobis distance method used in this classification process is used to determine the degree of similarity between features in order to produce a more optimal face recognition. To determine the similarity of facial features, we compare the training features of face that stored in the database with the features of facial image on testing process. These results will produce identification data and stored as attendance data.

III. Results and Discussion

From the research that has been done, it can produce an attendance system based on face recognition using CNN-PCA. The result of the attendance system is shown in Fig. 3 and Fig. 4.

Testing experiments on the proposed face attendance system as shown in Table 1.

The face recognition system on the proposed attendance machine can produce accuracy between 90% -96% on the use of feature extraction using PCA. The use of CNN-PCA in the proposed research can produce an accuracy of between 90% -98%. An attendance system based on face recognition using CNN-PCA can work better than using only PCA.

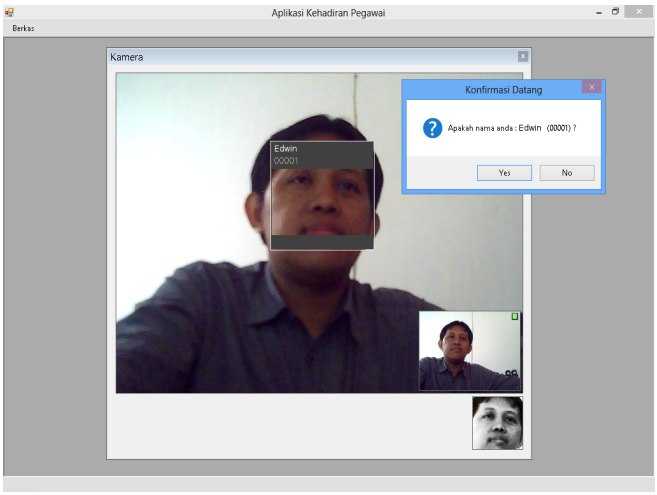

Fig. 3. The interface of the face recognition-based attendance system

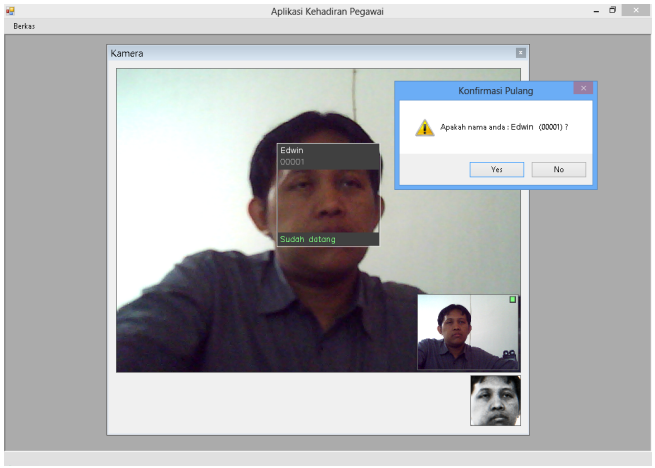

Fig. 4. Facial recognition model in the face attendance system

IV. CONCLUSION

From several studies on face recognition, there are still many methods and algorithms that have not been investigated specifically the use of reconstruction algorithms from 2D images to 3D forms that are used as a database in face recognition. In this study, a study of facial recognition using an approach to the development of 2D to 3D image reconstruction models using Convolutional Naeural Network (CNN) and the use of PCA are used as the feature extraction method. The CNN method is used to produce a 3D face image from a 2D face image. The PCA method used as a feature extraction method and the Mahalanobis method used as a classification method on the proposed face recognition-based attendance system can work well. The proposed method can produce a face recognition that has a high accuracy of up to 98%.

TABLE I. THE ACCURACY OF FACIAL RECOGNITION IN THE PROPOSED FACIAL ATTENDANCE SYSTEM

Object	Accuracy (%)	
	PCA	CNN-PCA
10	90.00	90.00
20	90.00	95.00
30	93.33	96.67
40	95.00	97.50
50	96.00	98.00

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