A Review Paper on Attendance Marking System based on Face Recognition

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***Abstract*—Providing accurate attendance marking system in real-time is challenging. It is tough to mark the attendance of a student in the large classroom when there are many students attending the class. Many attendance management systems have been implemented in the recent research. However, the attendance management system based on facial recognition still has issues. Thus many research have been conducted to improve system. This paper reviewed the previous works on attendance management system based on facial recognition. This article does not only provide the literature review on the earlier work or related work, but it also provides the deep analysis of Principal Component Analysis, discussion, suggestions for future work.**

***Keywords*—Principal Component Analaysis, Facial Recognition, Histogram Oriented Gradient, Automatic System, AMS.**

I. Introduction

Facial recognition development has received many interests in recent years. It is a critical application in image analysis yet it is very challenging to create an automated system based on facial recognition; a system with ability to recognize human face accurately.

One application of facial recognition is in the field of attendance management system. The manual attendance system is time-consuming, thus many research has been conducted with the automatic [1], [2], [3] or smart attendance management [4] system to resolve this issue.

One solution is the application of biometric attendance management system. However, it is difficult to verify each student in the classroom as there are many students who attend the class, and if the system cannot detect or recognize one student, it will interrupt the learning process. In addition, the biometric system needs much hardware that requires high cost and a lot of interaction with the students that makes it a time-consuming system. The research on applying real-time facial recognition in attendance management system has been a real challenge. Automatic attendance marking can solve the main issues such as the error when inputting the data from the sheet to the manual attendance system, especially there is a concern that the data is not 100% accurate in the traditional attendance marking method considering the extremely large number of students in a university.

The facial recognition process has many steps such as capture, extraction, comparison, and matching [5]. The operation in each process is:

Step one: capture is the way to snap the picture during the enrollment of the system. Then in the second step, extraction is used for finding or extract the specific feature from the face. The third step is comparison, where new input is used for comparison with the database (sample data). Finally, the last step is matching: the system will try to find the matching of the new face with the registered face based on extraction and comparison process. The sequence of the processes is illustrated in Fig. 1.

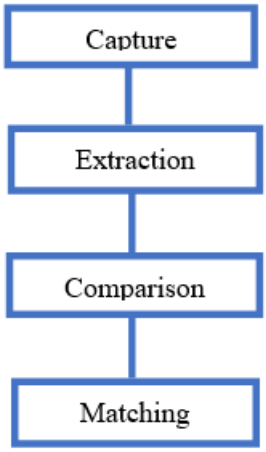

Fig. 1. The operate process of face recognition system.

There are several methods and algorithms that can be implemented in facial recognition system. Study conducted by [6] implements LBP (local binary pattern) to recognize the human face and SVM (support vector machine) to find the similarities of the images stored in the database with the image acquired by camera inside the classroom.

There are a lot of limiting on the research done in the past. The detail of the limitations will be introduced in next part of literature survey. The literature review gives a summaries of information about the previous research and how each researcher implements the attendance management system by using face recognition. In section five gives a comparison of each paper based on the criteria by the author and provides the small discussion about face recognition algorithm in attendance management system. At the last section, will concludes

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all the discussion in this paper and gives some advice for refinement of attendance management system.

II. Face Recognition

In the introduction, an overview of facial recognition in attendance marking system is discussed. Then, in this section, we explain the various approaches to facial recognition such as:

A. Geometric Approach

This approach recognizes human based on geometry point on the face. There are many features of geometric approach that has been explored: [7] uses geometric approach to improve the accuracy of the system when the images have complex background.

B. PCA Based

PCA is a statistical method used in facial recognition for feature extraction and used to remove redundant information. PCA also used to decrease dimensionality and conserve the information. When new image is input to the system; facial recognition will process it to find the match between the new image and the image inside the databases. Principal component or Eigenface is a face image that contains feature and characteristic. The image with the $M \times M$ can be written to 1-dimensional M^2 to reduce the dimensionality.

C. LDA Based

This method is used to maximize the scatter image in the same or different class, which is enhanced from PCA. In PCA, a subspace is selected that contains the most variation. Since 1997, Fisherfaces [8] has been used in the application of Fishers linear discriminant (FLD). The Fishers linear discriminant chooses the linear subspace Φ that maximize the ratio.

$$\frac{\Phi^T S_b \Phi}{\Phi^T S_w \Phi} \tag{1}$$

where

$$S_b = \sum_{i=1}^{m} N_i (\,\bar{x}_i - \bar{x}\,)\,(\,\bar{x}_i - \bar{x}\,)^T \tag{2}$$

with

$$S_\omega = \sum_{i=1}^{m} \sum_{x \in X_i} (\,\bar{x}_i - \bar{x}\,)\,(\,\bar{x}_i - \bar{x}\,)^T \tag{3}$$

S_b : between-class scatter
$S\omega$: within-class scatter
m : number of subject in the database

In [8], this method was tested with a front-view of face images, and the result had less error than Eigenfaces-based method.

D. Local Binary Pattern

This approach is used in computer vision, which is first introduced in 1990 for classification. In 1994, research papers [9] and [10] showed that combination of LBP and HOG (histogram of oriented gradient) had a great performance in texture classification and it improved the performance detection on some relevant data sets

E. Active Appearance Model

This model was first introduced by Edwards, Cootes and Taylor [11], [12] in the same year. This approach has been used extensively to do facial matching and it is also used in medical interpretation field.

III. Face Recognition Techniques

A. Principal Component Analysis (PCA)

PCA is commonly known as method of dimension reduction and feature selection. However, it is also used to extract the number of principal component of multidimensional data. Human recognition system using principal component analysis was first developed by Turk and Pentland [13] which was used to solve facial recognition in two-dimensional rather than three-dimensional geometry because both of the captured image and basic vector constructed by the PCA have the same dimension [14]. Reconstruction of the human face has been done by [15] for solving the retrieval of large database images. In the recent development of automatic facial recognition, the feature extraction has become significant to extract features such as nose, eyes, and mouth. Moreover, the main goal of PCA is keeping the original information of the data, minimizing original loss information and improving the face analysis. The principal component analysis mainly uses Eigenface that has extremely large size, thus it requires dimension reduction process [16]. Study conducted by [17] introduces a way to calculate the discriminant feature of PCA by using a recursive algorithm. In the following section focus on the step of PCA in facial recognition system by using Eigenface.

- Capturing and preparing image for training
  Suppose we have images $X_1, X_2, ..., X_2$ for training in face recognition system. The images must be the same size.
- All the face in X_i are transformed as a vector and put into a training set.

  $$S = \{\Gamma_i, ..., \Gamma_n\} \tag{4}$$

  Which we assume images has the size $N \times N$ or $1 \times N^2$ dimensional.
- Computing the mean face

  $$\bar{X} = \frac{1}{N} \sum_{i=1}^{i=n} x_n \tag{5}$$

- Computing the average of face vector
  The mean face is subtracted by original face and the result will be stored in variable.

  $$\Phi_i = \Gamma_i - \bar{X} \tag{6}$$

- Computing the covariiance
  Calculate the covariance matrix with the following mathematic formula :

$$C = \frac{\sum_{i=1}^{n} (\Gamma_i - \bar{X}) (\Gamma_i - \bar{X})^T}{n} \quad (7)$$

- Calculate the covariance matrix of Eigenvector and Eigenvalues
  All new face is transformed into its eigenface components and the resulting weights from the weight vectors with :
  ω= weight
  μ = eigenvector
  Γ = new input images vector
  $\bar{X}$ = mean face
  The weight vector Ω^T is given by

$$\Omega^T = \{\omega_1, \omega_2, ..., \omega_n\} \quad (8)$$

- Then Eigenfaces handle face recognition
  - The Training data project into PCA subspace
  - Query image project into PCA subspace
  - Find the nearest neighbor between the database image and training image which already projects into PCA subspace

IV. Literature Survey

The primary purpose of this review paper was to find the solutions provided by other authors and consider the limitations of their proposed methods. The best solution then proposed after reviewing all methods.

In the Fig. 2 show the current research paper has been published [18], [19] [6], [20], [21], [22], [1].

In [23], Kawaguchi introduces a lecture attendance system with a new method called continuous monitoring, with the students attendance marked automatically by the camera which captures the photo of a student in the class. The system has simple architecture with only using two cameras installed on the wall of the class. The first camera is a capturing camera used to capture the student image in the class and the second camera is sensor camera used to get the seat of a student inside the class and the capturing camera will snap the student image. The system then compares the picture taking from the capturing camera and images in the database. This process is done repeatedly to complete the attendance marking process.

Other paper proposed by [2] introduces real-time computer vision algorithm in automatic attendance management system. The system uses non-intrusive camera that can capture images in the classroom and compares the extracted face from the captured image with database inside the system. This system also uses machine learning algorithm which is usually used in computer vision. In addition, Haar classifier is used to train the images from the camera. The face captured by the camera then converted to grayscale and the image is put to subtraction process. The image then stored on the server to be processed later.

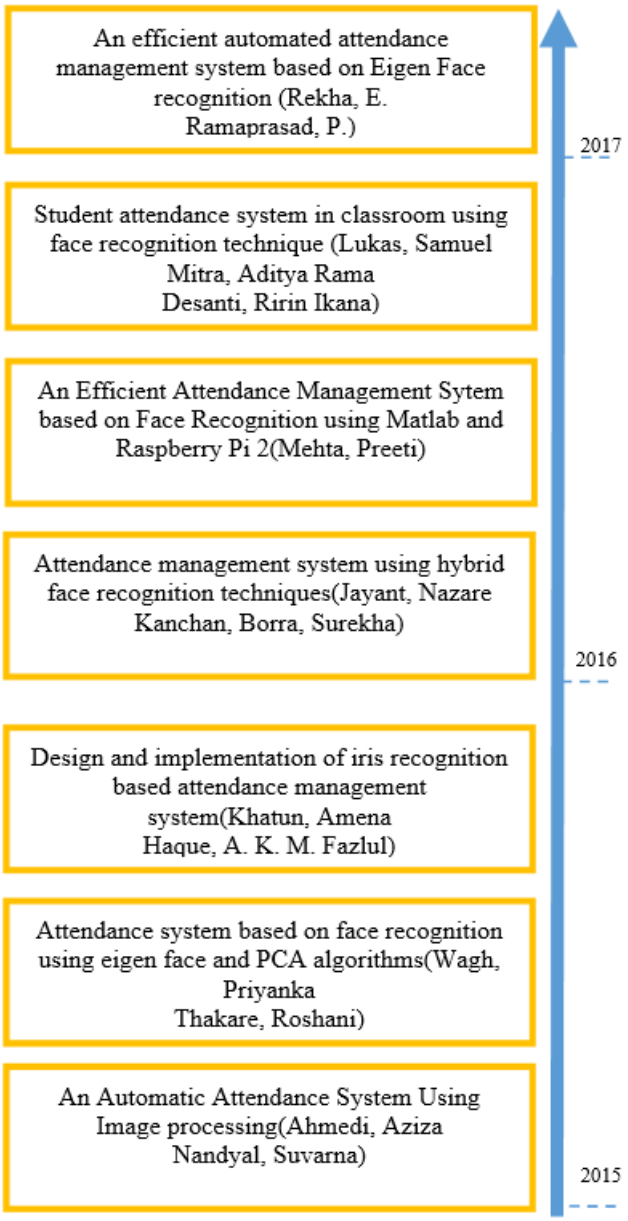

Fig. 2. The evoulation of attendance management system using face recogi-nition

In 2012, N. Kar [24] introduced an automated attendance management system using facial recognition technique that used the principal component analysis. This system uses two libraries which are OpenCV, a computer vision library, and FLTK (light tool kit). Both libraries help the development of the system, for example OpenCV supports algorithm [20] and FLTK [21] is used to design the interface. In this system, there are two processes, namely request matching and adding new face to database. In request matching, the first step is opening the camera and capturing the photo, then the face is extracted from the image. The next step is recognizing the face with the training data and projecting the extracted face onto

the principal component analysis. The final step is displaying the face that closely matched the acquired image. Meanwhile, adding new face to database process is started with capturing the photo, then the face is extracted from the image. The Haar cascade method then performed to the image to find the object in the image in different window size. The next step is storing the image into the database, then learning the face, and followed with application of principal component analysis algorithm. The final step is storing the information inside the face XML file. The system is focused on the algorithm to improve the face detection from acquired images or videos.

In [3], the author also proposes a system which implements automatic attendance using facial recognition. The system can extract the object in the face such as nose or mouth by using MATLAB with principal component analysis (PCA). The system [7] designed to resolve the issues of attendance marking system such as the time-consuming issue. The study result shows that the system can recognize face image in the dark background or different view of the face in the classroom.

Jyotshana Kanti [4] proposes a smart attendance marking system that combines two different algorithms, principal component analysis and artificial neural network. The study is able to solve the traditional attendance marking system and resolve the time-consuming issue. Principal component analysis extracts and identifies the similarities of the face database and acquired images in the system. Meanwhile, artificial neural network is used to solve the problem or learn from the input data and the expected value. This system also uses back propagation algorithm combined with mathematical function. The result shows that the system is able to recognize faces in various environment.

In [22], Priyanka Thakare proposes a method using Eigenface and principal component analysis with architecture as follows. The camera is installed in the front, which is used to capture entire face of the students inside the class. Then, the captured images are transferred into the system as inputs. The images captured from the camera could be too dark or too bright, thus enhancement is needed to convert them to gray images. In the next step, histogram normalization is used to remove the contrast of the images, thus it is easy to recognize the students who sit in the back row. The median filter is used to remove noise from the images. Noise sometimes still occurs even when high definition camera is used. The system also implements skin classification that changes all pixels to black, except the pixels that are close to the skin.

V. Comparison of Face Recognition Techniques

The aforementioned papers proposes several algorithms. Table I covers six papers that are related to facial recognition area and an overview of all papers, including the problems and Table II cover the limitations of each paper used algorithms . We also give a summary of every papers.

In Table III gives a brief pros and cons of each paper. All papers have conducted with attendance management system should be improved based on each paper in Table III. Which each paper has their own pros and cons on difference

TABLE I
Summary Paper

Authors	***Problem***	***Accuracy***	***Cost***	***Summaries***
Visar Shehu [2]	The recognition rate is 56%, having a problem to recognize student in year 3 or 4	Yes	High	Using HAAR Classifier and computer vision algorithm to implement face recognition
NAVAZ [25]	Low accuracy with the big size of images to train with PCA	Yes	High	Using PCA to train and reduce dimensionality and ANN to classify input data and find the pattern
N.Kar [24]	Repeat image capturing	Low	High	Using Eigenvector and Eigenvalue for face recognition
Joseph [3]	Validation of the student once marked present is not done	Yes	High	Using PCA with MATLAB to implement face recognition
E.Reakha [18]	Recognition only frontal face	Low	High	Using PCA and Eigenface to do a better attendance result
P.Wagh [22]	Low accuracy in lighting	Low	High	Using PCA and using Histogram, Remove Noise

TABLE II
The Algorithm in Each Paper

Atrribute	Visar Shehu	NAVAZ	N.Kar	Joseph	E.Rekha	P.Wagh
PCA	Yes	Yes	Yes	Yes	Yes	Yes
LDA	No	No	No	No	No	No
HAAR Cascade	Yes	No	Yes	No	Yes	No
ANN	No	Yes	No	No	No	No
Remove Noise	No	No	No	No	No	Yes
Sensor Camera	No	No	No	No	No	No
Camera	Yes	Yes	Yes	Yes	Yes	Yes
Histogram	No	No	Yes	No	No	Yes

environment of the implementation system. In the artificial intelligence-based method, artificial neural network is able to classify face images successfully and it has the best system performance compared to other artificial intelligence-based or conventional algorithms. Furthermore, integration of traditional and artificial intelligence-based algorithm such as presented paper titled Face Recognition using Principal Component Analysis and Neural Network also achieved better accuracy and performance than previous attendance management based facial recognition system. The various algorithms discussed in other papers are principal component analysis with AdaBoost [26], PCA with error back-propagation [27]

TABLE III
THE PROS AND CONS OF EACH PAPER

Authors	*Pros*	*Cons*
Visar Shehu [2]	The system integrated with the existing system that can use the existing feature from Learning Management System.	The ability of face detection still lacks on the system. The existing face database need to be updated
NAVAZ [25]	The accuracy is high due to the combination PCA with ANN. ANN use for classificaton is more accuracy than PCA with Eigenface	The computation time and implementation cost is higher because of combine PCA with ANN
N.Kar [24]	The system have prevented the fake attendance due to the implementation clock time in and time, which used for checking the student presence inside the class for the period or not	The recognition task is high only in frontal face. In the direction of $54°$ the accuracy only 58%
Joseph [3]	The pre-processing cropping the region of interest that make the accuracy more higher.	The system have tested with the single images only based on the result.
E.Reakha [18]	The pre-processing cropping the region of interest that make the accuracy more higher.	The author implmeneted only PCA and Eigenface. Due to the algorihtm implmeent in they system, so the computational cost is high.
P.Wagh [22]	Providing a better accuracy by implementation Ada-Boost algorithm on Face Detection. The database is update to date with the new images. Skin classification use for improving the accuracy of face detection	The will be a fake attendance if the student just come in classroom and then go back before the end of class period

[28], and PCA with ANN and Wavelet [29]. Each paper shows that the system accuracy is higher than the system with PCA that is not incorporated with ANN.

VI. CONCLUSION

This paper reviews several methods in terms of overall system capacity, throughput, and accuracy. The result shows that the PCA algorithm is incredibly effective in extensive database. PCA has better performance in the system of attendance management based on facial recognition than manual attendance system that is time-consuming. Convolutional neural network also contributes to attendance management system based on facial recognition by providing strong classifier. The focus in future work is improving the accuracy of the system by incorporating principal component analysis with convolutional neural network. The objective is to obtain good generalization abilities. In [25], ANN and PCA has been integrated to solve a blocking issue of attendance management system based on facial recognition. However, this system still has issues with system performance and accuracy in recognizing human face. Future work will use fast PCA with back-propagation to resolve this problem.

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