Implementation of The LDA Algorithm for Online Validation Based on Face Recognition

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Abstract. This paper report work in implementation of computer vision application in face recognition to the on-line validation for distance learning. Face recognition is chosen among many other alternatives of validation because its robustness. The problem with basic validation such as password cannot validate the student in distance learning. This cannot be accepted especially is distance examination. Face recognition algorithm used in this research is Linear Discriminant Analysis (LDA). By using this algorithm, the system capable of recognize the authorized persons about 93\% and reject the unauthorized persons 100\%.

1. Introduction

In some of last decades, the use of biometric security system was widely discussed in the world of computer vision and pattern recognition research. Face recognition is one of the biometric technology has now been applied for many applications in the fields of security, such as Access security system, Authentication system, and as a tool in tracking criminals [1]. High security system is one of the reasons the biometric continue to be developed, where the workings of the biometrics cannot be imitated and transferred to the second party. Some government agencies now select system security by using face recognition biometric.

Distance educations require authentication systems in order to find out the validity of their participants. Distance education itself is a system of education where teaching and learning among teachers and learners are not limited by space and time [2]. Some contents of e-learning and distance learning, such as [3][4], should be limited to the only member of the distance learning group. Authentication using face recognition can be a solution to overcome the anxiety of the Government in implementing a system of distance education.

Face recognition system offers some algorithms in the process of face identification. Linear projection method is one of the most commonly used algorithm in the application of face recognition system [5]. The process of this method is by projecting the image pixels into a matrix. Then, matrix is converted to a single-dimensional as vector data to obtain the eigen value and covariance value. This method is applied on the two Principal Component Analysis algorithms (PCA) and Linear Discriminant Analysis (LDA). The purpose of PCA and LDA methods solely to reduce the dimensions of high dimensional space into a low-dimensional space.

In this research, the education is based on distance online system. The proposed security system used the student ID number as user and face recognition as password to access the system. The algorithm used in this research is the LDA.

2. Face recognition and Algorithms
Face recognition is a complex problem in the verification process and identification of a face through the digital images or video frames [6]. The process of face recognition in a digital image or video frame is not an easy job. There are some challenges in the process of face identification on an image as follows [7]: intensity, pose, face rotation, and occlusion.

To overcome difficulties at the identification process of face image, it should take the right algorithm. In general, there are two techniques that are proposed, namely the approach of local features and holistic approach [8]. But lately, the development of new technique in the form of hybrid approach has already been done, i.e. a merger between engineering approach of holistic and local features.

### 2.1 Principal Component Analysis

![PCA Base (left) and PCA reduction to 1 d (Right) [9]](image)

PCA is a standard technique for high-dimensional data visualization and for pre-processing of data [9], [10]. PCA can reduce data dimension without losing relevant information. Extracting the space component of the lower dimensions includes the highest variant. Figure 1 shows the data reduction process of the PCA.

### 2.2 Linear Discriminant Analysis

Like PCA, LDA is also an algorithm which aims to reduce dimensions. LDA finds an optimal projection so that it can project the input data on space with smaller dimensions where all patterns can be separately maximized [11][12]. Separation of the LDA will maximize the dissemination of data-input between different classes and also minimizing the spread of input in the same class. The difference between the class represented by the matrix of the Sb and the difference in class is represented by the matrix Sw [13].

![The difference of covariance between PCA and LDA [7]](image)

Weight matrix Transpose PCA is the input for the LDA, this shows clearly that most of the algorithm LDA must run view steps through the PCA algorithm. The following algorithm LDA [10]:
- Vector data input from transpose weight PCA become input to the LDA:

  $X = [x_{11}, x_{12}, ..., x_{1n}, ..., x_{21}, x_{22}, ..., x_{2n}, ..., x_{m1}, m2, ..., mn]$.
• Calculates the spread between classes \( (S_b) \) and grade \( (S) \):

\[
S_w = \sum_{j=1}^{n} \sum_{i=1}^{N_i} N_i (x_i^j - \Psi_j)(x_i^j - \Psi_j)^T
\]

\[
S_b = \sum_{i=1}^{n} N_i (\psi_i - \Psi)(\psi_i - \Psi)^T
\]

**Description:**
- \( N_i \) = The number of data training in class \( i \)
- \( n \) = The number of different class
- \( \Psi \) = The Mean total of vector to a sample to the \( i \)
- \( \psi_i \) = The Mean of the sample on to the \( i \)
- \( x_i^j \) = vector of PCA from pictures to \( i \) and results from classroom to \( j \)

• Calculate the value of the Covariant LDA with formula \( C = S_b S_w^{-1} \)

• Then calculate the value of the Eigen vector and eigen value equations:

\[
S_b \psi_i = \lambda_i S_w \psi_i
\]

**Description:**
- \( \lambda_i \) = Value of the eigen value LDA
- When the eigenvalues are lined up in ascending order, a matrix consisting of eigenvectors \( q \) becomes EQ [13].

\[
\nu_{LDA} = [\psi_1, \psi_2, \ldots, \psi_q]
\]

**Description:**
- \( \nu_{LDA} \) = Value of the eigen vector LDA

• Calculating Feature Matrix equation with LDA:

\[
f = \sum_{n=1}^{N} (P - \psi)^T \times v
\]

**Description:**
- \( f \) = the value of the features of the PCA

3. The proposed Research Method

This research used a holistic approach with LDA algorithm. The system is tested using 10 dataset classes. Each class consists of 8 image training. Following are the steps in the process of face detection:

- Enrollment

At this point students enrolled in Distance Education website. This image will be stored in MySQL database as the training image. Figure 3 shows one of the training picture stored in Mysql.

![Image](image.jpg)
• Face detection
The following are the steps: Convert to grayscale image, Generate histogram of grayscale image, Equalize the image, Generate histogram of equalized image, Remove noise from an image, then the image classification of skin. Figure 4 and 5 show the process enhancement and face detection.

Figure 4. Process enhancement to grayscale image

Figure 5. The Process of Face Detection

The process of face detection algorithm using viola jones but this research not emphasis on discussion of this algorithm.

• Training Image
This stage uses LDA algorithm to train images stored in database after previous process. Figure 6 shows the results of LDA training.

Figure 6. Result of LDA training

• Face Recognition
LDA algorithm becomes the final determinant in defining the face is recognizable or not in this process. Figure 7 shows the whole system.

Figure 7. Online Distance Education System
4. Results and Discussion

This system was built using two different programming languages, on the side of the client/participant using the PHP programming language and on the server side using Java. System testing is performed with 10 participants, and 8 pictures for each of them. Each participant performs login tests to the system as much as 10 times to find out how it performs.

Table 1 shows the results of the testing participants who have already registered in the system. The results show that the system can work well when a face is unregistered. Average percentage indicates the level of accuracy as much as 93%. Error system shows the percentage of 7% at some login tests. e.

Table 1. The test results using the data training 8 per class for participants who enrolled in a Distance Education system.

| No. | The initials | The Number of Test | To be known | Not Recognized | The accuracy of the % | Error % |
|-----|--------------|--------------------|-------------|----------------|-----------------------|---------|
| 1   | User 1       | 10                 | 9           | 1              | 90%                   | 10%     |
| 2   | User 2       | 10                 | 10          | 0              | 100%                  | 0%      |
| 3   | User 3       | 10                 | 10          | 0              | 100%                  | 0%      |
| 4   | User 4       | 10                 | 8           | 2              | 80%                   | 20%     |
| 5   | User 5       | 10                 | 9           | 1              | 90%                   | 10%     |
| 6   | User 6       | 10                 | 9           | 1              | 90%                   | 10%     |
| 7   | User 7       | 10                 | 10          | 0              | 100%                  | 0%      |
| 8   | User 8       | 10                 | 10          | 0              | 100%                  | 0%      |
| 9   | User 9       | 10                 | 9           | 1              | 90%                   | 10%     |
| 10  | User 10      | 10                 | 9           | 1              | 90%                   | 10%     |
|     | Average      |                    |             |                | 93%                   | 7%      |

In addition to conducting trials on the participants who have registered in the database, testing is also done on a user who is not listed in the database. Table 2 shows the percentage of 100%, where the face who tries to login and not listed on the database cannot access the system.

Table 2. The test results for a user who is not enrolled in a Distance Education system

| No. | The initials | The Number of Test | To be known | Not Recognized | The accuracy of the % | Error % |
|-----|--------------|--------------------|-------------|----------------|-----------------------|---------|
| 1   | User 1       | 10                 | 0           | 10             | 100%                  | 0%      |
| 2   | User 2       | 10                 | 0           | 10             | 100%                  | 0%      |
| 3   | User 3       | 10                 | 0           | 10             | 100%                  | 0%      |
| 4   | User 4       | 10                 | 0           | 10             | 100%                  | 0%      |
| 5   | User 5       | 10                 | 0           | 10             | 100%                  | 0%      |
| 6   | User 6       | 10                 | 0           | 10             | 100%                  | 0%      |
| 7   | User 7       | 10                 | 0           | 10             | 100%                  | 0%      |
| 8   | User 8       | 10                 | 0           | 10             | 100%                  | 0%      |
| 9   | User 9       | 10                 | 0           | 10             | 100%                  | 0%      |
| 10  | User 10      | 10                 | 0           | 10             | 100%                  | 0%      |
|     | Average      |                    |             |                | 100%                  | 0%      |
5. Conclusion

From the results of this research it can be concluded that the online system could run on face authentication system using LDA algorithm. Some failure in the system are results of this holistic approach is still caused by several factors such as how big a difference the intensity of light received by each of the pictures, poses, and other additional attributes.

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