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Comparison Of LBPH, Fisherface, and PCA For Facial Expression Recognition of Kindergarten Student

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Abstract: Face recognition is the biometric personal identification that gaining a lot of attention recently. An increasing need for fast and accurate face expression recognition systems. Facial expression recognition is a system used to identify what expression is displayed by someone. In general, research on facial expression recognition only focuses on adult facial expressions. The introduction of human facial expressions is one of the very fields of research important because it is a blend of feelings and computer applications such as interactions between humans and computers, compressing data, face animation and face image search from a video. This research process recognizes facial expressions for toddlers, precisely for kindergarten students. But before making this research system Comparing three methods namely PCA, Fisherface and LBPH by adopts our new database that contains the face of individuals with a variety of pose and expression. which will be used for facial expression recognition. Fisherface accuracy was obtained at 94%, LBPH 100%, and PCA 48.75%.

Keywords: Eearly Health Detection; Kindergarten; Facial Expression Recognition; PCA, Fisherface; LBPH.

1. Introduction

Kindergarten is the earliest level of education before entering the world of formal education or commonly called elementary school. For ordinary kindergarten students aged 0-5 years. The introduction of facial expressions has become a very important field for a variety of studies over a long period of time [1]. Prolonged controversies sometimes even heat up, failing to show whether facial behaviors related to emotions are universal for men or specific for each culture [2]. This study focuses on the facial expressions of children for toddlers (around 0-5 years). In contrast to adults who have six types of sad, confused, happy, afraid, angry, and shocked facial expressions [3], kindergarten students only have four types of expressions that they normally display namely happy, smiling, sad and sleepy.

Facial expressions recognition is a popular study in the field of computer vision[4]. This system is useful for making smooth interactions between humans and computers [1]. There are many studies regarding the introduction of expressions using video technology [5]. The system for recognizing facial expressions of infants and young children began to be developed around 1980 [5]. This study compares three methods of recognizing facial expressions of students, namely PCA, Fisherface and LBPH. Using 342 training data that we obtained from the John Kenade dataset, Jeffa dataset, and facial expression dataset obtained directly into kindergarten. The data were tested using 80 images consisting of 20 sad expressions, 20 happy expressions, 20 sleepy expressions, and 20 smile expressions. Furthermore, the best method for the recognition of facial expressions will be used for early health detection systems.

2. Technical Review

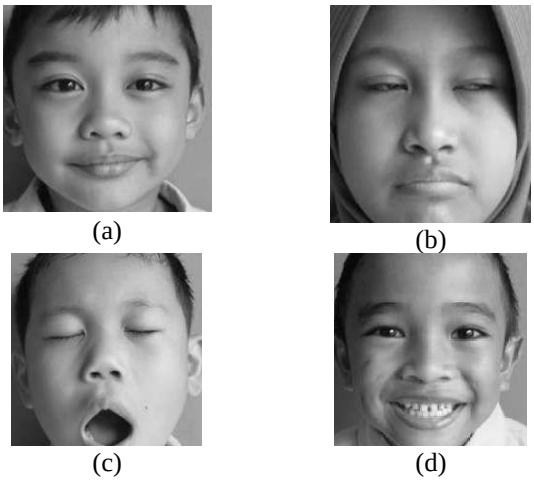
2.1. Face Detection

Face detection is a challenge with increasing use in several applications. This is the first step for facial recognition, facial analysis, detection of other facial features [6]. In this case, we recommend using the haar cascade method. This method allows the background area of the image to be disposed of quickly while spending more calculations in the area such as promising objects [7].

Figure 1. Face Detection

2.2. Expression Recognition

The challenges of facial recognition such as variations in poses, changes in expression, reduction of illumination of object identification and verification performance [8]. Beginning with face recognition, images are processed to find out facial expressions[9] displayed. There are four expressions that are often displayed by kindergarten students namely "happy", "sleepy", "sad", "smile". Apart from the many types of facial expressions, these four expressions are the expressions most often highlighted by kindergarten students.



(a) (b)

(c) (d)

Figure 2. Exspression Classification : (a) Happy, (b) Sad, (c) Sleepy, (d) Smile

2.3. PCA

Principal Component Analysis (PCA) is a classic feature extraction method and data representation technique that is widely used in pattern recognition [10] ven the introduction of facial expressions. This section describes the eigenface approach [11]. This method is effective in removing irrelevant information in images and overcoming their shortcomings [12]. Figure 3. Describing the steps of the PCA process.

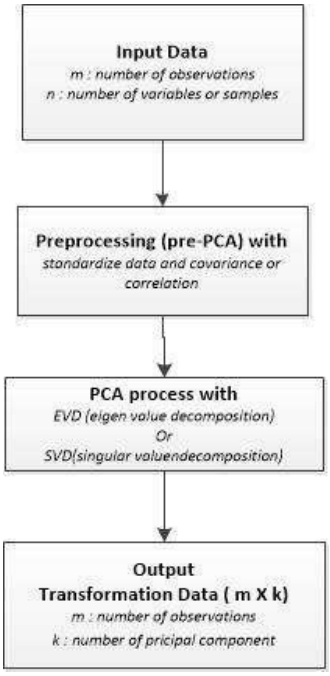


Figure 3. Step of PCA

This face recognition approach aims to describe face images into a small set of characteristic feature images called eigenfaces[13] that are used to represent existing and new faces. The training database consists of M mages of the same size. The image is normalized by converting each image matrix to an image vector equivalent to T_i. The training set matrix is a set of vector images with.

$$\text{Training set } T = [T_1,\ T_2, \dots, T_m] \tag{1}$$

Face average(ψ) is an arithmetic mean vector as given by:

$$\psi = \frac{1}{M}\sum_{i=1}^{M} T_i \tag{2}$$

The vector deviation for each image ϕ_i is given by :

$$\phi_i = T_i - \psi \qquad i = 1,2, \dots, M \tag{3}$$

Consider the difference matrix$A = [\psi_1, \psi_2, \dots \dots \psi_M]$ which only stores the distinguishing features for face images and deletes common features. Then eigenfaces are calculated by finding the Covariance C matrix from the training vector image with:

$$C = A.A^T \tag{4}$$

Because of the large dimensions of the C matrix, we consider the size of the matrix L $(M_t \times M_t)$ which gives the same effect as reducing dimensions.

The eigenvector of C (matrix U) can be obtained by using the eigenvector L (matrix V) as given by::

$$U_i = AV_i \tag{5}$$

The eigenfaces is :

$$eigenface = \left[U_1, U_2, U_{3,\dots,} U_M\right] \tag{6}$$

Instead of using M eigenfaces, m '<= M was chosen as eigenspaces. Then weights each eigenvector ω_i to represent the image in the eigenface space, as given by:

$$\omega i = {U_i}^T(T - \psi), i = 1,2, \dots, m' \tag{7}$$

$$\text{Weight matrix } \Omega = [\omega 1, \omega 2, \dots, \omega_{m'}]^T \tag{8}$$

$$\text{Average grade projection } \Omega_\Psi = \frac{1}{x_i}\sum_{i=1}^{x_i} \Omega_i \tag{9}$$

Euclidean distance δ_i (8) used to find out the distance between two face key vectors and given by :

$$\delta_i = \|\Omega - \Omega_{\Psi i}\| = \sum_{k=1}^{M}(\Omega_k - \Omega_{\Psi ik}) \tag{10}$$

The smallest distance is considered the result of a face match score.
In this study, we saved several training images into eigenface. Images display training images that have been changed to eigenface based on the classification of expressions:

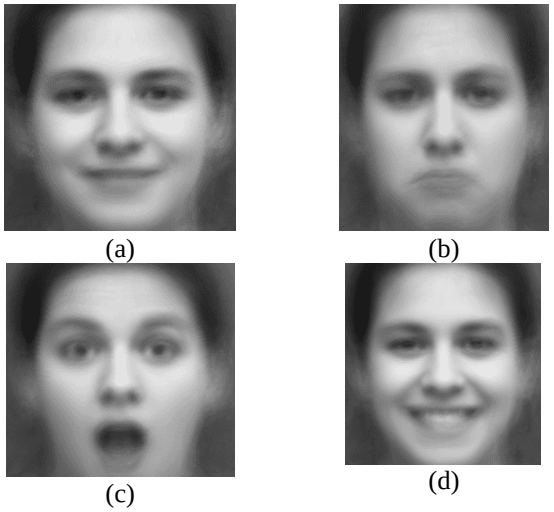


Figure 4. Eigenface (a) Happy, (b) Sad, (c)Sleepy, (d) Smile

2.4 FisherFace Recognition

FisherFace is an algorithm that uses linear methods to solve the problem of sensitivity to light conditions in facial recognition[14]. Fisherface is one of the best facial recognition methods that achieve 68% accuracy without threshold[15]. accuracy charts are displayed in figure 5.

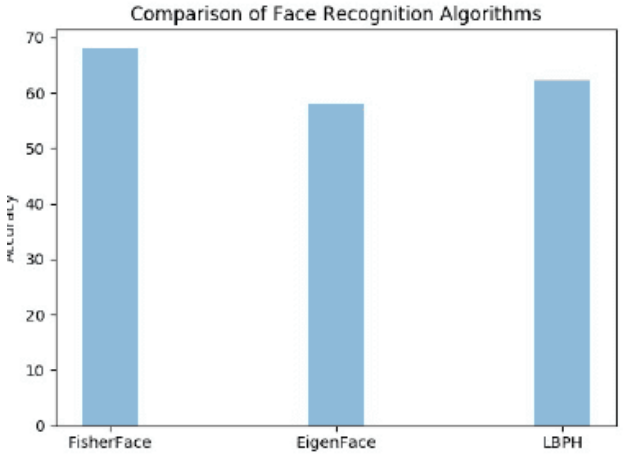


Figure 5. Comparison of accuracy of Fisherface, Eigenface and LBPH algorithms without threshold

Fisherface considers the face class as an addition to the eigenface, although both methods use PCA to reduce the existing dimensions. However, eigenface does not distinguish facial images from other classes [16]. Instead, Fisherface uses linear discriminant analysis [14] to distinguish faces between classes. The aim is to maximize the ratio of variation between classes with variations in a class. The scatter matrix in the class is defined as :

$$S_W = \sum_{i=1}^{C} \sum_{\chi_j \epsilon X_i} (\chi_j - \mu_i)(\chi_j - \mu_i)^T \quad (11)$$

Then the inter-class scatter matrix is defined as:

$$S_B = \sum_{i=1}^{C} N_i \, (\chi_j - \mu_i)(\chi_j - \mu_i)^T \quad (12)$$

Where μ_i is the average image of X_i and N_i is the sample number in class X_i in total class c then, to find the projection W that maximizes class separation by solving the eigenvalue equation. As an eigenfaces method, fisherface uses PCA to reduce dimensions. In addition, Fisherface uses LDA on dimensional features that are reduced after PCA [16].

2.5. LBPH

Local Binary Pattern Histogram (LBPH) is a local feature based on facial representation proposed by Ahonen et al.[17],[18]. This method is based on a local binary pattern (LBP), which was first proposed as a texture description method, the appearance of the LBP code in an image collected in a histogram. Classification is then done by calculating the similarity of a simple histogram. However, considering the same approach for facial image representation results in a loss of spatial information and therefore, people must encode texture information while maintaining their location. LBPH has an invariant advantage over light intensity but requires more processing time than a holistic approach [19] .
The histogram of an image labeled $f_I(x, y)$ can be specified as:

$$H_i = \sum_{x,y} I\{f_i(x,y)\}\, i = 0, \dots, n-1 \quad (13)$$

Where n is the number of different labels produced by the LBP operator and

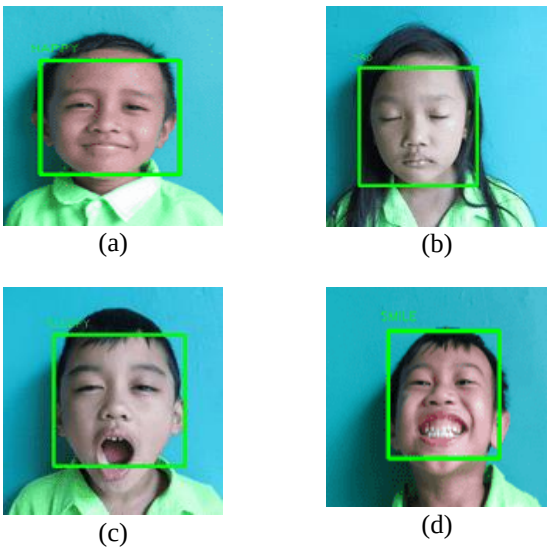
$$I\{A\} = \begin{cases} 1 & A \text{ is true} \\ 0 & A \text{ is false} \end{cases} \quad (14)$$

Histograms obtained from images containing information about local facial micro patterns including face edges, student facial expressions, eye location, and other flat areas for adequate facial representation. Comparative studies were conducted to determine the best type of facial expression recognition algorithm.

3. System Design

This study uses python as a collaborative programming language using open cv as a library. his is an image from the introduction of expressions using all three methods :

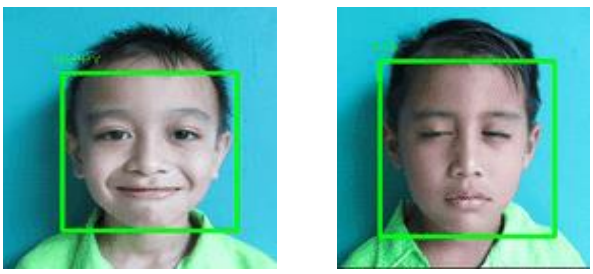
3.1. Used PCA



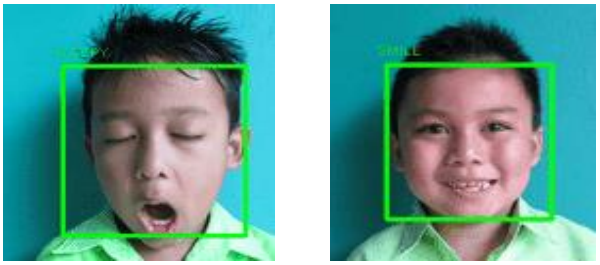
(a) (b) (c) (d)

Figure 6. Facial expression using PCA (a) Happy, (b) Sad, (c)Sleepy, (d) Smile

3.2. Used Fisherface



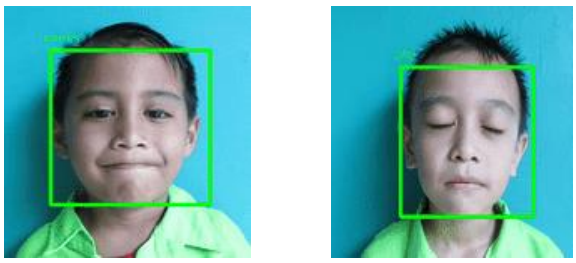
(a) (b)



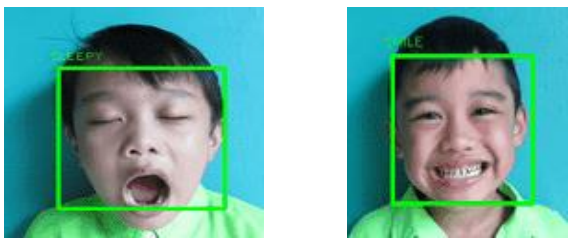
(c) (d)

Figure 7. Facial expression using FisherFace (a) Happy, (b) Sad, (c)Sleepy, (d) Smile

3.3. Used LBPH



(a) (b)



(c) (d)

Figure 8. Facial expression using LBPH (a) Happy, (b) Sad, (c)Sleepy, (d) Smile

4. Result and Discussion

This study used 80 test data which was divided into 4 classes, 20 sleepy facial expressions, 20 sad face expressions, 20 happy facial expressions, and 20 smiling facial expressions. This study used 342 training data consisting of 70 happy expression faces, 87 sad expression faces, 97 sleepy facial expressions, and 88 facial smile expressions. the training process uses Fisherface, PCA, and LBPH methods. for a comparison of the accuracy of each method used, shown in table 1.

Table 1. Comparison Table

Method	Result	
	Number Of Face	*Accuration*
PCA	80	48,75%
FisherFace	80	93,8%
LBPH	80	100%

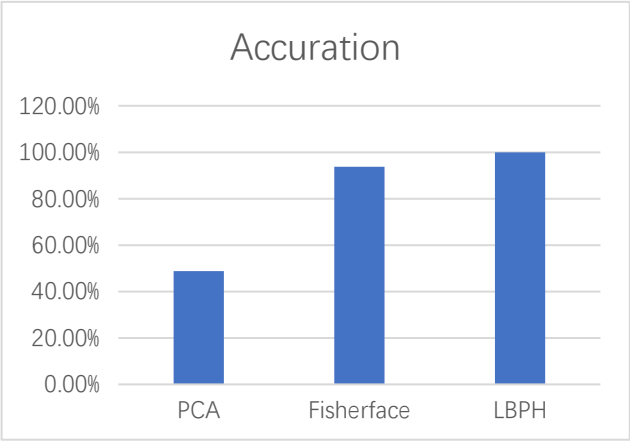


Figure 9. Recognition accuracy comparison chart

The placement of cameras and lighting is still the main cause so that the introduction of facial expressions has difficulty in carrying out the process. The camera should be installed with a distance not too far away and not too high with the object so that it can obtain clearer and better image quality.

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