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SIMILARITIES MEASUREMENT **OF** FACE EXPRESSION-RECOGNITION **BASED**

ON 2DLDA MODIFICATION METHOD 1FITRI DAMAYANT, 2WAHYUDI SETIAWAN, 3SRIHERAWATI, 4AERI RACHMAD 1,2,3,4

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1fitri2708@yahoo.com, 4aery_r@yahoo.com ABSTRACT Facial expression recognition is the development of face recognition in an environment of pattern recognition (feature recognition). Research on facial expression recognition is very useful in many fields, for example

33**in the field of human computer interaction, in**

this case the computer recognizes facial expressions of the user, then the computer programmatically perform the appropriate instructions to the facial expression of the user. Facial expressions can also be used as a measure of customer satisfaction with public services. In this study, the facial expression recognition applications were built to measure customer satisfaction with the process of feature extraction using the Modified Two Dimensional Linear Discriminant Analysis (Modified 2DLDA) to obtain input characteristics on each face. 2DLDA modification method is the development of methods 2DLDA; which may have the similarity measurement using Euclidean Distance, Manhattan Distance, and Two Dimensional Correlation Coefficient. The combination of these test methods uses Jaffe database which is a database that contains Japanese female facial expression. The highest test results using the Euclidean Distance is 88.57%, the Manhattan Distance method is 89.92%, and the method Two Dimensional Correlation Coefficient of 90.48%. Keywords: Facial Expressions, Euclidean, Manhattan,Two Dimensional Correlation- Coefficient, Modified 2DLDA 1. INTRODUCTION Intelligent system is a system that allows the computer to have a system of reasoning and intelligence thinking like human. The development of intelligent systems have several research fields such as pattern recognition, geographic information systems, decision-making systems, and others. Recognition system facial expression is the development of face recognition system which in an environment of pattern recognition now is more and more being studied. This is because the demand to develop something is more advanced in the field of intelligent systems. So that the computer does not only recognize a person's face, but also to recognize facial expressions of someone including anger, disgust, fear, happiness, neutral, sad or surprised. There are several studies of such facial expression recognition research which is done by Neeta Sarode, Shalini Bhatia in 2010, entitled "Facial Expression Recognition" [1]. Their study was about crating software for facial expression recognition using local 2D appearance-base approach and data test using Jaffe database. These studies showed recognition with an accuracy of 81%. Yong Xu, Zhu Qi, Yan Chen in 2013 also have similar research which is entitled

31**"An Improvement to the Nearest Neighbor Classifier'** s **Face Recognition**

Experiment" [2]. The study discusses the use of a modified method of nearest neighbor for facial expression recognition. The data test are AR database. These studies showed recognition with an accuracy of 89%. Mandeep Kaur, Rajeev Vashisht, Nirvair Neerv in 2010, was doing a research in the same area which is entitled

28**"Recognition of Facial Expressions with** Principal **Component Analysis** (PCA) **and Singular Value Decomposition**

(SVD)" [3]. This study uses Princicpal

> 29**Component Analysis (PCA) and Singular Value Decomposition (SVD)** for the **introduction**

of facial expressions which the database also used Jaffe database. The level of accuracy of the study reached 80%. Broadly speaking, research on facial expression recognition system has two stages. The first stage is the feature extraction, which is taking the features in the image, so that the feature is different between an image with another image.

> 19**ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195 The** second step is **the** measurement **of** similarity, which is **the** measurement between **the**

image of testing with the image of training is to get the value that is used as a benchmark to find the most similar image. Methods

> 16**Linear Discriminant Analysis (LDA)** is **a method** of **extracting feature that**

is aimed to find the projection linear (commonly called the 'fisherimage'), to maximize matrix covariance between objects (between-class covariance matrix), and also to minimize matrix covariance within the object itself (within-class covariance matrix) [4]. LDA also imposes a separate statistical properties of each object [5]. The LDA method uses models based on vector data representation. Generate vectors typically have a higher dimension. This is a drawback of the method of LDA [6]. Method Two Dimensional Linear Discriminant Analysis (2DLDA) directly assess within-class scatter matrix of images without image transformation matrix into a vector, and it solves singular problems in within- class scatter matrix [7]. 2DLDA uses fisher criterion to find the optimal projection discriminatory. Methods 2DLDA search the value of R and L values which are used

> 32**to calculate the within- class and between-class scatter**

scatter. So there are two values within-class scatter i.e. S WR dan S WL ,, as well as the value of two S Rb and S Lb

> 9**between-class scatter. The** calculation **of** two values **within-class scatter** and **the**

two values between-class scatter causes computation which is required even greater. Modification Method

> 13**Two Dimensional Linear Discriminant Analysis** (Modified **2DLDA)**

directly assess without transformation matrix image into vector image. 2DLDA modification method calculates the value of

> 4**within-class scatter and the between-class scatter** values. This **can**

reduce the computation time required. In this study, we modified the method of

> 3**Two Dimensional Linear Discriminant Analysis** (Modified **2DLDA).** This **2DLDA** modification method **can**

directly assess without transformation matrix image into vector image. Moreover, this method calculates the value of

> 4**within-class scatter and the between-class scatter** values. It also **can**

reduce the required-computation time which is compared to use 2DLDA. 2DLDA modification method is used as a feature extraction and an introduction of process using several methods of measurement of distance, namely: Euclidean Distance, Manhattan Distance, and Two Dimensional Correlation Coefficient. The results from the combination of these methods were compared to obtain optimal accuracy results 2.

> 30**SYSTEM DESIGN 2.1. Feature Extraction Feature extraction** in **the**

training process is conducted by using Modified Two Dimensional Linear Discriminant Analysis (Modified 2DLDA). This stage aims to get the features that are selected from the data enter training. These features are selected obtained from all the facial features, look for eigenvalues and eigenvectors greatest. Features that are selected will be used for the classification process is used for training and testing data feature extraction. Feature extraction in the testing process is done by taking the feature extraction results on the training process applied to the test data. Feature extraction results on this test data will be used as input to the classification process testing. 2.2.

> 17**Two Dimensional Linear Discriminant Analysis** (2DLDA) 2DLDA **is the** development **of**

methods of LDA. In LDA on face recognition with 2D matrix, it must first be transformed into a one-dimensional shape vector image. While on 2DLDA or image projection technique which is called as direct matrix 2D facial image

> 9**does not need to be transformed into** the form of **a vector** image, but scatter **image matrix can be** formed **directly** by **using the original image**

matrix. {A1,….,An}is n matrix image, where Ai (i=1,…,k) is r x c matrix. Mi (i=1,…,k)

> 13**is the average of the** classroom to the **training** image **i**

and

> 13**M is the average image of** all **training**

data. Assuming ?1 x ?2 dimension(dimensionalspace) L?R shows the tensor product, L span {u1,…,u?1}

and R span {v1,..,v?2}. Thus, it defined two matrix

8L = [u1,…,u?1] and R = [v1,..,v?2][

8].

6Feature extraction method is to find the

2L and R so that the space of the original image (original image space)) Ai is

converted into low- dimensional image space which becomes Bi = Bi=LTAiR.

6Low dimensional space is obtained by a linear

transformation L and R, the distance Db between-class and within-class distance Dw defined in equation (1) and (2). Db= ?i?1ni LT(Mi ?M)R k 2 F , (1)

20ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195 Dw = ? ? LT (X ? M i) R 2F , k (2) i? 1 x ??i

where F is Frobenius norm. The review is A 2 F = Ptrace(ATA) = trace(AAT) to A. So that the equation (7) and (8) can be further represented as the equation (3) and (4).

2Db=trace(?niLT(Mi ?M)RRT(Mi ?M) TL), k i?1

(3)

2Dw = trace(? ?LT(X ? Mi)RRT(X ? Mi)T L). k i?1

x??i (4) Similarly, LDA,

62DLDA method is to find the

matrix L and R, so

6that the class structure of the original space remains in the projection room. So, the benchmark (criterion) can be defined as

an equation (5). J1(L,R) = max Db . (5) DW It is clear that the equation (5) consists of the

23transformation matrix L and R. The

optimal

23**transformation matrix L and R can be** obtained **by**

maximizing Db and minimizing Dw. However, it is very difficult to calculate the optimal L and R simultaneously. Two optimization functions can be defined to obtain L and R. For a definite R, L can be obtained by completing an optimization function according to the equation (6). J2(L) = maxtrace((LTS WR L)-1(LTS bR L)), (6) which SRb =

2**?ni(Mi ?M)** RRT **(Mi ?M)T,** k (7) **i?1**

S R k W = ? ?

15**(X ?Mi)** RRT **(X ?Mi)T.** (8) **i?1 x??i**

Note that the size of the matrix and SWR dan S Rb is r x r

2**smaller than the size of the** matrix **Sw and Sb in classical LDA.**

For a definite L, R can be obtained by solving the optimization function in equation (9). J3(R) = maxtrace((RTS WL R)-1(RTS bL R)), (9) which S bL =

8**ni (M i ? M)T LLT (M i ? M**) , k ? **i?1**

(10) k S L W = ? ?

8**(X ? M i)T LLT (X ? M i), i?**

1 x??i (11) S Lw and S bL matrix size is c x c is

2**smaller than the size of the** matrix **Sw and Sb in classical LDA.** 2.3 Modification **of**

38**Two Dimensional Linear Discriminant Analysis** (Modification of **2DLDA)**

This method is the development of 2DLDA methods which can calculate

17**class-scatter and within-class scatter** only once. **So** that, **the**

computing time is less than the 2DLDA method.

4**In this method, the** calculation of 2DLDA **between class scatter and within class scatter**

is done twice, they are calculating S Lw dan S bL , SWR dan S Rb . The method of computing time 2DLDA is used to perform feature extraction of O(n3), whereas the method of modification 2DLDA only takes amounted O(n2). Here is the algorithm method 2DLDA Modification: 1. Input is a matrix x 2. Calculating mi= 1 n x??i x is the average i ? class i, and m = n ?ik?1 ? 1 x??i x is the global average. 3. Calculating the

26**between class scatter matrix. Between class scatter matrix (Sb)** is **the** distance matrix **between classes.**

In accordance with the equation

15**Sb = ? k i?1 ni (mi ? m)(mi ? m)T**

4. Calculating the

4**within class scatter matrix. Within class scatter matrix** (Sw) **is the**

distance matrices in the same class. In accordance with tShwe=eq?uaitk?io1?nx??i

37**(x ? mi)(x ? mi)T** 5. Calculating **the**

generalized eigenvalue (?i) and eigenvector (V) of Sb dan Sw in accordance with equation (12) using SVD. Z= . (12)

10**ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195 2.**

4 Distance Measure Facial expression recognition is essentially matching two facial expressions by constituting one facial expression facial expressions which have been trained and placed in a database; and then compared with images or image expression test of new facial expression. The match is using the distance measurement method. Basically, the distance measurement is used to calculate the difference between the two vectors images in eigenspace. After the image is projected into space facial expression of the face, the next task is to determine where the image of a facial expression is most similar to the image in the database. There are many ways to measure the degree of similarity and distance among the Euclidean distance, Manhattan, and 2D Correlation Coefficient. Moreover, it will ultimately be compared to the distance which has the highest level of compatibility. 2.5 Euclidean Distance Euclidean space is finite-dimensional space with valuable real. Euclidean distance between two points is the length of the hypotenuse of a right triangle. Where x is the image of training and y is the input image test. If

18**x = (x1, x2, x3, ..., xn) and y = (y1, y2, y3, ..., yn) are** two **points in** space Eulidean **n, the**

Euclidean distance x to y is according to the equation (13) : (13) If the vector in Euclidean Distance value

is close to 0, then the image of testing and training image is stated to resemble. 2.6 Manhattan Distance Manhattan Distance is one of the most widely used measurement which involves replacing the squared difference by summing the absolute differences of the variables. This procedure is called absolute block or better known as the city block distance. Equation (14) is a measurement using the Manhattan Distance. (14) If the vector in Manhattan Distance value is close to 0, then the image of testing and training image stated to resemble. 2.7 2D Correlation Coefficient In this study, the third method is used to measure the similarity is 2D Correlation Coefficient This method aims to measure the distance between the image similarity testing with imagery training. Weight matrix testing the data will be processed by the 2D Correlation Coefficient which works by comparing the entire result of reduction in the value matrix of the i-th weight training data and value-i weight matrix to the data of testing with its square root. Data are considered most similar is the maximum value of each data comparison results of testing and training [9]. (15) Where: A = weight training image B = weight testing image = weighted average of the training image = weighted average of the testing image 3. EXPERIMENTS AND RESULTS 3.1 Data Training The trial of facial expression recognition system developed in this study is conducted at the Jaffe Database which was taken from 10 samples of Japanese women. Each women has three poses and 7 expression of happiness, sadness, surprised, anger, disgusted, fear, and neutral. Thus, each sample of 21 poses represents the total data of 210 images. All the images have the intensity of gray (greyscale) with a size of 256 x 256. The parameters which were used in this test were: 1.

> 34**Variation of the** sequence **of training samples** per **class is**

used. In Jaffe Database sequence data taken as training data varies, not sequential as preliminary data in the database. 2. The amount of

> 39**training samples per class** is used. **The** amount **of**

data used in the training process is divided into several scenarios. 3.

> 16**The number of** features taken **in the** process of **training and testing.**

Feature fetch as much as 5, 10 and 15. 3.2 Testing Method Tests on facial expression recognition system developed in this research is done by separating the facial image data in a database into two sets of mutually exclusive (disjoint) i.e. the set of

> 35**training images and test images. The** calculation **of the**

percentage of successful introduction of testing is done on a set image.

> 25**ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195** Scenario testing **is** done by varying **the**

sequence of face images in a database, varying the amount of training data, and varying the features is taken. The test was carried out using five variations in the amount of training data, shown in Table1. Table 1.Test Scenario Figure 2. Graph accuracy of facial expression recognition method 2DLDA Modification and 3.3 Testing Result methods Manhattan These test method are in three groups. The first group uses 2DLDA Modified method for 3.6 Results of Treatment using the Modified feature extraction and Euclidean method is for 2DLDA and methods of 2D Correlation classification. The second group uses modification

Coefficient methods 2DLDA for feature extraction and Figure 3 shows the recognition accuracy classification methods to Manhattan. The third by using Modified 2DLDA and 2D Correlation Coefficient method for making feature 5, 10 and group uses methods Modification 2DLDA for 15. feature extraction and 2D Correlation Coefficient method for classification. The test results for each group of methods can be seen in the following sections of this section: 3.4 The Result of Recognition by Using 2DLDA Modification Method and Euclidean Method. Figure 1 shows the recognition accuracy by using Modified 2DLDA and Euclidean method for retrieval features 5, 10 and 15. Figure 3. The resulting graph the accuracy of facial expression recognition method 2DLDA Modification and methods of 2D Correlation Coefficient 3.7 Analysis and Results of Testing System Figure 1, Figure 2 and Figure 3 show that the number of features has 15 levels higher accuracy than the number of features of 10 and 5. Table 1 shows a comparison among the recognition Figure1. Graph of the recognition accuracy using accuracy and Euclidean method 2DLDA Modified, facial expression recognition 2DLDA modification Modified method 2DLDA and Manhattan, methods methods and the methods of Euclidean modifications 2DLDA and 2D Correlation Coeffisient, which use a variety of testing. The 3.5 Results of Treatment using the Modified conducted fifth scenario test can be seen that 2DLDA and methods Manhattan scenario No. 5 has the amount of training data of Figure 2 shows the recognition accuracy 105. This recognition accuracy rate is higher than by using Modified 2DLDA and methods for the other scenarios. Classification using 2D retrieval features Manhattan 5, 10 and 15. Correlation Coefficient generate higher recognition

24**ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195** accuracy than **the method of**

Manhattan Distance Euclidean Distance. Table 1 Results of comparative recognition accuracy 4. CONCLUSION The highest percentage of accuracy of facial expression recognition using the Modified-2D Correlation 2DLDA Coeffisient is equal to 90.48%. There are three important variables that affect the success rate of introduction, ie sequence variations of

22**training samples per class, the number of training samples per class,** and **the** number **of** features. **The**

factors which affect the failure of an image can be recognized correctly due to the similarity of facial expression or pose different between one person and another person. SUGGESTION This research will continue to develop using classification method other than the method of measuring distance. The test can be developed by using a database of other facial expressions. REFRENCES: [1]

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