Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 10, October - 2017

# Implementation Distance Transform Method in Kernel Discriminant Analysis for Face Recognition Using Kohonen SOM

Bayu Angga Wijaya[1]
[1]Student of Magister Teknik Informatika,
University of Sumatera Utara
North Sumatera, Indonesia, 20155

Amir Mahmud Husein[2] and
Mawaddah Harahap[3]
[2,3]Department of Computer Science
Universitas Prima Indonesia
North Sumatera, Indonesia, 20113

Muhammad Khairuddin Harahap[4]
[4]Department of Computer Science
Politeknik Ganesha Medan
Indonesia

***Abstract*— Face recognition is one of the areas of research are quite popular because it can be used for various fields such as security, passport, access control, etc. face recognition is a process of identification with the image so it can be recognized. There are several techniques used for face recognition, in this study we discussed the combination method of Distance Transform on a Kernel Discriminant Analysis Method to extraction, and the recognition using Kohonen SOM. A combination of these methods we apply with two approaches, the first approach is a combination of KDA-DT-Kohonen, the second is KDA-Kohonen and tested on two datasets: CALTECH and Computer Vision (CE1). The second dataset is used to describe the effect of rotation of the face and background. Extraction of KDA without DT is more accurate as the Kohonen SOM network parameters for recognizing the face at CALTECH dataset.**

***Keywords*— DT, KDA, SOM, Face Recognition**

## I. INTRODUCTION

Face is the most common biometric identifiers used by humans, so a lot of research on face recognition for various purposes [13], such as information security, access control, law enforcement, supervision and police department, military and company [17]. Face has a strong stability and individual differences that make it suitable for authentication [14]. Face image data is always high-dimensional so takes computing to the classification, so it needs to be the implementation techniques of linear discrimination for extracting features that are effective to drain the image dimensions [10].

Principal Component Analysis (PCA) was one method of classification that proved accurate in face recognition because of its ability to extract global structure of a group of high-dimensional data, by reducing in-process data attribute [3], however the features extracted globally, so it's not optimal to distinguish one class the other face. The application of kernel on PCA (KPCA) proposed as a non-linear extension of the PCA to pattern recognition [2], [3], which can effectively be extracting facial features with a nonlinear principal component count in a non-linear space [4]. However, the model PCA and KPCA based on matrix covariant, that is easily influenced by abnormal samples and make the results are not quite stable [15].

Linier Discriminant Analysis (LDA) proved to be used for a variety of applications such as handwriting recognition, face, image segmentation and other, LDA is able to optimization the pattern recognition [5], analysis of the area to distinguish one character with other characters [6], but the LDA is not optimal for multi class [7]. The application of kernel function on the LDA (KDA) can overcome the disadvantage of multi class on LDA, with a level of recognition accuracy that is accurate [9], However, for large sample takes a high computing [8], because the image of a face is a signal that can be fickle [17].

Method of distance transform (DT) is a method that calculates the distance between each pixel on a binary image with the closest point [11] and has proven it can be used for various applications such as image processing, computer vision, pattern recognition and analysis of the geometry and computational geometry [1], so DT method proposed to apply on KDA for facial features extraction, as for face recognition applying Kohonen SOM Neural Network method. Kohonen SOM is one method of unsupervised network which is a process of self-organizing begins with the selection of a random node weights on Kohonen layer, SOM proved accurate in face recognition [19], [13]. This paper is presented as follows: Chapter 2 related research and Chapter 3 Proposed method. Chapter 4 discussion and Chapter 5 conclusion.

## II. RELATED RESEARCH

KDA is the development of LDA method, the application of kernel for extracting non-linear discriminating features and KDA is able to cope with the complicated image variations such as change of pose and illumination (both indoor and outdoor). The basic idea of KDA is a nonlinear mapping $\Phi$: $x \in Rd \rightarrow \Phi(x) \in F$ to data input vector x in input space Rd and then to do the LDA on the feature space mapped by F. The feature space F considered

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 10, October - 2017

as a linier space. However, it can be a great dimension and possibly infinite. Implementation of the LDA method to feature space is not possible. So using the kernel trick, where the product in Φ (xi), Φ (xj) in F can be replaced with a kernel function K(xi, xj), for exc. K (xi, xj) = Φ (xi), Φ (xj) = Φ (xi) T · Φ (xj), which xi, xj is the vector input pattern on the input space Rd. So the nonlinear mapping Φ can be done implicitly in the input space Rd along the line. [16]

In the research of [14] the methods of the LDA/KDA with PCA/KPCA for face recognition Yale sourced UMIST. The test results, the method of LDA/KDA is superior than PCA/KPCA method. The implementation of kernel function can cope with the dimensions of a large space, however implementing the kernel doesn't necessarily ensure better performance and even will degrade performance if it the linear problem. [20] doing research with developing skin detection scheme of amalgamation of Spatial Analysis with modeling Adaptive skin applying distance transform (DT) method to solve a problem that is limited to the territory of the LDA is the size of a large kernel. On the research of [13], proposed discrete cosine transform (DCT) method for the facial characteristics and PCA method for the reduction of spatial, but the kohonen SOM used for face recognition by comparing with DCT DCT + PCA against kohonen SOM for facial characteristics against three different database, testing result of the combination Kohonen DCT is more accurate.

From the above research problems of face recognition based on the accuracy of the results of facial feature extraction is very important to increase accuracy, so in this study, we combine the KDA method for facial feature extraction, DT method to resolve the territorial boundaries of the face and Kohonen SOM for face recognition based on the DT parameter.

## III. PROPOSED METHOD

### A. *Kernel Discriminant Analysis (KDA)*

The basic principle of KDA method are illustrated in Figure 1, the implementation of kernel function to overcome the weakness of the non-linear properties are difficult to compute directly discriminatory characteristics between two classes of pattern space input (image), so the separataion of image features in linier is need to be done.

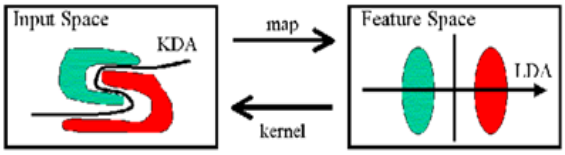


Fig 1. Kernel Discriminant Analysis

In figure 1, is an input image that need the distribution with the separation of image features in linier to feature space based on a non-linear mapping from the input space to high-dimensional feature space (right). By implementing the appropriate kernel functions with a non-linear mapping, eigen decomposition problem can be solved. Implementation kernel, LDA's operation initially linier performed a mapping for high-dimensional feature with a non-linear mapping with the aim to find a transformation that maximizes the variance between classes and minimizing the variance in the class with equation:

$$J(\alpha) = \frac{\alpha^T S_B \alpha}{\alpha^T S_W \alpha}$$

become (1)

$$S_B = \sum_{c=1}^{C} (\mu_c - \bar{x})(\mu_c - \bar{x})^T \qquad S_W = \sum_{c=1}^{C} K_c (I - 1_{lc}) K_c^T$$

Where Kc is a kernel matrix to class c, uc is the column that mean vector for Kc, I is the identity matrix, LC is the number of samples in the class c and 1lc is a matrix lc x lc with all the entries 1/lc.

### B. *Distance Transform (DT)*

The purpose of the implementation DT method is to find the closest distance of binary image with the count every pixel of the image and the nearby points, map of the possibility of writing the numbers based on the Euclidean distance or distance in common vector of writing numbers with non-writing number calculated in the appearance of writing numbers on every pixel of the x and y reference pixel, the definition is as follow:

$$Dx = \left[ \sum_{i=1}^{n} \left( v_i^{(x)} - v_i^{(r)} \right) \right]^{\frac{1}{2}}$$

Where $v_i^{(x)}$ is dimension I from the vector distance transform the appearance of the writing number that appear to pixel x, I is dimension, while n the number of dimensions, x is the weight vector of the first class, r is the second.

### C. *Kohonen SOM*

Kohonen Classifier Self-Organizing Maps (SOM) introduced by a Finland, Professor Teuvo Kohonen at 1982. SOM is a type of artificial neural network trained using unsupervised learning to produce a low training representation dimension sample. Kohonen method does not use activation function and bias weight. Kohonen network able to compose itself based on the value of a specific input in a group called cluster and cluster formation, the output of this method is based on a pattern that is included and will be selected as winner, neurons winner will represent a dataset will be known by SOM network. [12]. In this study a artificial neural network method applied to classifying vector based KDA and KDA + DT into a group of neurons so that can recognize each face of the total dataset tested. A detailed explanation of the workings of the kohonen SOM can be found at [13].

## IV. DISCUSSION

The testing process is carried out by several stages, KDA method is used to extracting the facial features by calculating best value from the difference between the two classes of face, then the results of extraction using DT method in determining the closest distance netween pixel and face vector as input for Kohonen SOM method to face recognition. Calculation of the accuracy using Mean Square Error (MSE) with the value 0.001 and epoch value 50 for training and classification. On testing of KDA + DT Kohonen method, we propose using two different datasets, this two datasets will become our analysis to serve as a comparison.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 10, October - 2017

*A. Datasets*

1. CALTECH's database (uncontrolled environment UCE)

CALTECT's database is a database of face photos that add up to 396 for display objects with 24 poses and face expressions of different backgrounds. In Figure 2 shows a few examples of photographs, the face resolution is normalized into 255 * 32 process for classification.

Fig 2. Some examples of CALTECH's database

2. Facial dataset

Fig 3. Some examples of training images (CE1)

Figure 3 is part of facial dataset, this database contains 153 people with facial images and 20 images for each individual. This dataset is a images collection from a variety of racial origins, majority of individuals is the face image aged 18-20 years, but there are some older pictures. Every single image is different to each other either from lighting or facial expression. This image consists 256 colors with size 200 * 180, some pictures of the face using glasses and beard. The total number of face image is 7900.

*B. Experiments and results*

The results of this testing based on CALTECH and CE1 with the face data that will be used for training as many as 100 of the facial image, from 100 facial features will generate a matrix (C * 100) which contains the relevant coefficients from the training images. Then implementing DT to find the nearest distance vector values to build classification. The value of the class on each individual image normalizing with gray scale size 120 * 100 pixels. After calculating each vector value of image training, this value will be used as training of Kohonen SOM network named the KDA-DT-Kohonen SOM. This test using 100 coefficients of each face class from total dataset.

TABLE 1. The accuracy results of face recognition

| RR | KDA-Kohonen | KDA-DT-Kohonen |
|---|---|---|
| CE1 | 98,79 | 92,78 |
| CALTECH | 79,65 | 76,09 |

Based on table 1 the accuracy results of face recognition, implementation DT method with Kohonen method is lower than the combination of KDA with Kohonen SOM against two datasets. In Figure 4, and Figure 5, is the result of testing each class on each dataset. The combination of KDA-Kohonen more efficiently for face recognition by total faces on dataset CE1, but for dataset CALTECT the result is still less accurate.

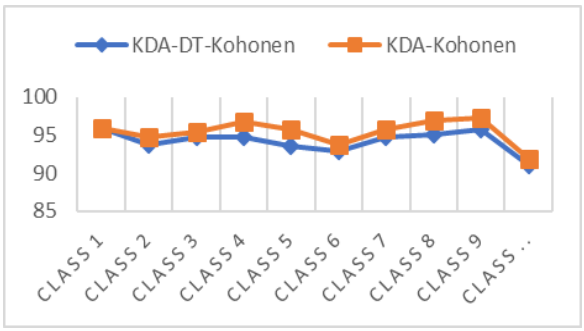


Fig 4. KDA-DT-Kohonen CE1 dataset

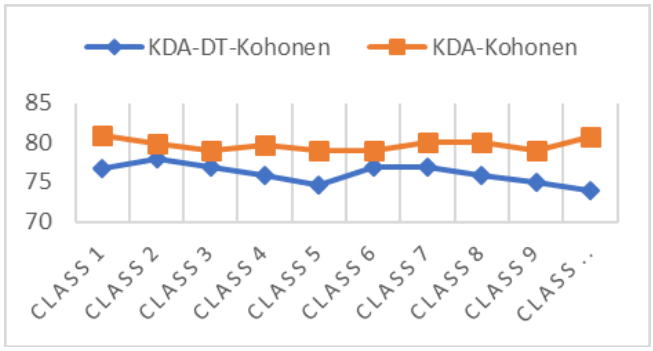


Fig 5. KDA-DT-Kohonen CALTECT dataset

From the results of Figure 4 and Figure 5, we conclude that the kernel function in Linear Discriminant Analysis method is more accurate for Kohonen SOM network parameters compare to the combination of DT, but still can be used for efficient time of recognition.

## V. CONCLUTION

From the results of testing, we describe the implementation of unsupervised neural network method. Kohonen SOM for face recognition identifier, KDA as an extraction feature, and DT to find the nearest distance image pixel of KDA extraction results on first approach, while the second approach does not use DT. Testing using two different datasets for the comparison results of the combination KDA-DT-Kohonen with KDA-Kohonen. The combination of KDA-DT-Kohonen have lower of accuracy values compare KDA-Kohonen for CE1 dataset, for CALTECT's dataset still needs to be done in further research on calculation of the variance background by implementing the other transform method.

## REFERENCES

[1] C Arcelli, G S Baja, and L Serino. Distance-driven skeletonizing in voxel images. IEEE Transactions on Pattern Analysis and Machine Intelligence, 2011, 33(4), 709–20.

[2] K I Kim, K Jung and H J Kim. "Face Recognition Using Kernel Principal Component Analysis", IEEE Signal Processing letters, 2002, Vol 9, No. 2.

[3] W Y Zhao, R Chellappa, A Rosenfeld, and P J Phillips. Face recognition: A literature survey, 2000, UMD CfAR Technical Report CAR-TR-948.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 10, October - 2017

[4] W Lei. Research on global statistic and local geometry based dimensionality reduction algorithm. 2009, University of Science and Technology of China, Beijing, China.
[5] T F Gao, C L Liu, High accuracy handwritten Chinese character recognition using LDA-based compound distances. Pattern Recognition 41 (11), 2008, 3442–3451.
[6] D Tao, L Liang., L Jin, and Y Gao. Similar handwritten Chinese character recognition by kernel discriminative locality alignment. Pattern Recognition Letters 35, 2014, 186–194.
[7] C Yao, Z Lu., J Li, Y Xu, and J Han. A subset method for improving Linear Discriminant Analysis. Neurocomputing, 2014, 138, 310–315.
[8] Z Fan, Y Xu, M Ni, X Fang, and Zhang, Individualized learning for improving kernel Fisher discriminant analysis. Pattern Recognition 58, 2016. 100–109.
[9] J Gui, Z Sun, J Cheng, S Ji, and X Wu, How to Estimate the Regularization Parameter for Spectral Regression Discriminant Analysis and its Kernel Version? IEEE Transactions on Circuits and Systems for Video Technology, 2014, Vol. 24, NO. 2.
[10] X Y Jing, H S Wong, D Zhang. Face recognition on based on discriminant fractional Fourier feature extraction Fourier feature extraction[J]. Elsevier Pattern Recognition Letters, 2006, Vol. 27, 1465–1471
[11] J Wang, and Y Yagi. Shape priors' extraction and application for geodesic distance transforms in images and videos. Pattern Recognition Letters, 34(12), 2013, 1386–1393. doi:10.1016/j.patrec.2013.04.008.
[12] K K Kanchia and V Ca, Real Time Facial Expression Recognition System Using 2D-DCT andNeural Network, International Journal of Current Engineering and Technology, 2013, 280-287. ISSN 2277 – 4106.
[13] F Z Chelali, A Djeradi, and N Cherabit. Investigation of DCT/PCA combined with Kohonen classifier for human identification, 2015, 978-1-4673-6673-1.
[14] H Gupta, A K Agrawal, T Pruthi, C Shekhar, and Rama Chellappa. An Experimental Evaluation of Linear and Kernel-Based Methods for Face Recognition. Proceedings of the Sixth IEEE Workshop on Applications of Computer Visio, 2002, 0-7695-1858-3.
[15] X Ruan, S Wang. Face Recognition based on Weighted Multi-Resolution Kernel Entropy Component Analysis. 2017, 978-1-5090-4657-7. 6118- 6123.
[16] W S Chen, P C Yuen, J Huang, and J Lai. Wavelet Kernel Construction for Kernel Discriminant Analysis on Face Recognition. Proceedings of the Conference on Computer Vision and Pattern Recognition Workshop. 2006, 0-7695-2646-2.
[17] Z Liu and X Lu. Face Recognition Based on Fractional Fourier Transform And PCA. 2011, 978-1-4244-9793-5. 1406-1410.
[18] A Majumder, L Behera, and V K Subramanian. Local Binary Pattern based Facial Expression Recognition using Self-Organizing Map. 2014 International Joint Conference on Neural Networks (IJCNN). 2014, 2375- 2382.
[19] Y Kun, Z Hong, P Ying-jie. Human Face Detection Based on SOFM Neural Network. Proceedings of the IEEE International Conference on Information Acquisition. 2006, 1253-1257.
[20] M Kawulok, J Kawulok, and J Nalepa. Spatial-based skin detection using discriminative skin-presence features. Pattern Recognition Letters. 2014, 3–13.

## ACKNOWLEDGMENTS

This paper is supported by computer laboratory University of Sumatera Utara and computer laboratory Universitas Prima Indonesia for research needs.