IJITKM Volume 7 • Number 1 • December 2013 pp. 132-136 (ISSN 0973-4414)

Facial Expression Recognition Using Texture Features

Shalu Gupta, Indu Bala
ECE Department, Lovely Professional University, Jalandhar, Punjab(India)
shalugupta54@gmail.com, sajjanindu@gmail.com

Abstract
This paper provides a new approach to recognize facial expressions. In this paper, facial expression recognition is based on appearance based features or we can say that low level features. We introduced the new approach Improved Principle Component Analysis (IPCA) in order to categories the expression into seven different classes. IPCA help to differentiate the feature set on the basis of spreading element in matrix and scale parameters. The computational complexity is not more than PCA, FLD, and ICA. Our analysis based on JAFFE database. The experimental results show that the average recognition rates of different expressions, which is80.3 %.
Keywords- Facial expression recognition; IPCA, FLD, ICA.

1. INRODUCTION

Facial expression recognition plays a vital role in case of robotics and automation. As Robotic field has grown quickly in recent years. The applications of facial expression recognition are increasing day by day. HMI (human machine interaction), computer vision design are the different area's which is covered by Facial expression recognition. Machine is more related to robots such as industrial robots, protection robots. With the help of expression robot can interact with their user in the more familiar way. Human life cannot be expected without communication [1] phase. Each and every phase of one's life is covered with help of communication. It is a way to express the ideas not even idea but feelings emotion views also. Facial expression is one of the ways of communication. Expression is different position or state of the face's skin muscles, because as face moves muscles move their positions. Expressions convey

the emotional message to the listener. It is a way of non verbal communication. Facial expression comes under the category of spoken language because in spoken language one has to use expression. Communication can be split into two parts. First, verbal communication and second is non verbal communication. An expression comes under the category of non verbal communication. As we know one or two year's child can't speak but still he or she can communicate, so facial expression becomes an interesting field for research. In order to recognize the expressions there are two methods to move. The choice of method depends upon the nature of features which is used. First, includes appearance based features. Scale Invariant Feature Transform (SIFT) Independent Component Analysis (ICA), Linear discriminate analyses (LDA) [2], Principle Component Analysis (PCA) are the example of appearance based features methods. Second includes geometric feature which is oldest method. Active Appearance [3] Method and Active Shape Model are the examples of geometric based features methods. Appearance based features and geometric [4] features both have their own advantages and disadvantages. The biggest disadvantage of geometric based features is reduction in spatial information. Another problem is high degree of ensemble rate. If matching of the models is not accurate then the overall performance degrades. The low level features like texture [5] represents characteristics of facial image. In this paper, we propose a facial expression recognition method based on person – specific approach. In our approach IPCA could classify the different variables or values of feature vector according to different scale in statistics. To get the classification of the facial expression characteristics, we have to measure the similarity between the templates by calculating the distance and then do facial expression recognition in nearest algorithm. In our approach we calculate distance between an expression and neutral expression. After calculating the distance we classify the expressions based on distance.

2. Related work

Face recognition and facial expression recognition used three basic and very familiar approaches for their operation such as Principal Component Analysis (PCA) [6,7], and Independent Component Analysis (ICA) [8] Fisher's Linear Discriminate (FLD) [9]. These three algorithms which are introduced above used for analysis in the case where there is need of low dimensional state. All of these three algorithms have its own advantages and disadvantages, these algorithms have been used according to application not a single algorithm replaced other one. From another point of view, advancement of any algorithm will affect the other algorithms, and move to new improvements in theses algorithms. PCA is the earliest algorithm among above three algorithms for different analysis especially for recognitions. Karhunen-Loeve method is another name for PCA. PCA applied successfully in case of face recognition in [6]. PCA has been calculated in second-order statistical relationship of value of data

such as variance or co-variance, and is well used in case of the signals where signals have Gaussian distribution. Following the work of [6,7], a new approach that is Kernel Principal Component Analysis (KPCA) [10] was proposed for recognition. KPCA is somewhat advanced version of PCA, where non linear PCA is used in place of PCA alone. In this paper they calculate the useful features in high dimensional feature space with the help of exponential function. The performance of KPCA has been checked used by applying it to character recognition with the US Postal Service (USPS) database of handwritten digits in [11].Another approach is Generalized Principal Component Analysis (GPCA) [12] algorithm has been proposed to calculate a combination of linear subspaces from feature values points. After the work of [12], a advanced Robust GPCA (RGPCA) [13] algorithm has been proposed and applied to medical image segmentation. The work of [11,12,13,] comes from the same basic idea. Both GPCA and RGPCA require a very low dimension of input signals. As mentioned in [11,12,13], if the sub space dimension of input data is large typically greater than 12 the evaluation of these two algorithms could be evaluated. After this, ICA [14] has been proposed to evaluate the order other than second order statistical relationship among different variables. It is also states that: "PCA can be use to take the advantage of special version of ICA which uses Gaussian source models [14]." In order to compare with PCA, ICA is suitable for signals of Gaussian distribution, as well as suitable for the signals of Super-Gaussian model distribution and Sub-Gaussian source model. Two different methods to use ICA have been proposed in this paper. ICA could use in conjunction with PCA in recognizing faces and changes in expressions. Following the work of [14], Enhanced ICA (EICA) [15], Independent Gabor Feature (IGF) [16] and Multi resolution for ICA (MICA) [17] are proposed for face recognition and different expressions. These different approaches such as EICA, IGF and MICA are required to perform PCA in order to reduce the dimension of input signals. Topological Principal Component Analysis (TPCA) [18], which is concerned about topological relationships. In this paper the contribution of sample variables has been proposed. It gives the linear relationship between different variables of feature vector. But there is a limitation of TPCA. The computational cost which is occur due to the reason of covariance matrix of size of m x m must be appear as diagonal form where m is the dimension of feature vector [19]. In case of FLD's again the PCA is for dimension reduction, which gives the benefit of computational time saving. Without PCA there is drawback of computational cost occur in case of FLD's Last but not least the brief conclusion or summary of the above work state: After PCA [6,7], there are different algorithms have risen as discussed above. But all of these algorithms, such as RPCA [13], GPCA [12], FLD [9], KPCA [10], ICA [14], etc., still need traditional PCA to reduce the dimension of input signals. So PCA itself required to improve the evaluation parameter. It is very crucial task in recent years. Now according to other approach, if the performance of PCA itself was improved, then few different or new algorithms could be proposed

3. Face preprocessing

Face preprocessing is very first step that has been used in case of image preprocessing. The face preprocessing is combination of two basic operations. First, it includes local information of an image. Second, it gives background information along with alignment of face image it includes the local information of an image. We obtain the images of uniform shape and size.fig 1 shows the disgust expression of original and localized image respectively of JAFFE database.

a. Original image b. Localized image

Fig 1. Pre-processing of face image

4. DATABASE

Facial expression recognition has been performed on JAFFE [20] database. This database is available publicly. So anyone can access the images of JAFFE database. There are seven basic expressions (neutral (NA), happiness (HA), sad (SA), fear (FE), disgust (DI), anger (AN), surprise (SU)) presented in the JAFFE database. The JAFFE database has total 213 images of seven different expressions. There are three different persons in JAFFE database each person has above seven different expressions. All the images in JAFFE database have 256 x 256 resolutions. Only the female expressions are present in JAFFE database. But one can take the advantage of three different persons.

Our frame Work

Feature extraction :- In the initial step we resize the images of JAFFE database. In this work we use resolution of 128 x 128 for every image, as the original resolution of each image in database is 256 x 256. Then we extract the features of the images. When we applied Improved PCA to database we get feature set. The basic idea behind IPCA comes from the limitation of PCA, because there is some information regarding to object which is not used by PCA or FLD. This information can be characterized as scale numbers and parameters. The spreading of element in matrix is defined as:-

$\sum_{k=1}^{p}(xi-u)(a)$……..(1)

Where xi (i=1…n) is column vector of which has value in m dimension space. Where a is define as $(xi-u)^T$ or transpose of difference between column vector and mean value. In order to receive the variables, which has small variability and higher weight we have calculate optimum value along with diagonal matrix.

$A_x = diag(d_1\ d_2\ d_3\ d_n)$…….(2)

Now optimum value for approximation of above algorithm is

$S_{opt} = \arg\max | s(xi-x_0)\ A_x\ s^T |$ ……..(3)

Here xi (i=1…n) is column vector and T stands for transpose of S. In some region, such as physical experiments, the size of feature vector in most of the cases is constrained by the number of observation that is used in experiment, so there is tradeoff between these two.

There are some important steps to do the feature extraction.

- First of all acquire the facial expression image database, and then pre-process each image, which include two basic operations such as rejection of different noise points and local adjustment.
- Now we calculate the high-dimensional features vector of seven different expression regions that available in the database. Both training and test images follow this step.
- In this step we use output of second step and calculate their optimum value and scale parameters as defined above. These values are calculated for training and test images.
- Now Calculate the distance from the new test image and then classify them according to the distance between them, or nearest algorithm.

These steps are performed for all the images.

The flow chart for facial expression recognition is given below.

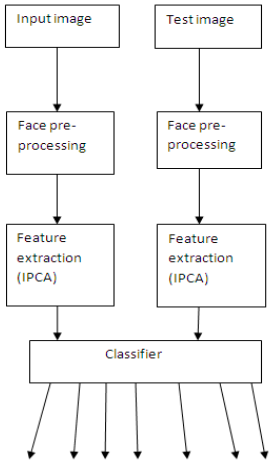

Fig 2 flow chart of FER

Experimental result

In our work we perform expression recognition with some modification in PCA. We use IPCA for the purpose of feature extraction. Table 1 shows the performance of IPCA on the JAFFE database. We perform our operation of 161 total images of JAFFE database. We choose the images for each expression randomly. In this paper we use 12 images of each expression for the training purpose. The total no. of images is 84 for training of the network. We use 11 images of each expression for testing purpose. The total no. of images is 77 for testing of the network.

Table 1 confusion matrix for recognition based on IPCA features.

AE \ P E % →	HA	AN	SA	SU	FE	DI	NE
HA	72.7	0.00	18.1	0.00	0.00	9.09	0.00
AN	0.00	81.8	0.00	9.09	0.00	9.09	0.00
SA	0.00	0.00	63.6	0.00	27.2	0.00	9.09
SU	0.00	9.09	0.00	90.9	0.00	0.00	0.00
FE	9.09	0.00	9.09	0.00	72.7	9.09	0.00
DI	0.00	9.09	0.00	18.1	0.00	54.5	18.1
NE	18.1	0.00	9.09	0.00	0.00	0.00	72.7

In this table P.E stands for predicted expressions percentage and A.E stands for actual expressions.

When features are extracted with IPCA, the performance has good result for two expressions such as anger and surprise. The accuracy for these two expressions is more than 80 percent. On the other hand the recognition rate is not good for disgust expression. So it is clear from the above results IPCA requires to take action in direction of disgust expression as it is confused with surprise and neutral expression. But the procedure to choose the dimension of the small feature vector is an important and difficult task for ICA, PCA, FLD, EPCA and IPCA. Different researchers have used different values of the dimensions of the reduced feature vector, such as 200 used by [21] and only 50 used by [22]. It depends upon user and obviously, performance criteria of the experiment. In general, as the number of feature vectors of facial expression recognition increases it requires more computing time. But there is an advantage of high value of feature vector that is it gives more accuracy. In our experiment, the numbers of features will be changed up to 30, and then

we take the result corresponding to the number of features.

5. Conclusion and future work:-

IPCA is advanced version of PCA and it gives superior result then PCA alone. IPCA enhance the performance when applied for the purpose of face and expression recognition. PCA which is existing method when performed then give the average accuracy. It mainly used for data compression. If small number of training images are provided even though recognition rate is good because reduced dimension is given by PCA. There are some advantages such as it is fast, simple to use, and works well in a constrained environment also. The principal components are selected for each class independently to reduce the Eigen space. Our approach IPCA is not sensitive to the large scale changes on the brightness of directions. IPCA is enhancement of some popular algorithms such as PCA, FLD and ICA and is more stable than the ordinary PCA algorithm. One of the important advantages of IPCA is its simplicity and outwork performance. When only PCA is used for feature extraction there is problem of optimization that occurs when there are independent sources available. So the problem of optimization in case of IPCA would be easily solved without adding more computational complexity than other PCA, FLD, and ICA algorithms. So in future we have to concern about the deep investigation of the feature vector space that means the dimension of feature space. Now, we have some problem of the scope of the variance of the values of the reduced feature vector dimensions according to the highest expression recognition performance rate for different acquired image set. Our experiment based on person specific images. Our proposed method is limited to pre processing. If two or more than two features are used then experiment may give more superior results. There are some typical conditions in which our proposed technique doesn't give accurate results. When there is change in illumination or scale than the proposed network is not prove as best approach. So we have to use some other approaches that compensate these kinds of problems. Another problem is rotation of the image. Now in future we will try for further efforts to examine the expression recognitions under such situations like recognitions of dynamic expressions, variable expression intensity, more complex expressions, mixed expression, person independent expressions. We can further move towards paralyses face expressions, which may prove helpful in the direction of medical science. For future work we take step also towards the reduction of training time along with performance accuracy.

REFERENCES

[1] A. Mehrabian and Wiener, "Decoding of inconsistenty communication," j. Per Soc. Psychol., vol.6, no. 1, pp. 109-114, May 1967.

[2] Z. Wen and T. Huange, "Capturing sutable facial motions in 3D face tracking," in proc. IEEE ICCV, 2003, pp. 1343-1350.

[3] P.N. Belhumeur, J.P. Hespanha, D.J. Kriegman, "Eigenfaces vs. Fisherfaces: recognition using class specific linear projection," IEEE Transactions on Pattern Analysis and Machine Intelligence 19 (7) (1997) 711–720.

[4] T. seneschal, V. Rapp, H. Salam, R. Seguier, K. Baily, L. Prevost, "Facial action recognition combination heterogeneous feature via multikernal learning," IEEE Transaction on system, man, and cybernetics-part B, vol. 42, No. 4, August 2012

[5] G. Dorko and C. Schmid, "Object class recognition using discriminative local features". IEEE PAMI, 2004.

[6] M. Turk and A. Pentland, Eigenfaces for Recognition, Cognitive Neuroscience 3 (1) (1991) 71-86.

[7] U. Tariq and T. S. Huang , "Features and fusion for expression recognition - A comparative analysis," 978-1-4673 IEEE 2012.

[8] B. Scholkopf, A. Smola and K.R. Muller, Nonlinear component analysis as a Kernel eigenvalue problem, Neural Comput. 10 (1998) 1299-1319.

[9] R. Dahyot, P. Charbonnier and F. Heitz, Robust visual recognition of colour images, In: Proc. IEEE Conf. on Computer Vision and Pattern Recognition. vol. 1 (2000) 685-690.

[10] B. Scholkopf, A. Smola and K.R. Muller, Nonlinear component analysis as a Kernel eigenvalue problem, Neural Comput. 10 (1998) 1299-1319.

[11] F. Y. Shih, C. Chuang, "Automatic extraction of head and face boundaries and facial features", Information Sciences, Vol. 158, 2004, pp.117-130.

[12] R. Vidal, Y. Ma and S. Sastry, Generalized principle component analysis (GPCA), In: Proc. IEEE Conf. on Computer Vision and Pattern Recognition. vol. 1 (2003) 621-628.

[13] RRamanathan, A.S.Nair, N.Sriram. A Support Vector Machines Approach for Efficient Facial Expression Recognition. In: 2009 IEEE International Conference on Advances in Recent Technologies in Communication and Computing , Kottayam, Kerala, 2009,pp.850- 854.

[14] M.S. Bartlett, J.R. Movellan and T.J. Sejnowski, Face recognition by independent component analysis, IEEE Trans. Neural Networks. 13 (6) (2002) 1450–1464.

[15] C.J. Liu, Enhanced independent component analysis and its application to content based face

image retrieval, IEEE Trans. Systems, Man and Cybernetics. 34 (2) (2004) 1117-1127.

[16] Guiling Li, Hui Zhao. Facial expression recognition based on the second feature selection and support vector machines. Computer Knowledge and Technology, 2008,pp.2700-2702.

[17] K.E. Hazim and S. Bülent, Multiresolution face recognition, Image and Vision Computing 23 (5) (2005) 469 477.

[18] A. Pujol, J. Vitrià, F. Lumbreras and J.J. Villanueva, Topological principal component analysis for face encoding and recognition, Pattern Recognition Letters 22 (6-7) (2001) 769-776.

[19] Vaibhavkumar, J. Mistry, Mahesh , M. Goyani, ”A literature survey on Facial Expression Recognition using Global Features,” International Journal of Engineering and Advanced Technology ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013

[20] J. Whitehill, C. Omlin, “Haar features for facial action coding system action unit recognition”. In Proc. IEEE Intl Conf. Face and Gesture Recognition, 2006.

[21] Liting Wang, Xiaoqing Ding. A robust automatic face feature location
method. Automation Technology, vol. 35,issue 1,2009.

[22] T. W. Marian, S. B. Javier, R. Movellan ,” Facial Expression Recognition Using Gabor Motion Energy Filters” 978-1-4244-7030 IEEE 2010.