A Survey on Facial Expression Recognition

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Abstract : Till now many work is done in Facial expression recognition. This paper tends to study the work done in recognition using different techniques. Facial recognition is important aspect in creating more human like computers where human interactive machine can be build. Different techniques are used till now on different aspect, in this paper we will be mainly focusing on feature based facial expression recognition. This paper also focuses on classification techniques.

IndexTerms **- FER, facial expression recognition , Survey, standard techniques, frontal face, multi-pose face**

I. INTRODUCTION

In real world their are many expression but basically defined basic seven expression[1] that is angry, disgust, happiness, fear, sad, surprise and neutral. The task is here to detect different expression computationally so that it can used in future for many purpose like human computer interactions or automatic surveillance buglers, robotic sense to interact with human and list may increase so on. An fully automatic facial expression system can applied as real time application to extract non verbal gesture of human can be used in several other research works like human behavioral , vision systems.

Computer being an most important part of day to day life its important and computer can understand the state of human. Not only computer even many different gadgets can be introduce to understand the state of emotion to have good interface. Even in visual interface facial expression can be used for better , easier and helpful to human and computer interactions. The more better accurate recognition can be done more the better interface would be created.

As every task has its own issues here also many issue are to be faced or overcome and sometimes it has to assumed it won't happen. There are still many problems related to face recognition so same problems goes on facial expression recognition. Facial expression recognition also consumes its own problem like image blurring, bugler's , image illumination's, and further more issues. Moreover issues of accuracy and time complexity is still major point to be resolved.

Many techniques are used and research is still going on the techniques so that a efficient and general emotion recognition tool can be generated. In this paper many different method used [1-13] are studied. Different techniques are mostly derived from different mathematical models and show a sustainable effect in the facial recognition task.

Facial expression recognition task majorly divided into four parts[10].

- Face detection
- Normalization
- Feature extraction
- Classification

Here face detection is itself an earlier concept of research while going on facial expression detection face detection is assumed to be accurate rather data set are take on so context. Even depending on the face detected many challenges are derived while doing emotion recognition. For example pose invariance, distance invariance etc. This type of challenges are the main issues in recognition task. Normalization sometimes also taken as pre-processing task where some techniques like mean normalization or blur removing , making similar dimension of detected face image is done. While feature extraction stands for the vectors of characteristic extracted from the sample data and is given to classifier for supervision. Same extraction technique is used for input question images for which emotion is to be detected and given to classifier. And lastly the level of classification comes where classifier uses the sample features to classify the input image's emotion.

Many feature extraction techniques like Principal component Analysis[7,10,13], Morphological operations[2], Gabor filter[3], Log Gabor filter[3,11,13], Gaussian filter[4], LBP[5,9], Single Value Decomposition[7], SURF[6,8,11] are studied in this paper. This different techniques are based on primarily three approach feature based approach, holistic approach and hybrid approach[10]. In feature based approach first of all local feature of face like lips, eyes etc are detected. After that segmentation of this feature is used to train classifier. In holistic approach statistic of whole image is used to extract feature. And in hybrid approach both this approach is combined and better system is tried to built. None of the above approach specifies any classifier. Though use of appropriate classifier also make difference to result of recognition of emotion. Most case effectiveness of SVM classifier is counted good so it is used most probably.

II. FEATURE EXTRACTION TECHNIQUES

2.1 Principal Component Analysis

Principal component analysis is an unsupervised technique also know as [7]Karhunen-Loeve transformation widely used for dimensionality reduction in pattern recognition and signal processing. Image contains lots of information and lots of feature from it is redundant. So in this technique the most important information stored as feature vectors. This is an reduce and contains most important data of an image. A face image of two dimension of n × n can be stored in (n*n) ×1 either that as one dimensional vector of n.

To calculate this feature vector through this technique first of all needed pre-processing step are performed. Especially for facial expression recognition normalization is needed as pre-processing which by subtracting mean of training samples from each images of training samples. Now after that covariance matrix is calculated.

$$c = \emptyset\emptyset' \qquad (1)$$

Here $\emptyset$ set of all images and $\emptyset'$ transpose of the set. From this covariance matrix Eigen value and eigenvectors are calculated and vectors with highest Eigen value is taken and lower value eigenvectors are dropped. This vectors are the principal components.

2.2 Principal Component Analysis ith Single Value Decomposition

This is an type of variation to principal component analysis where mean centered images are obtained than using linear algebra single value decomposition is applied. This technique is derived by the renowned mathematicians in linear algebra. On any matrix of a × b where a, b are real no. representing row by a and column by b. Any image matrix say N can be factorized into three different matrix:

$$A=X\ S\ Y^T \qquad (2)$$

where X is orthogonal matrix of [x1,x2,x3,...,xa]

xi is the column vectors xi is for i=[1,2,...,a]

S is orthogonal matrix of b × b

Y^T is transpose of Y a orthogonal set form of diagonal ones and others zero. i=1,2,..b

2.3 Morphological Operations

This is an well know techniques used in image processing or similar area for detecting salient feature of any object. In case of face detection darkest point in an image of face is detected. [2]Rather estimating the pupils and detecting the face. So in detecting facial expression three steps are followed. In first stage the darkest parallel feature are detecting in upper part of face using morphological operation like erosion. This applied in a grey face which gives eyes localization. Now in the second stage on the basis of estimated distance between the pupils is used to find mouth. And in third stages on basis of this boundaries salient feature localization is done. The efficiency of this method depends on the structure of the face.

Now after having the boundaries of the salient facial feature of the face need to extract feature for facial expression recognition. The mean and the standard deviation are utilized as the facial highlights. This decreases the heft of information and henceforth the multifaceted nature of the computation. The classes of delight, outrage, amazement and nauseate are worked to identify facial feelings .For each picture in the class, the facial highlights are processed. The highlights' areas of each picture inside each class are acquired. The mean and standard deviation are processed to extricate these highlights and lessen information amount.

2.4 Gabor and Log Gabor filter

Gabor filter is extraordinary compared to other known tunable channels suitable for catching introduction data from the picture. Aside from introduction, it can likewise give the stage data of the pixel which is invariant to enlightenment. This filter is used to mainly detect edges in the images . This filter are derived from one wavelet.

Log Gabor filter overcomes the limitations of the Gabor filter as it performs DC composition. This filter not only allow to acquire more information in high frequency but also their characterstics. Gabor filter can be given by:-

$$g(x,y)=\exp\left(-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)\right)*\cos\left(\frac{2u}{\bar{x}}+\emptyset\right) \qquad (3)$$

where x & y are spatial frequency extent, ø is phase shift.

Log Gabor function can be given by

$$G(w)=e^{(-log(r/f_0)^2\ /2log(k/f_0)^2)} \qquad (4)$$

where f_0 is the central freq. of filter and r is radius.

2.5 Linear Binary Pattern

Linear Binary Pattern an efficient method to extract texture from the image. This operator labels the 3× 3 neighborhood of each pixel with the center value. Here values are taken as binary. The operator detects all edges curved and rest texture feature of the face

and can be stored as the facial emotion feature for different expression. In histogram of an image we do not get micro patterns which is acquired by the linear pattern operator.

The implementation of the techniques is applied or mixed with other methods. As in [9] sobel feature are extracted first using sobel operator on that operator is applied to get linary binary pattern. But for such operation face detection should be accurate plus the hair part should excluded in any way.

Implementation also be done by localizing the feature of the face like eyes mouth extra as done in [5]. And on that localized part of the face Linear binary pattern is applied by which the final feature is extracted. This extraction of the feature is done emotion wise and stored for classifier.

Another variation creating the edge based linear binary pattern where first of all edges are detected and on that texture description is extracted using simple local binary pattern feature extraction technique. The edge detection can be done by sobel operators and a linear binary pattern using population mean gives more deeper salient feature of the face. This is done in [9] which shows the simple non linear binary pattern technique than linear binary pattern with sobel also linear binary pattern with populating mean and again in with variation of sobel plus linear binary pattern using population mean.

III. CLASSIFICATION

The most widely used for the classification purpose are KNN and SVM classifier. There are many other classifier used to classify finally any emotion in recognition of any expression. Many other like C-means clustering, simply calculating Euclidean distance can be used to classify. In all the case the main or important part is to project the input image to the plane. The extracted feature is on some plane on the same plane the testing image should be first projected. Projection aspects means different in different feature extraction techniques. On basis of technique feature also need to be projected to some plane. Defining the plane is an crucial as well as important part to do. When the feature and input image feature is presented to the classifier. Below KNN and SVM classifier is discussed, these are most widely used for classification in facial expression recognition.

KNN is a strategy for requesting objects in light of closest planning cases in the part space. KNN is a kind of case based learning or languid acknowledging where the limit is simply approximated locally and all figuring is yielded until portrayal. K-NN is a sort of case based learning, or impassive acknowledging where the limit is simply approximated locally and all computation is yielded until arrange. It is called slow in light of the way that it doesn't have any readiness organize or insignificant getting ready stage. All the arrangement data is required in the midst of the testing stage and it uses all the readiness data so if we have broad number of educational gathering then we require outstanding technique to tackle some portion of data which is heuristic approach. Regardless of the way that game plan remains the fundamental use of KNN, we can use it to do thickness estimation besides. The k-nearest neighbor computation is among minimal complex of all machine learning counts. K-nearest neighbor portrayal was made from the need to perform isolate examination when strong parametric assessments of probability densities are dark or difficult to choose.

Support vector machines are the learning models using labels and the feature vectors as input for the training of the network. The feature vectors are the data of the are the inputs obtain from the training data while similar feature vectors are produced from testing data and also from the input data. This feature vectors may be in different form depending upon the implementation. In respect to image processing multi class support vector machines are to be used in forms for matrix either specifically vectors. And another matrix requires for labeling the vectors depending respective vectors depends on which class.

Sometimes classification technique and the extraction technique combination make difference in the accuracy. But most of the time support vector machine has been seen the resulting the best. Multiclass support vector machine performing complex classification whose dimension depend on the number of class either that number of the emotion we need to recognize.

IV. RESULTS AND DISCUSSION

In most of the methods the main issue is dimensionality which increase's the computational or storage cost by the facial expression recognition system. Principal component Analysis rather using for feature extraction is used for dimensionality reduction in [7,13]. When Principal component Analysis is directly used it was capable to applied on neutral, happy and sad not resulting good.

While using Log Gabor filter over principal component analysis[13] for anger , happy, sad, neutral, disgust, fear and surprise. Three variations of the method is used where sad emotion is not accurately detected in first method simply using Log Gabor filter but due large data processing time is an issue. Than in second method features are extract than on same principal component analysis is applied for reduction of the dimensionality. The result decrease over all average of last method but increase bit in recognizing sad emotion. Except angry emotion all other emotion are recognition rate decreased. Subjects of training images where not present in testing image in all methods. Even when applied for six emotions[13] happy, sad, angry, disgust, fear and neutral both Gabor and log Gabor filter is applied giving 83% and 95% which is good result while using log Gabor filter. SURF and Gabor feature are used together[11] for robust against pose of the face in image for happy, surprise, anger and disgust giving 65.75% average which bit low. Morphological operation in [2] for four expression joy, anger, surprise and disgust on an average 85.82% accuracy but computation is complex yet not to flexible for expression.

Linear binary pattern technique applied for the emotion recognition for six expression happy, anger, surprise, fear, sad and disgust in [5] giving an average of 94.09% of accuracy where salient feature are extracted and stored hence initial processing is large but stored data is reduced and processing for classification also get reduced as data get reduced. Here data is also reduced due to the steps taken before feature extraction rather saying feature localization is done. Where when applying variation of linear binary pattern in [9] by

simple linear binary pattern 82.99% accuracy is achieved while combining with Sobel features decrease the efficiency. But applying edge based linear binary pattern with sobel it show efficient and effective result than simple linear binary pattern feature extraction technique.

V. CONCLUSION

The motive was to study facial expression recognition methodologies where different feature extraction and classification techniques are applied and also some times preprocessing. In all the methodologies result are uneven through the aspect of different emotion. Yet anger is an emotion recognized very accurately while other different emotion in different techniques raise to accurate detection. Classifier also plays an important role in accuracy and also more in processing. Sometimes in complex techniques same result are achieved as compare to other lesser complex technique. Principal component analysis proved to be an good dimensionality reduction step before going for feature extraction by other technique which in turns give lesser processing time, rather applying it for feature extraction through it.

REFERENCES

[1] Automatic Facial Expression Recognition Based on a Deep Convolutional-Neural-Network Structure, Ke Shan, Junqi Guo*, Wenwan You, Di Lu, Rongfang Bie College of Information Science and Technology Beijing Normal University Beijing, P.R.China 978-1-5090-5756-6/17/$31.00 ©2017 IEEE SERA 2017, June 7-9, 2017, London, UK .

[2] Detection of Facial Expressions based on Morphological Face Features and Minimum Distance Classifier, Kenz Ahmed Bozed, Osei Adjei, Ali Mansour, 14th international conference on Sciences and Techniques of Automatic control & computer engineering - STA'2013, Sousse, Tunisia, December 20-22, 2013.

[3] Facial Expression Recognition, Ketki R. Kulkarni, Sahebrao B. Bagal,2015 IEEE.

[4] Product Review Based on Optimized Facial Expression Detection, Vikrant Chaugule, Abhishek D, Aadheeshwar Vijayakumar, Pravin Bhaskar Ramteke, and Shashidhar G. Koolagudi,2015 IEEE.

[5] Automatic Facial Expression Recognition Using Features of Salient Facial Patches, S L Happy, Student Member, IEEE and Aurobinda Routray, Member, IEEE, IEEE transactions on affective computing, vol. 6, no. 1, january-march 2015.

[6] Multi-Pose Facial Expression Recognition Based on SURF Boosting, Qiyu Rao, Xing Qu, Qirong Mao, Yongzhao Zhan, 2015 International Conference on Affective Computing and Intelligent Interaction (ACII).

[7] Emotion Recognition Using Principal Component Analysis With Singular Value Decomposition, Ajit P. Gosavi, S.R. Khot, 2014 International Conference on Electronics and Communication System (lCECS -2014).

[8] Improved Emotion Detection by Regression Algorithm with SURF Feature and SVM, International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 3 Issue 10 October, 2014 Page No. 8639-8642.

[9] Edge based Mean LBP for Valence Facial Expression Detection, 978-1-4799-6085-9/15/$31.00©2015 IEEE.

[10] Facial Expression Detection Techniques: Based on Viola and Jones algorithm and Principal Component Analysis, 2015 Fifth International Conference on Advanced Computing & Communication Technologies

[11] Expressions Invariant Face Recognition Using SURF and Gabor Features, 2012 Third International Conference on Emerging Applications of Information Technology (EAIT)

[12] Facial Expression Detection, 978-1-4799-1597-2/13/$31.00 ©2013 IEEE

[13] Facial Emotion recognition using Log Gabor filter and PCA, Computing Communication Control and automation (ICCUBEA), 2016 International Conference, IEEE.

[14] JAFFE database

[15] A Comprehensive Study On Facial Expressions Recognition Techniques, Roshan Jameel, Abhishek Singhal, Abhay Bansal, 9781-4673-8203-8/16/$31.00 c 2016 IEEE.

[16] http://www.csd.uwo.ca/~olga/Courses/CS434a_541a/Lecture8.pdf.

[17] https://en.wikipedia.org/wiki/Support_vector_machine

[18] https://en.wikipedia.org/wiki/K-nearest_neighbors_algorithm