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A Survey on Predicting the Nature/Emotion of an Individual in Group Discussion using Image Processing

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***Abstract*: Crowd Analysis is an area where getting data in real time is a gift. Crowd Analysis is collecting, aggregating and finding uses for information that relate to people going about their everyday lives. Our objective is to create a unique image processing application which is completely automated, needs no human intervention, is cost effective which most present applications fail to do. Here we propose a web application which is used to automate the group discussion process by passing the real time camera feed through neural network which detects the emotion and attentiveness of the person. It is carried out by analyzing their emotions/ behavior by means of real time image processing by performing three steps namely pre-processing, object detection and event/behavior recognition. Thus, the nature of a person is being determined by means of analyzing the emotions. This application can be used to select excelling candidates from the Group discussion process thus making the recruitment process much more effective.**

***Keywords*: emotion recognition, face expression recognition, feature extraction, patched geodesic texture transform, neural network, curve let feature extraction, bag of words method, local directional number pattern, regional registration technique, gradient feature matching.**

1. Introduction

Facial expressions of input image are then recognized. Humans have a very strong Emotion Recognition technique. Human brain is so sophisticated that it can recognize faces even with the vast changes in appearance. The scientists have always been amazed by the human brain capacity to recognize face under different varied condition. A lot of attempt were made to replicate this technique of our brain. Various algorithms were developed for Emotion Recognition based on this. The efficiency of recognition depends on feature extraction method adopted. Evolutionary algorithms like neural networks, fuzzy logic etc. were also incorporated with the Emotion Recognition algorithms to increase the recognition rate. But there are a lot of constraints that has been implemented in applying these algorithms, like the poses should not vary, or there should not be any difference in the illumination, the expressions should not vary, there should not be much changes with age etc. Overcoming even a single constraint is a great challenge. In this paper techniques that has overcome one of the constraints i.e. the face expression is considered. An algorithm which has a good recognition rate in normal Emotion Recognition may fail when used to recognize a face with expression. This is because a face with expression will be showing a lot of variations from the neutral face. In this paper different algorithms adopted for face expression recognition are reviewed. The key factor in the Face Expression Recognition is the descriptor. FER's efficiency depends on how easily features can be extracted for the descriptor and also on the efficiency of the descriptor. Descriptors of different expression should show high variance while same expressions should show little or no variance. Geometric feature based and appearance based methods are the two common approaches that are used for facial feature extraction. In Geometric feature based method the image is represented with the help of geometric parameters like points, curves etc. This representation is achieved by locating the distinct parts of the face such as eyes, nose, ears, mouth etc. and measuring their relative positions, width and constructing geometric shapes to represent these parameters. In Appearance based method importance is given to pixel values rather than relative distance or shape of feature components. In this method various parameters of the pixels for e.g. Intensity, histogram etc. are considered for representation. These values are represented as a 2D array called templates.

2. Techniques and methods

The process of emotion recognition involves the processing images and detecting the face then extracting the facial feature. Facial Expression Recognition consists of three main steps. In first step face image is acquired and detect the face region from the images and pre-processed the input image to obtain image that have a normalized size or intensity. Next is expression features are extracted from the observed facial image or image sequence. Then extracted features are given to the classifier and classifier provides the recognized expression as output.

A. Face detection and pre-processing

The face detection is the process of extracting the face region from the background. It means to determine the position of the face in the image. This step is require because images having a

different scales. Input image having a complex backgrounds and variety of lightning conditions can be also quite confusing in tracking. Face expression recognition tends to fail if the test image has a different lighting condition than that of the training images. For that facial point can be detected inaccurately for that pre-processing step is required.

B. Feature Extraction and Classification

Selecting a set of feature points which represent the important characteristics of the human face. After the face has been located in the image, it can be analysed in terms of facial features. The features measure the certain parts of the face such as eyebrows or mouth corners. Various methods exist which can extract feature for expression based on motion of the feature such Active Appearance Model which is statistical model of shape and gray scale information. The Features describe the change in face texture when particular action is performed such as wrinkles, bulges, forefront, regions surrounding the mouth and eyes. Image filters are used, applied to either the whole-face or specific regions in a face image to extract a feature vector. Principal Component Analysis, Local Binary Pattern (LBP), Fisher's Linear Discriminator based approaches are the main categories of the approaches available. After the set of features are extracted from the face region are used in classification stage. The set of features are used to describe the facial expression. Classification requires supervised training, so the training set should consist of labelled data. Once the classifier is trained, it can recognize input images by assigning them a particular class label. The most commonly used facial expressions classification is done both in terms of Action Units, proposed in Facial Action Coding System (FACS) and in terms of six universal emotions: happy, sad, anger, surprise, disgust and fear.

The technique involves following steps:

- *Acquiring Images:* Images are taken for sample data. They can be saved images or can be captured with the help of camera.
- *Processing Images:* The acquired image is resized and converted to gray scale for further processing. Gray scale images are very common and sufficient for various tasks.
- *Feature Area Extraction:* From gray scale images eyes and mouth portions are extracted since these areas carry the more essential emotion information.
- *Feature Extraction:* Feature extraction is done using 2D Discrete Cosine Transform (2D DCT) which changes the image data from the spatial to the frequency domain. The feature vector, which is created using the DCT matrix, is used to train the Pattern Recognition Network.
- *Training Classifier:* Training classifier is Feed-forward neural network which uses back-propagation algorithm to train the classifier for input data against given target data i.e. all six emotions.
- *Simulation:* The trained classifier is then simulated to test new real world data and identify all six basics emotions i.e. Happy, Sad, Anger, Fear, Surprise and Neutral. More real life applications can be explored like driver monitoring and studying human psychology. In the proposed system the feature areas are extracted manually, automatic feature area extraction can be done. Mix Emotions like Happy and Surprise, Sad and Fear from an image can also be detected.

3. Recent approaches on emotion recognition

A. Expression invariant 3D Emotion Recognition using Patched Geodesic Texture Transform

The Texture of the 3D face image is extracted for Emotion Recognition in this method. Local Feature vectors are extracted from the texture of the face by using Geodesic texture transform accompanied by Pseudo Zernike Moments. Farshid et. al. [1] has proposed a method of Emotion Recognition using Patched Geodesic Texture transform (PGTT) which is expression independent.

The algorithm is as follows. The range and texture images of the 3D face model is created. One point on the face is chosen as the reference point. The Geodesic distance for all the face points is calculated with reference to this reference point. The texture image of the face is transformed into a new texture image based on the computed Geodesic distance. The new image is called transformed texture image. The transformed texture image is then partitioned to patches. The patches are of same size and also they are non-overlapping. Feature vector is extracted for each patch by applying a patch descriptor. All the feature vectors that are extracted from the individual patches are concatenated to get the final feature vector. The input face feature vector is compared with the face feature vectors in the gallery and the similarity between the query image and the images in the database is taken to identify the face. Order of the PZMs is one of the main parameter that determines the accuracy of this method. Size of the patches is the second factor, the accuracy increases as the size of the Patches decreases. The order zero of the PZM is the DC components that do not carry any personal identity information. BU-3DFE database was used for experimentation purposes. The neutral face was taken as gallery images and the face with expressions were used as probes. The rank-I recognition rate of the proposed algorithm was calculated. The angry expression showed an accuracy of 90% and the disgust expression has shown the worst accuracy of 78%.

B. Curvelet Feature Extraction for Emotion Recognition and Facial Expression Recognition

Xianxing and Jieyu Zhao has proposed a new approach for facial expression recognition based on the Curvelet transform and PCA. This method is based on the fact that the face expression contains details like curves and lines. It is more

accurate to use curvelet rather than wavelet in this condition because the wavelets can represent only point singularities. The algorithm follows a four stage process for the expression recognition. The flow chart of the steps involved in this method is shown in Fig. 1.

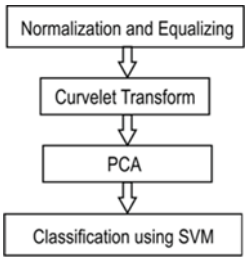

Fig. 1. Steps involved in curvelet feature extraction

The first step in this method is face detection. Once the face is detected the face area is extracted. The extracted face area is then normalised and it is processed using histogram equalization. The resulting image is decomposed by using discrete curvelet transform. The curvelet co efficient are obtained by performing the fast curvelet transform. These co efficients are then converted to vectors. Then the dimensionality reduction is done in order to reduce the huge amount of curvelet coefficient obtained in previous step. For this Principal Component Analysis can be used. This is the third step. The final stage is the classification. This can be done using SVM. The experiments for Facial expression recognition is carried out using JAFFE database.

C. Local Directional Number Pattern for Face Analysis: Face and Expression Recognition

The local Directional Number pattern introduced by Adin Adin Ramirez Rivera and Jorge Rojas Castillo [4] encodes the structural information and intensity variations of the face's texture. For encoding the structure the LDN analyses the directional information. Edge responses in the eight neighborhood is calculated with a compass mask. The top positive and top negative directions from all the directions is considered for producing the descriptor. This will help to distinguish the intensity changes in the texture. Also in this method the descriptor is produced considering the entire neighborhood and not the sparse points like in LBP. Here importance is given for structure of the texture and its intensity transitions. These components are represented by using a six bit binary code assigned to each pixel of the input image. As discussed earlier the top directional numbers are used for computing the descriptor. These numbers i.e. both positive and negative responses gives the information of the structure of the neighborhood. The gradient direction of the bright and dark areas in the neighborhood are revealed by these numbers. For each instance of swapping between positive to negative and negative to positive a different code is generated which will help in distinguishing between dark and bright areas in the image. This information is critical since these transitions occur in the face more often, for example, the top and bottom edges of the eye brows and mouth have different intensity transitions. Also since this is a six-bit code it is very compact. Face expression Recognition is conducted by using SVM. Different kernels are used to classify the facial expressions. The proposed method was tested with five different databases: CK, CK+, JAFFE, MMI and CMU-PIE.

The proposed method was found to be very robust and reliable under various expressions, time lapse and illumination variations.

D. Face and Expression Recognition Based on Bag of Words Method Considering Holistic and Local Image Features

Bag of Words method is a Local matching approach introduced by Zisheng et. al. [3]. Here the image is represented as a collection of local features. The collection is order less. These patches of local features are the basic elements called "words". These patches are represented as numerical vectors by applying feature descriptors to these patches. These numerical vectors are converted to "code words" to produce a "codebook". The codebook is made using clustering methods. The code words are defined as the centers of the learned clusters. The image is represented by a code word histogram by mapping each patch in the image to a code word through clustering process. For facial expression recognition the face as a whole is not considered for partitioning. Instead of this the facial components are extracted first and clustered. This method can effectively classify the facial expressions.

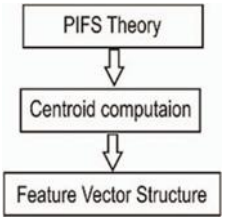

Fig. 2. Local features

E. Regional Registration for Expression Resistant 3D Emotion Recognition

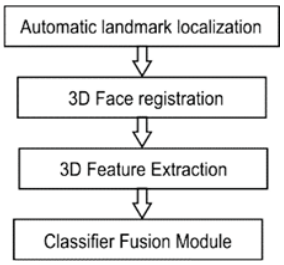

Fig. 3. Block Diagram of Regional Registration for Expression Resistant 3D Emotion Recognition

Nese Alyyuz et. al. used an efficient facial surface registration approach incorporated with discriminative 3D features. This method is resistant to illumination variations and the presence of intraclass variance due to presence of expression. A region based rigid registration approach is

followed in this method. 3D point coordinates are used to represent facial features. The block diagram of the proposed system is shown in fig. 3.

F. FARO: Face Recognition against occlusions and expression variations

FARO Emotion Recognition method proposed by Maria De Marsico et al. [6]is based on PIFS theory [31]. FARO is a factral based approach. The main steps in FARO are (i) Application of PIFS Theory. By applying PIFS theory they defined the ranges and domains. (ii) Computing the centroids. The face components are addressed by PIFS as separate regions. (iii) Feature Vector Structure. After the computation of the centroids these are rearranged so that it can be used for comparison. For comparing two faces we have to compare the average standard deviation of corresponding centroids. Fig. 4 shows a block diagram representing steps in FARO.

FARO was tested with the presence of illumination variations, changes in expressions and also partial occlusions. AR Database was used for the experiments. FARO is robust to presence of occlusions. Eyes, Nose and mouth are considered for this method. As a future scope eyebrow can also be included which will increase the accuracy of the system. Also the basic PIFS method can be modified for getting better results.

G. Gradient Feature Matching for Expression Invariant Emotion Recognition using Single Reference Image

An Expression Invariant Emotion Recognition method that uses intrinsic edges in the face was proposed by Ann Theja et al. [9] Hereno approximation method is involved in the edge detection. The edges are represented as an attributed string which is very robust and is not affected by noise. ie it is immune to noise. The pre-processing steps in the proposed algorithm are face detection, cropping, registration/alignment, resizing. This algorithm is carried out in in two steps (i) Edge Feature extraction and (ii) Feature matching procedure

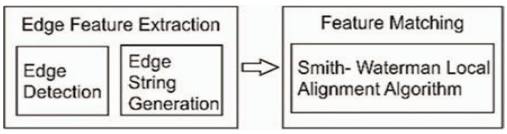

Fig. 4. Edge feature extraction

Edge Feature extraction consists of two steps namely edge detection and edge string generation. In the proposed method they are using Canny edge detection algorithm since it is immune to noise. Once the edges are detected edge strings are generated from the detected edges. The angle and distance values in the polar coordinates are the two attributes of the edge string. In feature matching procedure the edge-strings are compared using string matching. Smith- Waterman Local alignment algorithm [25] is used for the string matching as it gives best local alignment. Experiments were conducted on Yale Database [26], JAFFE (Japanese Female Face Expression) Database [27] and on CMU AMP Expression database [28]. Proposed method gave a recognition rate of 94% in the Yale database, 99.52% in JAFFE database and 100% in the CMU AMP database. The proposed method was found to be independent of expression variations and gave a very good result when applied on Yale, JAFFE and CMU AMP databases. The future scope includes the testing of the proposed method on larger databases like CK+ and AR databases.

H. H.A design for Integrated Face and Facial Expression Recognition

In their paper [8] Kai Tai Song and Yi-Wen Chen have proposed an algorithm for integrated Face and Facial Expression Recognition using Active Appearance model. In this importance is given for both the facial shape and texture. ie a model is generated which extracts both the shape feature and texture features of the face. Once the AAM model is formed it is fed into a Back propagation Neural Network system for face and facial expression recognition. In this method two approaches are considered, first is one in which the face of a known person is recognized. Each expression for a person is stored in the database as different entries. Once the person's face is recognized the expression is found out from that person's expression database. This is done in order to increase the efficiency of the system, since same expressions will be different for different persons. If the input image probe is that of an unknown person then the expression is checked against the whole database. Here Modified Lucas-Kanade algorithm which was developed by Baker and Matthews [29] based on the Lucas - Kanade method developed by Lucas and Kanade [30] is used for image alignment. In order to get a faster fitting response in AAM an inverse compositional algorithm is introduced in the Modified Lucas-Kanade method. A High Recognition rate of 98.3% was obtained when conducting experiments on BU-3DFE database. The proposed method gave a face expression recognition rate of 83.8% in the integrated method.

I. Emotion Recognition using 3-D model

Kostas compares muscle contraction and expansion from the human face to relevant data taken from a 3-d model of a head [2]. This takes place at curve level, with each curve being drawn from detected feature points in an image sequence or from selected vertices of the polygonal model. The result of this process is identification of the muscles that contribute to the detected motion; this conclusion is then used in conjunction with neural networks that map groups of muscles to emotions. The notion of describing motion with specific points is also supported in MPEG-4 and the relevant encoded data may easily be used in the same context. It observes the temporal movement of facial keypoints, which reveals the type of emotiontaking place in a video sequence. The comparison is based on synthetic 3-D generated prototypes for the corresponding points. Ekman conceived the notion of an action unit, which is in essence the recognizable result of the flexing of a single or a small group of

facial muscles. The muscles that are related to expressions are superficial, i.e. near the surface of the head, and are responsible

Table 1
Literature survey of different methods of face expression recognition

S.No.	Method/Technique(s)/ Database	Result/ Accuracy	Conclusion	Future scope
1	Curvelet Feature Extraction	The FER is carried out on JAFFE database. The recognition rate was 94.74% (72/76)	This paper introduced curvelet transform for addressing the FER	Combination of curvelet transform with other dimensionality reduction method like ICA, LLE etc.
2	Expression invariant 3D Emotion Recognition using Patched Geodesic Texture Transform	The experiments were conducted on BU-3DFE. The algorithm was tested with 6 expressions. Disgust has the lowest recognition rate 78% and anger has maximum (90%)	PGTT can be used for expression invariant Emotion Recognition. It gives superior results.	
3	FER based on Bag of words Method Considering Holistic and Local Image Features	Facial expression Recognition rate is 96.33% on Cohn-Kanade database	This method can give excellent Emotion Recognition performance under various conditions including extreme expressions, strong non uniform lighting and partial occlusions.	
4	Local Directional Number Pattern for Face Analysis: Face and Expression Recognition	The proposed method was tested with five different databases: CK, CK+, JAFFE, MMI and CMU-PIE. AN average of 94.4% accuracy was obtained	The proposed method was found to be very robust and reliable under various expressions, time lapse and illumination variations.	
5	Regional Registration for Expression Resistant 3D Emotion Recognition	An accuracy of 97.51% is achieved for FRGCv2 database. The recognition rate in Bosphorus database is 98.19%.	A fully automatic Expression insensitive 3D Emotion Recognition system was proposed by the authors. The identity of the person is inferred by using the facial surface characteristics	Future studies must investigate aggregation of data from different sensors
6	FARO: Emotion Recognition Against Occlusions and Expression Variations	FARO was tested with the presence of illumination variations, changes in expressions and also partial occlusions. AR Database was used for the experiments.	FARO is robust to presence of both natural and synthetic occlusions like scrafs, sunglasses etc.	As a future scope eyebrows can also be included which will increase the accuracy of the system. Also the basic PIFS method can be modified for getting better results.
7	Gradient Feature Matching for Expression Invariant Emotion Recognition using Single Reference Image.	Proposed method gave a recognition rate of 94% in the Yale database, 99.52% in JAFFE database and 100% in the CMU AMP database.	The proposed method was found to be independent of expression variations and gave a very good result when applied on Yale, JAFFE and CMU AMP databases.	The future scope includes the testing of the proposed method on larger databases like CK+ and AR databases.
8	A design for Integrated Face and Facial Expression Recognition	A High Recognition rate of 98.3% was obtained when conducting experiments on BU-3DFE database. The proposed method gave a face expression recognition rate of 83.8% in the integrated method.	An integrated face and face expression recognition system with high recognition rate was introduced. It is a two stage process. In the first stage users face is recognized and facial expression is recognised by using his/her personal expression database	The authors are planning to implement this method on an interactive service
9	Emotion Recognition using 3-D model	This system utilizes automatic feature extraction and motion estimation techniques, along with 3-d face models to compare motion data to predefined prototypes, which results in muscle activation information which is mapped to groups of emotion.	The result of this process is identification of the muscles that contribute to the detected motion; this conclusion is then used in conjunction with neural networks that map groups of muscles to emotions	
10	Emotion Recognition using Matlab	The study about emotions represents a computationally efficient approach for edge detection which further leads to classification of facial expression recognition from static facial images.	The proposed approach can be applied to hardware implementation. Due to the proposed method has simple structure, it is suitable to be implemented in hardware to achieve very high performance and low power system.	

11	Emotion Recognition through Facial Expression using Desktop Devices	The development of a robust real-time perceptive system, which will take into account the facial expressions, detect human face and code the expression dynamics.	This flexibility is not extended over vertical rotations of image. Although it is unable to discover compound or mixed emotions. The system accurately detects the emotions for asingle face, however this correctness reduces prominently for multiple faces.
12	Emotion Detection using Patches	Face is detected and then physically crop from record images as a resolution of 256*256 pixels. Then, an entire set of patch are extract from the imagery. Then a patch harmonizing process is takes place. Here change the extract patches into distance facial appearance.	This method can give excellent Emotion Recognition performance under various conditions including extreme expressions, strong non uniform lighting and partial occlusions.
13	Emotion detection using Genetic Algorithm	Double structured neural network has been applied in the methods of face detection and emotion extraction. In this, two methods are proposed and carried out; they are lip detection neural network and skin distinction neural network. Facial action coding is given to every facial point.	The applications of this emotion classification system are many such as from identifying criminals through a police enquiry to helping bedridden disabled dumb patients.
14	Emotion Detection using Deep Belief Network	The performance of a Deep Belief Network is a powerful deep learning architecture for the task of classifying the face emotion. The DBN architecture learns representationally useful and human interpretable features of the input autonomously even with unlabeled data.	We have less refined predictions with regards to the influence of the size of hidden layers, but generally anticipate that forcing information compression by reducing the number of units in the hidden layer will result in better abstractions

of the general shape of the head. Most of these muscles work collectively; as a result, it is difficult to separate the margins between the areas of influence of distinct muscles.

4. Conclusion

In this paper some of the efficient methods for face and face expression recognition are reviewed. The paper also gives a brief idea of the algorithm used by these techniques. The expressions that are considered for recognition are Happy, Anger, Disgust, Fear, Sadness and Surprise. The techniques here are considered to give a very good recognition rate when applied to the most widely used databases available. These techniques are using a hybrid algorithm in which both holistic and local features are considered so as to increase the recognition rate and achieve greater performance. Among the Techniques used FARO and Bag of Words method can recognize face even in the presence of occlusions in the image. We studied emotion recognition by using various techniques. The paper gives an overview of the few techniques available for emotion detection and recognition. It will help to understand these techniques in short and to choose from them which can be well suited for future evaluation depending on the individual's project. Though there are various techniques available but the key concept remains the same. We have to first select that portion of the images which helps in detecting the emotions. These feature extractions can be performed using various techniques such as 3-D model techniques, Matlab, patch based feature extraction. After extracting the features, it should be analyzed with the database to recognize which type of emotion it is. These is done using neural networks, deep belief networks, pattern recognition method, etc. and the final output is produced giving the emotions from the images.

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