A Brief Review of Facial Expressions Recognition System

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***Abstract*— A wide range of applications exist for Facial Expression Recognition (FER) like neutral, sadness, surprise, happiness, fear, anger, contempt and disgust, which include Emotional / Mental state recognition, stress and anxiety detection in medial domain, security domain, human computer interaction etc. In computer vision field Facial Expression Recognition is very interesting and challenging area. In this paper, review some of the facial expression recognition methods are presented. The feature extraction techniques play a crucial role. In this paper a few Facial Feature Extraction techniques like Local Binary Pattern, Local Directional Pattern are discussed. Also recognition based on support vector machines and deep learning algorithms are discussed and compared.**

Keywords— facial emotion recognition, deep learning based FER, LBP, LDP.

I. INTRODUCTION

Facial Emotion plays an important role in human communication which helps to understand intention of other person. Mostly, people infer the emotional state of other person, such as happy, sad and anger using facial expressions and vocal tone[23]. According to survey from verbal communication one cannot find exact emotion of a person but nonverbal communications convey emotion accurately. Nonverbal communication includes Facial Expressions, gestures, body posture, stance etc. Therefore now a days research on Facial Expression recognition is gaining more attention.

Facial expressions can be recognized by discovering change in facial features like open mouth, raising eyebrows, lips, eyes, cheeks etc. These features get affected due to skin color, gender, age and head movements, occlusions etc. Till date most if the emotion recognition work is done on 2D images, but know the work is started on 3D faces to deal the above challenges and to get better accuracy[1].

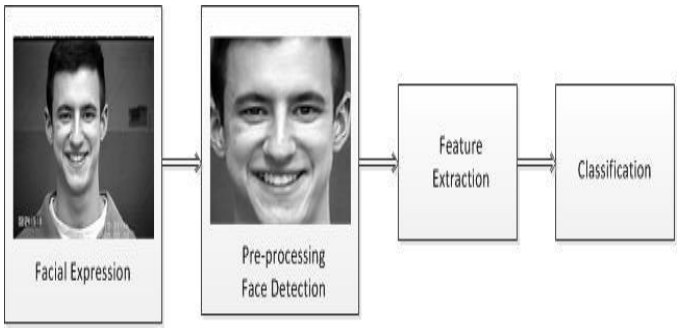

Fig. 1. Facial Expression Recognition Process

II. EMOTION DATABASE

In facial expression recognition systems to do experimentation and comparison various different publically available databases were there. Mostly, human facial expressions have been studied using either 2D static images or 2D video sequences[23].

Therefore, now we will discuss in following points some popular databases related to FER :

- Extended Cohn-Kanade Dataset (CK+), which contains neutral, sadness, surprise, happiness, fear, anger, contempt and disgust expressions of 123 subjects in 593 gray scale image formats, of 640*490 resolutions with facial expression labels text file[18].
- Japanese Female Facial Expressions (JAFFE) , which contains neutral, sadness, surprise, happiness, fear, anger, and disgust facial expressions of 10 subjects, in 213 static gray image format, with resolution 256*256 and labels[19].

- MMI Database, which provides 1280 videos and over 250 images data of 43 subjects, color database of resolution 720*576, here we need to categorize the data by writing our own program[20].
- Indian Spontaneous Expression Database (ISED), contains color 428 videos for sadness, surprise, happiness, and disgust expressions of 50 subjects, of resolution 1920*1080 with labels [21].
- Extended Yale B face (B+), comprises of set of 16,128 facial images taken under a single light source, and contains 28 distinct subjects for 576 viewing conditions, including nine poses for each of 64 illumination conditions. The size of each image is 320*243.

In early days databases were available to do research in face detection or specific object identification , but now a days databases are available for facial expression , scene identification and finding different image modalities. [21].

(a) CK+

(b) JAFFE

(c) MMI

(d) ISED

(e) B+

Fig. 2 Examples of databases related to FER,a,b,c,d,e.

III. RELATED WORK

1. Veena Mayya, Radhika M. Pai, Manohara Pai M. M.[3] used deep convolution neural network to recognize facial expressions and the database used was Extended Cohn-Kanade, Japanese Female Facial Expression database. Caffe on Graphics Processing Unit (GPU) was used for extracting features. Leave one out and tenfold cross validation methods were used to estimate the performance. Achieved accuracy of 96.06% for CK+ dataset and 98.82% for JAFFE dataset. For future work explore other DCNN pre-trained models such as GoogLeNet.

2. Viraj Mavani, Shanmuganathan Raman, Krishna P Miyapuram [7] Used CFEE and the RaFD datasets with 7 basic emotions, are trained and tested using deep convolutional neural network and achieved accuracies of 74.79% and 95.71%, respectively. Then image product of the cropped faces and their visual saliency maps were computed using Deep Multi-Layer Network for saliency prediction and were fed to the facial expression recognition CNN and achieved accuracy of 65.39%. Achieved good accuracy for disgust, happy, sad and surprised expressions , but angry and sad expressions lowered the accuracy.

3. Gibran Benitez-Garcia Tomoaki Nakamura Masahide Kaneko [10] have studied facial expressions from psychological point of view. Authors analyzed culturally specific facial expression recognition of Western and East-Asian expressive faces. Used 3 different feature extraction methods appearance based, geometric based, and a proposed hybrid-based. Their study was focused on 4 specific facial regions (eyes-eyebrows, mouth, nose and forehead/outline) and feature length was reduced using Principal Component Analysis (PCA) .Feature extraction methods are evaluated using Support Vector Machines (SVM) and 4 standard databases.

4. Jadisha Yarif Ram´ırez Cornejo, Helio Pedrini [11] in this paper , authors have used Cohn-Kanade (CK+) data set and the Japanese Female Facial Expression (JAFFE) data set. Occluded facial regions are reconstructed by applying Robust Principal Component Analysis (RPCA), then Census Transform Histogram (CENTRIST) features as well as Local Binary Patterns (LBP), Local Gradient Coding (LGC) and an extended Local Gradient Coding (LGC-HD) are extracted. The feature vector is reduced through Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). For facial expression recognition, K-nearest neighbor (KNN) and Support Vector Machine (SVM) classifiers are applied and tested. Achieved average accuracy of 90% for occluded faces.

5. Madhumita Takalkar, Min Xu, Qiang Wu & Zenon Chaczko [16] This paper is an survey-cum-analysis of the various micro-expression recognition techniques. Starting with framework for analysing micro expressions and classification. Then discussion of new trends that were followed in design. How to use new deep learning features, replace the hand-crafted features for facial micro expression recognition. Done comparison based on accuracy of the models.

6. Ankit Goyal, Naveen Kumar, Tanaya Guha, [5] addressed the problem of continuous emotion prediction in movies from multimodal cues. Taken data of 12 video clips, each from a different movie and around 30 min long and separated audio and video channels for further processing, for audio data Mel Frequency Spectral Coefficients (MFCC) and Chroma features are extracted and Shot frequency Histogram of Optical Flow (HOF) ,Histogram of Facial Area (HFA). Computed the mean absolute Pearson correlation coefficient (PCC) between the predicted label and ground truth label for all movies.

7. Yoann Baveye, Emmanuel Dellandr´ea, Christel Chamaret and Liming Chen [6] discussed use of deep learning algorithms for emotion prediction in movies. Created their own dataset of 30 movies under Creative Commons licenses, continuously annotated along the induced valence and arousal axes (publicly available) is introduced. Used convolutional neural network (CNN) for emotion detection and support vector machine for regression and combination of both for emotion prediction, calculated the performance of system on two conditions i.e. Valance and Arousal, with mean square error of 0.021.

IV. FEATURE EXTRACTION AND CLASSIFICATION

After face detection the next important step is feature extraction. There are many feature extraction techniques but the most popular and widely used ones are explained below.

A. Local Binary Pattern

For image texture analysis Local Binary Patterns algorithm is used. In local binary pattern algorithm there is comparison of each pixel in age with its neighborhood. Take one of the pixel as center pixel and apply a threshold to neighboring pixel. If the intensity of the center pixel is greater-equal its neighbor, then denote it with 1 and 0 if not. After that operation will get a stream of binary numbers. With 8 surrounding pixels you'll end up with `2^8` possible combinations, which are called Local Binary Patterns or sometimes abbreviated as LBP codes. [1]

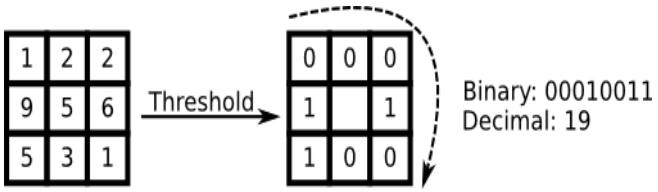

Fig 3. LBP

Fig. 4. LBP of still image

B. Local Direction Pattern

Local Direction Pattern (LDP) was proposed by Jabid. LDP has mainly been applied in biometrics, face recognition, signature verification and facial expression recognition. LDP features are based on eight bit binary codes assigned to each pixel of an input image. It is computed in 3 steps:

1. Calculation of eight directional edge responses values of particular pixels using the krisch compass edge detector in 8 orientations
2. Thake the maximum 3 values from the output of first step and replace it with 1 and all other values as 0.
3. Multiply the output of previous step with a weighted matrix to get a single value. [22]

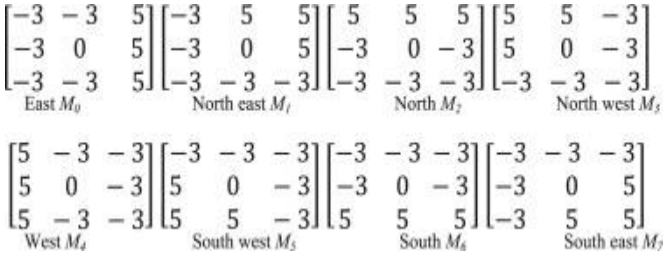

Fig. 5. Krisch masks

For classification of facial expressions implement support vector machine and deep convolution neural network algorithm for classification of facial expression images in seven different categories. Experiment with user created or recorded videos having occluded faces or head pose variation and varying illumination condition.

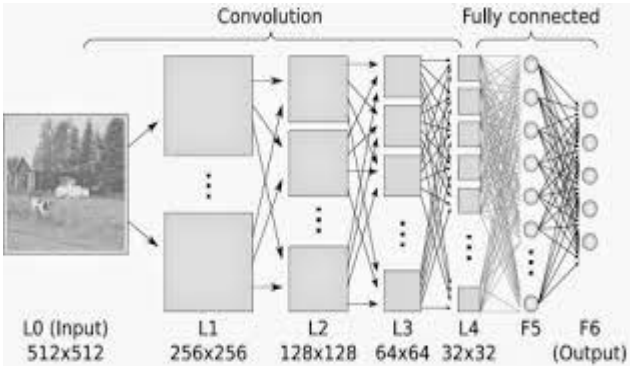

Fig. 6. DCNN architecture

V. CONCLUSION

In this paper we have gone through different public databases which can be used for research in facial expression recognition systems. Then the previous work done related to the subject. Then we have seen the important feature extraction techniques and classification techniques. In future Deep learning algorithms would be useful to achieve high accuracy.

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