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Review on Smile Detection

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ABSTRACT
Facial expressions are a result of specific movement of face muscles, and these face expressions are considered as a visible sign of a person's internal thought process, intensions, and internal emotional states. Smile is such a face expression which often indicates, satisfaction, agreement, happiness, etc. Though, a lot of studies have been done over detection of Facial Expression in last decade, smile detection had attracted researcher for more deeper studies. In this review paper, different type of available smile detection so far has been discussed such as Deep Convolutional Neural Network (CNN), Hidden Marcov Model(HMM), K-Nearest Neighbours(KNN), Self Similarity of Gradient(GSS), Histogram of Oriented Gradients (HOG), Gabor-Energy Filters and Local Binary Pattern(LBP) etc and classifier like HAAR Classifier, Hidden Markov Model(HMM), Adaboost Support Vector Machine (SVM),Softmax Classifier and Extreme Learning Machine(ELM).This review paper will prove beneficial for learning about smile detection and its application.

Keywords : Smile Detection, Adaboost, GENKI4K, CNN

I. INTRODUCTION

Facial expressions are a result of specific movement of face muscles, and these face expressions are considered as a visible sign of a person's internal thought process, intensions, and internal emotional states.[1] As per Mehrabian,[15] in an effective way of communication, approximately 55% of words (emotions) are relayed by some of the specific face muscles movement, 38% by the accent i.e. the way words are pronounced and merely 7% depends on the inherent meaning of the words when spoken at that time. Smile is such a face expression which reflect an optimistic feeling[2]. In today's era of technology motivated by different theoretical studies such as biometric engineering and Human-Robot Interaction Facial Recognition[2], [3] studies had attracted researchers from multiple desciplines, and various application are being made such as taking product reviews from customer, patient monitoring, distance learning system and interactive session feedback[1], [2] . Also, In smile detection technology there are various challenges as there are various exaggerated facial expressions occur rarely in real-life situations. More crucially, sudden facial expressions induced in normal environment differ from posed expressions or intentionally some different type of facial expression,[4] which include both in terms of muscles movement and how dynamically they move. For recognizing a facial structure and its

expressions[4], [5], there are few algorithm derived. Such algorithm evaluates the expression by evaluating the position and movement of nose, lips and eyebrows etc. These set of features are implemented for congruency of picture and obtaining the similar looking characteristics.

The algorithm applied for configuring purpose could be classified into two segment, First is Geometrical Approach[1] through which one can obtain the distinctive feature of face while the second one is photometric approach which consists of stats that fragment the pictures into some values and create some distinction template and values for abrogating variations.

The algorithm which are implemented for recognition purposes are designed over evaluation principle which are characterized by evaluation of discrimination in straight (linear), Zed form, Implementing Eigen Faces, matching of the graph over spanning set by algorithm such as Hidden Markov Model and Face Fisher algorithm and matching the link over neural network.[5]

II. RELATED STUDY

Irshad Ali[1] ,proposes a Smile Detection System, the algorithm support amalgamating of GEE,LBP using KSOM and Autoencoder based classifier.

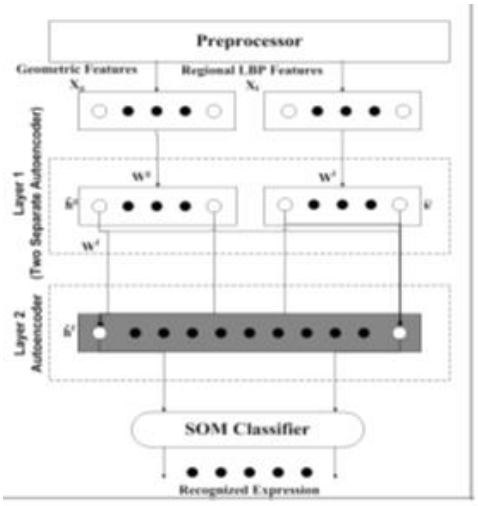

Fig 1 Proposed Architecture

A.GEOMETRIC FEATURE EXTRACTION

In geometric feature input set comprises of eye interpolation proportion and geometrical data of facial point is utilized.

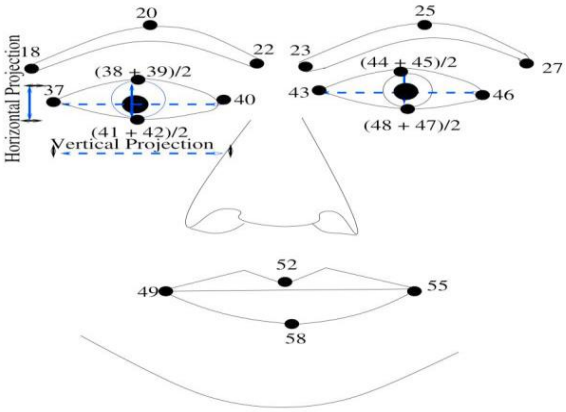

Fig 2 GFE

In the figure, it demonstrate how facial geometrical data of eyes, nose, eyebrows and lips region are utilized. There are following step used for extraction of geometric feature from an input image.

1. Identifying both the eyes.
2. Identifying face and getting estimate Face Height.
3. Finding eyes co-ordinate and measuring the eye's and eyebrows area. Obtaining the eye area estimate height.
4. Finding the mouth and nose areas with the help of eye's centre point and face height.

After finding all those major areas, the nostrils, eyes, lips and eyebrows region are then fragmented and characteristics are taken out from these key regions. These extracted features are then mined by taking the proportion of 2D Projection of that fragmented area.

B. LBP FEATURE EXTRACTION

In this method, the images pixels are labelled by binary operator. The scatters are then used as texture indicator. In this method the operator explain

specific pixel by relatively gray levels over its surrounding pixels. It then compare the grey level of surrounding pixels and if the pixel is equal to are higher than the central pixel, the value assigned will be 1 otherwise it will be assigned to 0.

Fig 3

Fig 3 shows resultant image of smile, the rightside image represents LBP image of mouth region.

C. AUTOENCODER

Autoencoder is an algorithm which is based on unsupervised schooling and uses BPN technique for determining the input feature vector. It helps in cognizing on improved presentation of features in compressed form.

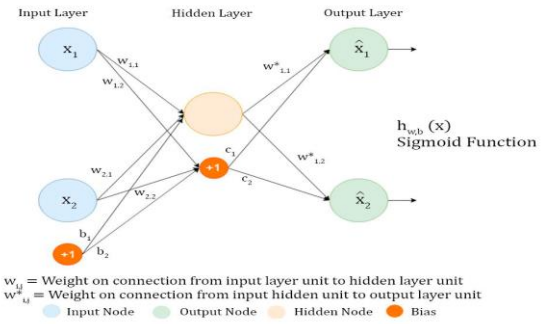

Fig. 4 Structure of an Autoencoder

D. KSOM BASED CLASSIFIER

The SOM algorithm is based on unsupervised learning and is a part of Neural Network. it is used for mapping the feature from multilayer network.

III. EXPERIMETAL RESULT

After amalgamating the extracted feature from GEE and LBP method the result was tested over GENKI4K[4], [6] Dataset and accuracy of proposed method was 98. 89±0.46 , which was comparatively higher than any other method.

Caifeng Shan[7] proposed an efficient approach for smile detection. He used intensity differences between pixels in the grayscale[4], [7], [8] face images as features. Considering real world unconstrained scenarios, it is difficult tracking accurate and reliable detection feature points. As appearance features are less sensitive to errors in feature point detection and hence, it can encode skin texture change which is important for modeling of facial expression. And therefore Appearance Feature is considered more promising for unconstrained facial expression analysis.

Baleja[7], [8] introduced relationship between two pixel intensities as feature. By comparing intensities of a few pixels they obtained high accuracy on gender classification and face orientation discrimination.

Fig.5 Normalized Face Images ; Top 2 rows shows smiling, Bottom 2 rows shows non smiling faces

In this experiment the images were converted to grayscale[4], [7], [8] and then the faces were normalized to a cannonical face of 48 x 48 pixels which is based on the manually labelled eye positions. Then the normalized faces images were partitioned into two sets and into four groups. Two group of smiling and two group of non-smiling faces. One of the set was used as testing data and other was used as training data.

After extracting the intensity differences features of face images which are pre-processed by Histogram Equalization(HE). They run adaboost[7]–[10] to choose distinctive features and combined the selected weak classifiers as strong classifier. Trained over selected 500 features, Adaboost achieved the accuracy rate of 89.7 %. In the experiment each pixels weight is accumulated and the grayscale intensity of the picture was assigned proportional to the times of pixel used. The involved pixel where mainly distributed around mouth and few were from eye areas; considering that the main difference between smiling and non-smiling faces were in the lips, mouth and eye region.

Smile involves many different pair of face muscles which can generate very wide variety of Smiles. In this paper Jacob Whitehill focuses on detection of prototypical smiles, commonly called as "Zygomatic Smiles"[11].

In this experiment testing and training datasets were DFAT and GENKI eyes were found automatically or manually. The tested image representation were Box Filters (BF),Gabor Energy Filters (GEF), Edge Orientation Histogram or a combination of BF and EOH. The tested learning algorithm were GentleBoost and linear Support Vector Machine(SVM).

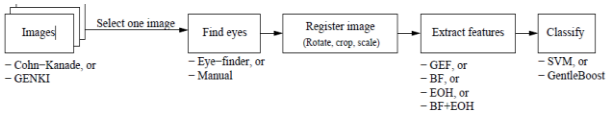

Fig 6 represents Flowchart of smile detection under evaluation

- **Training Set** while testing, a face was considered as a successful detected only if the average deviation between the automatically detected eye allocation and true eye locations was less than the true intr-ocular distance.
- **Image Registration** For image registration they converted images to gray scale and then normalized the images by cropping, rotating and scaling the faces about eyes for reaching a Canonical face width of 24 pixels.
- Keeping feature type constant BF + EOH classifier trained on DFAT had achieved only 87.5% accuracy on GENKI, whereas the classifier trained on equal sized subset of GENKI when use the database of images from the Web achieved an accuracy of 98.6% showing that web images database is more effective as web based data set are useful in capturing more wide range of imaging conditions however, they tend to lack in variability in facial expression.

In his paper V.Jain[12] employed Multi Scale Gaussian Derivative (MGD).For smile detection on the Data Set of GENKI-4K and fnds result better than Gabor Energy Filters. In the experiment, they used 3577 out of 4000 images in GENKI4K Dataset. Images with ambigious cases having partial lightening on the faces and having serious illumination problem were removed from the Dataset.

Then, using Open CV Face Detector. Face- detection was then performed on the selected images in the Dataset. And then, a Half Octave Gaussian Pyramid was constructed over normalised imagette of the faces, which were of the size 64 X 64 pixels.

They used 60% of the images for training and rest of the images for testing. And thus, achieved a classification accuracy of 92.7% using MGD with Principal Component Analysis (PCA) which was more than 90.78 % accuracy of Gabor Energy Filters[7], [8].

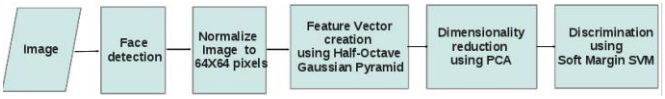

Fig 7 Schematic of Multi-scale Gaussian Derivatives

IV. DESIGN OF A SMILE DETECTION SYSTEM

There are various approaches available for smile detection technique. After going through several smile detection technique and amalgamating all those technique in the previous portion a generalized smile design of a face expression recognition system is implemented and constituted over techniques which is based on knowledge for section of facial expression recognition and Geometric Orientation technique. The reason for opting for this technique is that it does not have any reliability term issue and it could be applied in smooth manner.

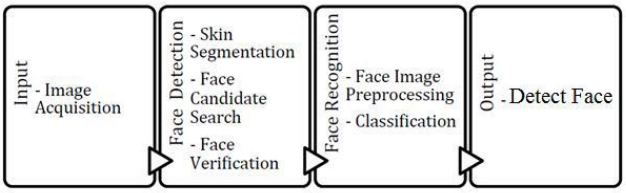

Fig 8 Face Recognition Approach

A. **Input Part**: This is most important factor in Facial Expression Recognition. Image Acquisition operation is applied in this section. The picture clicked is converted into digital form for the purpose of computation of image processing. After this, the acquired pictures are sent over to the Face Detection Algorithm.

B. **Face Detection Part:** In this part, it executes the procedure of discovering and implementing the method over a facial photo for FER. The facial picture is then segmented and analyzed with various geometrical orientation and hence, the face is verified.

C. **Geometric Feature Extraction:** In this part, The characteristic are taken from four most smile specific important fragmented key region i.e. lips, eyes, eyebrows and nose. These characteristics are then mined by proportion of 2D projection of segmented area.

D. **Output:** After collecting all the characteristic the data is matched from various databases available such a GENKI4K and Adaboost databases and after configuring, it gives the output of whether is smiling or not.

The problem associated with system of smile detection are identifying the face and natural facial expression and evaluating it. A lot of academic research have been done over FER (Facial Expression Recognition)[8][6]. Still, smile detection is not so widely studied as it is very hard to catch subtle differences between different smiles as people may have different perception of smile and even one person may have different type of smiling expression. Many smile detection system have been developed in recent years with improving performances. C.Shan[8] developed smile detection algorithm which is based on Adaboost[9], in which the algorithm compare the grey intensity pixel for obtaining distinctive feature from images. As multiclass and regression models gives better output as compared to binary based classifier Girard had proposed smile detection technique which is based on employed intensity-traind multi-class and regression model[13]. Jain had used SVM and Multi-scale Gaussian Derivative (SVM)[12] for smile detection obtaining an accuracy of 92.97 % over GENKI4K Database. H. Liu amalgamated SVM Classifier and Adaboost for smile detection and had obtained improved result over GENKI4K database[11]. Le An had used Holistic Flow- based face recognition method for extracting feature and Extreme Learning Machine (ELM) which had an accuracy of 88.3% on GENKI4K database and an accuracy of 94.4 % and mix database. Liu proposed and employed regression forest and conditional random forest for smile detection which had obtained and accuracy of 95.80% Labeled Faces in the Wild (LFW)which improves to 93.94 % on CCNV-Class database

V. CONCLUSION AND FUTURE ASPECT

Though, there is comparatively less research done for smile detection over Facial Expression Recognition, it is imperative that there should be improving accuracy with further research deepening. Geometrical Segmentation, Neural Network, LBP Feature Extraction and amalgamating SVM classifier[7] and adaboost had enhanced the accuracy manifold over different databases like GENKI4K and CCNU-class database. However there are few challenges which would attract researcher for more deeper studies. Low Detection Rate and high false alarm system,Detection over Oblique faces, posing facial expression picture taken in low visibility are some of the challenges which need to be eliminated for boosting the smile detection technique[14]. Smile detection had attracted a lot of scholar in last decade, but now researcher are more focussed in detecting naturally occurring smile expressions. Differentiating and validating between fake and real smile is one of the most challenging task. Also it is very tough to detect People facial expression when they are using certain face cover like muffler and spectacles etc.(as it will hinder face recognition). Also as per Sebe if a person already knowing about the shooting of picture it is highly probable that they will intentionally smile which make it challenging for determining natural smile .After mitigating these challenge the major task is shooting with real appearance and in different type of exposure and impediment situation. Also, providing lable to available data set it challenge to overcome. Collecting and labelling the unlabled dataset is a stiff work and high Precision should be taken while labeling. Future expansion of research in this field will bring huge impact while collecting review from customer,the Speaker-Audience interaction and also in studying psychology and mental health of a person. This review paper represented a common available technique for smile detection. After reviewing various research paper the technique proposed in this review paper amalgamated different techniques available and provide high accuracy in a faster manner. Content written in this paper will be proved beneficial for further Research and it could be further extended by matching with dataset of different databases apart from GENKI4K.

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