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Survey on an Accurate Facial Emotion Recognition System Based On PCA

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Abstract— *Facial expression is the movement of the muscles beneath the skin of the face. Through facial expressions human can convey their emotions without any verbal means. In this paper we have study for raw database of color images; Training and testing set of images are created. Color information in an image is used to detect the face from the image. Important features from the detected face are extracted to form feature vectors using Gabor and Log Gabor filters. Principal Component Analysis (PCA) is used to reduce the dimension of the extracted features. Then these reduced features are classified using Euclidean distance. The main aim is to work upon three emotions-happy, neutral, surprise. Facial expression recognition (anger, sad, happy, disgust, surprise, fear expressions) is application of pattern recognition and classification task. Through facial expression human beings can show their emotions. Its applications are in human-computer interaction (HCI), robotics, border security systems, forensics, video conferencing, user profiling for customer satisfaction, physiological research etc. This paper presented a Facial Expression Recognition system based using Log Gabor Filter and PCA. Euclidean distance is used as a classifier. The proposed system is designed and tested with FEI database. Two emotions to be recognized are happy and neutral.*

Keywords— *Log-Gabor filter, PCA, HCI, AIBO, Euclidean distance, FEI database, YCb Cr.*

I. INTRODUCTION

Human beings can show their emotions like angry face, smiley face etc. It is the movement of the muscles of the face, through facial expressions. Facial expression is one of the most powerful and natural means for human beings to show their emotions [1]. It is the position or movement of the muscles beneath the skin of the face. This movements show the emotional state of an individual [2]. The movement of different facial muscles which causes different facial expressions. Recognition of facial expression is often a hard task. FACS (Facial Action Coding Systems) describes the changes in facial expression that human can detect by observing changes in facial muscles. Each component of facial movement is called an Action Units [8]. Facial expression recognition is an interesting and challenging area. Its application is found in many areas like human-computer interaction (HCI), robotics(AIBO robots), border security systems, forensics, machine vision, video conferencing, user profiling for customer satisfaction, physiological research etc.[10].

There are two different approaches in Facial Expression Recognition (FER) system, geometric based and appearance based [1]. Geometric based method is an old way. It consists of detecting and processing the movement of some facial points on image [4]. The tracked spatial position and shapes of these facial points are used to form feature vectors for geometric based method [2]. Rather than detecting and processing movements of these facial points, the parameters that vary within time, color (pixels), texture of related region are processed in appearance based method. In the presented approach various algorithms are used to recognize facial expressions [3].

In the second algorithm Gabor and Log Gabor filers are used to form feature vectors [5]. In third algorithm PCA is used for data reduction and in the next algorithm Euclidean distance is calculated to recognize accurate emotions. Basic goal of the human–computer-interaction (HCI) system is to improve the interactions between users and computers by making computers more users friendly and receptive to user's needs [4]. Automatic facial expression recognition (FER) plays an important role in HCI systems and it has been studied extensively over the past twenty years. Border security systems, forensics, virtual reality, computer games, robotics, machine vision, user profiling for customer satisfaction, broadcasting, and web services are but a few different real world applications [9].

Facial Expression Recognition (FER) is really a speedily growing and an ever green research field in the region of Computer Vision, Artificial Intelligent and Automation. There are various application programs which use Facial Expression to evaluate human character, feelings, judgment, and viewpoint [5]. Recognizing Human Facial Expression is not just an easy and straightforward task due to several circumstances like illumination, facial occlusions, face shape/color etc. In this paper, we present some method/techniques such as Eigen face approach, principal component analysis (PCA), Gabor wavelet, principal component analysis with singular value decomposition etc. which will directly or/and indirectly used to recognize human expression in several situations [7].

Facial expression analysis consists of two different approaches and each approach has two different methodologies. When whole of the frontal face is use and processes in order to end up with the classifications of 6 universal facial expression prototypes: disgust, fear, joy, surprise, sadness and anger gives the outlines the first approach [11]. Instead of

using the whole face images, we can divide them into some sub-sections for further processing and this form up the main idea of the second approach for facial expression recognition.

Geometric Based Parameterization is an old way which consists of tracking and processing the motions of some spots on image sequences [6]. Facial motion parameters and the tracked spatial positioning & shapes of some special points on face, are used as feature vectors for the geometric based method. Rather than tracking spatial points and using positioning and movement parameters that vary within time, color (pixel) information of related regions of face are processed in Appearance Based Parameterizations [8].

Face perception is an important component of human knowledge. Faces contain much information about ones id and also about mood and state of mind [13]. Facial expression interactions usually relevant in social life, teacher-student interaction, credibility in numerous contexts, medicine etc. however people can easily recognize facial expression easily, but it is quite hard for a machine to do this [14].

Face recognition is one of the most active research areas in the study of pattern recognition and computer vision. Over the past several decades, much work is focused on two-dimensional images. Due to the complexity of the face recognition, it is still difficult to develop a robust automatic face recognition system [5].

The difficulties mainly include the complex variations in many aspects, such as poses, expressions, illuminations, aging and subordinates, of these problems [14]. The pose variations and illuminations commonly influence the accuracy of 2D face recognition. According to evaluations of commercially available and mature prototyped face recognition systems provided by face recognition vendor tests (FRVT), the recognition results under the unconstrained conditions are not satisfactory [16]. To develop a robust face recognition system, additional information needs to be considered. Two typical solutions are the use of infrared images and the use of 3D images. Infrared images are robust to changes in environmental lighting, but these are too sensitive to changes in environmental temperature [14].

II. RELATED WORK

Facial expression classification mostly focuses on gray scale image features, while rarely considering color image features. Facial Expression plays an important role in human-to human interaction, allowing people to express themselves beyond the verbal world and understand each other from various modes. Some expressions incite human actions, and others fertilize the meaning of human communication [5]. The RGB colour model is an additive colour model in which red, green, and blue light are added together in various ways to reproduce a broad array of colours. The main purpose of the RGB colour model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography [15]. Before the electronic age, the RGB colour model already had a solid theory behind it, based in human perception of colours. Facial expression recognition system by using various techniques. The system includes camera for capturing color images [17]. Then the images are pre-processed to minimize the effect of environmental and other variations in an image. This includes scaling of an image, lightning compensation, noise removal, detection of eyes, mouth, nose to create mask of the face. Then the features are extracted and dimensions of an image are reduced in the second and third step. Lastly using the reduced features different emotions are classified. A block diagram description of FER system is shown in Fig 1.

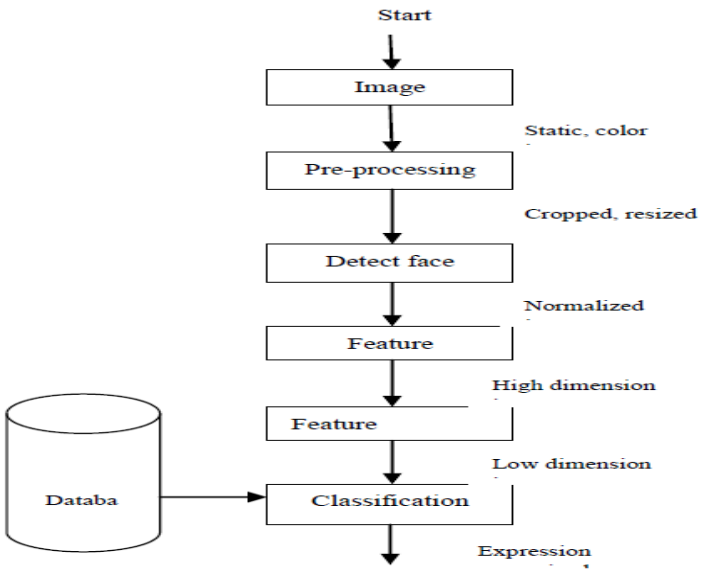

Fig: A block diagram description of FER system

Image Acquisition

Image is input to the system. Either static or dynamic image could be taken. Images could be 2-d monochrome (grayscale) or color images. However we have taken static, color image.

Image Pre-Processing

Image pre-processing is very important step in facial expression recognition task. In this step images are cropped and resized into same dimension.

Face Detection

Face detection may fail due to changes in shape, pose, lightning condition, occlusion, facial expressions. Therefore, to detect face correctly we have to go through the following steps.

Feature Extraction

Feature extraction is a process of extracting essential information from large dataset. It is better to pass the normalized facial images to the feature extraction phase before it is given to the classifier. Feature extraction generally reduces the dimensionality of the input space while retaining essential information possessing high discrimination power and high stability. We have used Gabor filter and Log Gabor filters in feature extraction phase.

Principal component analysis (PCA)

It is a mathematical procedure that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. This transformation is defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to (i.e., uncorrelated with) the preceding components. Principal components are guaranteed to be independent if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables. PCA is closely related to factor analysis.

Factor analysis typically incorporates more domain specific assumptions about the underlying structure and solves eigenvectors of a slightly different matrix. PCA is also related to canonical correlation analysis (CCA). CCA defines coordinate systems that optimally describe the cross-covariance between two datasets while PCA defines a new orthogonal coordinate system that optimally describes variance in a single dataset. It concludes that by using grey-scale images we can get facial expression recognition. But we want robust recognition, that's why we have to use color images in proposed method [18].

Facial image processing and analysis:

Face recognition systems are progressively becoming popular as means of extracting biometric information. Face recognition has a critical role in biometric systems and is attractive for numerous applications including visual surveillance and security [8].

Because of the general public acceptance of face images on various documents, face recognition has a great potential to become the next generation biometric technology of choice. Face images are also the only biometric information available in some legacy databases and international terrorist watch-lists and can be acquired even without subjects' cooperation. This special issue is particularly interested in recent progress in face detection and recognition that explores emerging themes such as digital video, 3D, near infrared, occlusion and disguise, long-term aging, and/or the lack of sufficient training data. Face and feature detections are:

- Face detection for best-shot selection
- Facial feature detection and extraction
- 3D head modeling and face tracking

Facial expression recognition:

Facial expression is a visible manifestation of the affective state, cognitive activity, intention, personality, and psychopathology of a person it plays a communicative role in interpersonal relations. Facial expressions, and other gestures, convey non-verbal communication cues in face-to-face interactions. These cues may also complement speech by helping the listener to elicit the intended meaning of spoken words [10].

Automatic recognition of facial expressions may act as a component of natural human machine interfaces (some variants of which are called perceptual interfaces or conversational interfaces). Such interfaces would enable the automated provision of services that require a good appreciation of the emotional state of the service user, as would be the case in transactions [19].

III. FACIAL DETECTION PROCESS BY USING VIOLA – JONES ALGORITHM

Face detection determines the presence and location of a face in an image, by distinguishing the face from all other patterns present in the scene. This requires appropriate face modelling and segmentation. The approach should also take into account the sources of variation of facial appearance like viewing geometry (pose), illumination (color, shadowing, and self-shadowing), the imaging process (resolution, focus, imaging noise, perspective effects), and other factors like Occlusion [13]. Alternatively, face detection can be carried out by using the entire face [4], [5], making occlusion difficult to handle. Face detection methodologies classified on the basis of the image information used to aid in detection—color [16], geometric shape [7], or motion information [8], [9].The following figure shows the process of detection in a still image or image sequence.

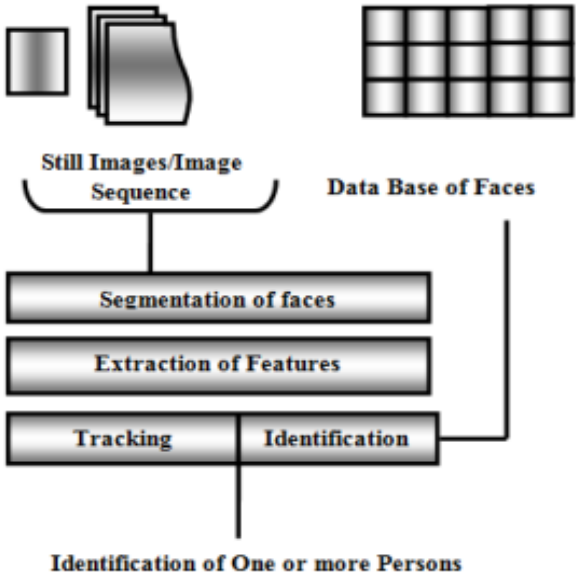

Fig: 2 Process of Detection.

Methods of Detection:

The following methods are generally used to detect the faces from a still image or a video sequence.

1) Viola Jones Face Detection Algorithm:

The Viola–Jones object detection framework [10] is the first object detection framework to provide competitive object detection rates in real-time proposed in 2001 by Paul Viola and Michael Jones. Even though it can be trained to detect a variety of object classes, it was motivated mainly by the problem of face detection. This face detection framework is capable of processing images extremely rapidly while achieving high detection rates. There are three key assistance.

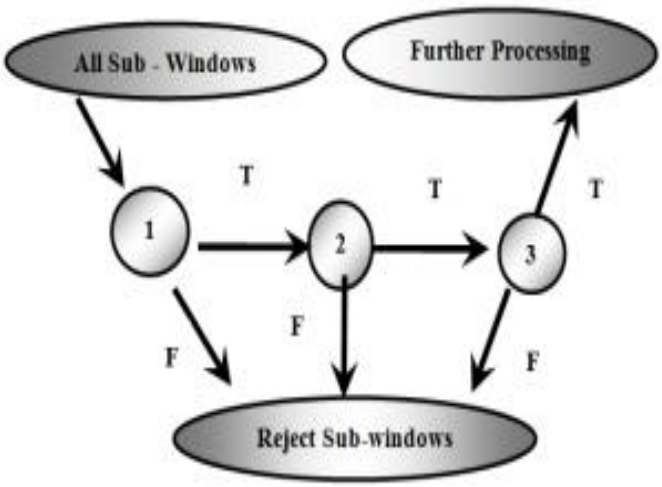

Fig: 3 Detection process by using viola – Jones algorithm.

- The first is the introduction of a new image illustration called the ―Integral Image‖ which allows the features used by our detector to be computed very quickly

- The second is an easy and efficient classifier which is built using the Ada Boost learning algorithm to select a small number of critical visual features from a very large set of potential features.

- The third contribution is a process for combining classifiers in a ―cascade‖ which allows background regions of the image to be quickly discarded while spending more computation on promising face-like regions.

2) Local Binary Pattern (LBP):

The local binary pattern (LBP) technique is very effective to describe the image texture features. LBP has advantages such as high-speed computation and rotation invariance, which facilitates the broad usage in the fields of image retrieval, texture examination, face recognition, image segmentation, etc. Recently, LBP [11] was successfully applied to the detection of moving objects via background subtraction. In LBP, every pixel is assigned a texture value, which can be naturally combined with target for tracking thermo graphic and monochromatic video. The major uniform LBP patterns are used to recognize the key points in the target region and then form a mask for joint color-texture feature selection.

3) AdaBoost Algorithm for Face Detection:

Boosting is an approach to machine learning based on the idea of creating a highly accurate prediction rule by combining many relatively weak and incorrect rules. The AdaBoost algorithm was the first practical boosting algorithm, and one of the most widely used and studied, with applications in numerous field. Using boosting algorithm to train a classifier which is capable of processing images rapidly while having high detection rates. AdaBoost is a learning algorithm which produces a strong classifier by choosing visual features in a family of simple classifiers and combining them linearly. Although AdaBoost [12] is more resistant to over fitting than many machine learning algorithms, it is repeatedly sensitive to noisy data and outliers .AdaBoost is called adaptive because it uses multiple iterations to generate a single composite strong learner.

AdaBoost creates the strong learner (a classifier that is well-correlated to the true classifier) by iteratively adding weak learners (a classifier that is only slightly correlated to the true classifier). Throughout each round of training, a new weak learner is added to the group and a weighting vector is adjusted to focus on examples that were misclassified in preceding rounds. The outcome is a classifier that has higher accuracy than the weak learners‘ classifiers.

IV. CONCLUSIONS

We have studied a facial expression recognition system using Principal component analysis and Log Gabor Filter method. The experiment was performed in image database. The logs Gabor filter outperform PCA producing largest improvement in recognition rate, its computation load is complex and time consuming. The percentage of correct classification varied across happy and neutral expressions. PCA, Gabor wavelet, principal component analysis with singular value decomposition etc. with the use of appropriate Datasets for detection of Human Facial expression and their recognition based on accuracy and computational time. Some methods we see contain drawbacks as of recognition rate or timing. To achieve accurate recognition two or more techniques can be combined, then features are extracted as per need and to evaluate results final comparison is done. The success of technique is dependent on pre-processing of the images because of illumination and feature extraction.

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