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Emotion Detection Using Facial Expressions -A Review

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Abstract— Facial expressions give important information about emotions of a person. Understanding facial expressions accurately is one of the challenging tasks for interpersonal relationships. Automatic emotion detection using facial expressions recognition is now a main area of interest within various fields such as computer science, medicine, and psychology. HCI research communities also use automated facial expression recognition system for better results. Various feature extraction techniques have been developed for recognition of expressions from static images as well as real time videos. This paper provides a review of research work carried out and published in the field of facial expression recognition and various techniques used for facial expression recognition.

Keywords— automated facial expression recognition system, face detection, emotion detection, and human computer-interaction.

I. INTRODUCTION

Recognition of facial expressions results in identifying the basic human emotions like anger, fear, disgust, sadness, happiness and surprise. These expressions can vary in every individual. Mehrabian [1] indicated that 7% of message is conveyed by spoken words, 38% by voice intonation while 55% of message is conveyed by facial expressions. Facial expressions are produced by movement of facial features.

The facial expression recognition system consists of four steps. First is face detection phase that detects the face from a still image or video. Second is normalization phase that removes the noise and normalize the face against brightness and pixel position. In third phase features are extracted and irrelevant features are eliminated. In the final step basic expressions are classified into six basic emotions like anger, fear, disgust, sadness, happiness and surprise.

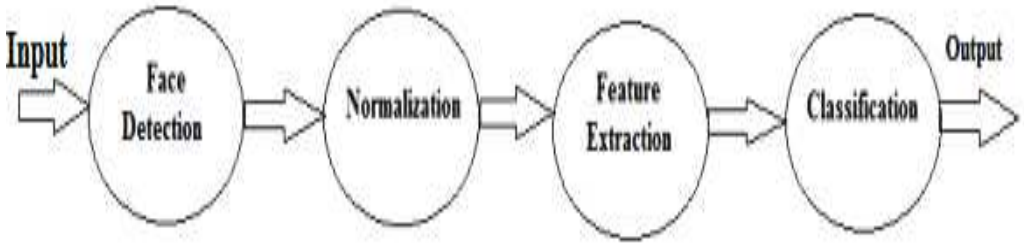

Fig 1. Architecture of facial expression recognition system

Facial expressions show the intention, affective state, cognitive activity, psychopathology and personality of a person [2]. In face-to-face interactions facial expressions convey many important communication cues. These cues help the listener to understand the intended meaning of the spoken words.Facial expression recognition also helps in human computer interaction (HCI) systems [3]. In some robotic applications facial expressions are also used to detect human emotions [4]. Automatic facial expressions analyses also have applications in behavioral science or medicine [2] [5]. The facial expression recognition also has major application in areas like behavioral science, medicine, social interaction and social intelligence. For automatic facial expression recognition system, representation and categorization of characteristics of facial features deformations is a problem area. The detailed information about the problem space for features extraction is given in [6]. This paper presents an overview of emotion detection using facial expression recognition, various emotions that can be automatically detected. Thereafter, a review of various recognition techniques some research challenges are also pointed out.

II. FACIAL EXPRESSIONS AND EMOTIONS RECOGNITION

In 1884, William James gives the important physiological theory of emotion that is in a person emotions are rooted in the bodily experience. First we perceive the object then response occurs and then emotions appear. For example, when we see a lion or other danger we begin to run and then we fear. Each emotion has its own characteristics and appearance figures. Six basic emotions i.e. fear, surprise, sadness, happiness, anger and disgust are universally accepted. Basic emotions can be distinguished as negative and positive emotions.

Happiness is a positive emotion and everyone wants to experience it. Happiness is an emotion or mood to attain a goal. It generally used as a synonym of pleasure and excitement. Fear, anger, disgust and sadness are negative emotions and most people do not enjoy them. Sadness can be described simply as the emotion of losing a goal or social role [7]. It can be described as distraught, disappointed, dejected, blue, depressed, despairing, grieved, helpless, miserable, and sorrowful. Fear is a negative emotion of foreseen danger, psychological or physical harm [7][8][9].

Anger is the most dangerous emotion for everyone. During this emotion, they hurt other people purposefully. Although anger is commonly described as a negative emotion, some people often report feeling good about their anger but it can have harmful social or physiological consequences, especially when it is not managed [11].Surprise is neither positive nor negative [9]. It is the briefest emotion triggered by unexpected events when you haven't a time to think about that event [10].

Disgust is a feeling of disliking and is the emotion of avoidance of anything that makes one sick [9]. Disgust usually involves getting rid of and getting-away from responses. Recently a real time emotion recognition system deployed on a Microsoft's Windows desktop is purposed that work on still images of face as well as in real time environment for feature extraction and emotion recognition [12].For an accurate and high speed emotion detection system edges of the image are detected and by using Euclidean distance Formulae edge distance between various features is calculated. This edge distance is different for every image and on the basis of these distances emotions are classified [13].

III. TECHNIQUES USED FOR FACIAL EXPRESSION RECOGNITION

This section provides an overview and comparison of various techniques that can be used for facial expression recognition. Principal Component Analysis (PCA) is a technique that reduces the dimensionality of image and provides the effective face indexing and retrieval. It is also known as the Eigen face approach [14]. Linear projection is used in PCA, which maximize the projected sample scattering [15]. Imaging conditions like lighting and viewpoint should not be varied for better performance. Fisher's Linear Discriminant is another approach that reduces the projected sample scattering and have better performance than PCA [15]. Independent Component Analysis (ICA) produces statistically independent basis vector while both PCA and LDA produces spatially global feature vectors [16]. ICA gives better performance than PCA but it is computationally expensive than PCA.

All the above methods are 1-dimensional in nature so 2- dimensional Principal Component Analysis (2DPCA) is introduced [17]. In 2DPCA 2D matrix is used rather than 1D vector. It needs more coefficients for image representation therefore the storage space requirement for 2DPCA is much more than PCA. Since all above techniques can be used only for gray scale images therefore there is a requirement for the approaches that can work with color images.

Global Eigen Approach [18] and Sub pattern Extended 2-dimensional Principal Component Analysis (SpE2DPCA) [19] are so introduced for color space. Global Eigen Approach uses the color information present in the images rather than the luminance information as used in PCA and LDA. YUV colors space provides high recognition rate with respect of RGB color space. SpE2DPCA is also introduced to work with colored images. The recognition rate of SpE2DPCA is higher than PCA, 2DPCA, E2DPCA. Multilinear Image Analysis uses tensor concept and is introduced to work with different lighting conditions and other distractions. It uses multilinear algebra [20]. Recognition rate of MIA is greater than PCA but color information is not incoluded in it. Color Subspace Linear Discriminant Analysis also uses tensor concept but can work with color space. A 3-D color tensor is used to produce color LDA subspace which improves the efficiency of recognition [21]. Gabor Filer Bank is another technique that gives greater performance in terms of recognition rate than other methods [22]. But this method has a major limitation that the maximum bandwidth is limited.

IV. PROBLEMS

As we know that we can recognize human emotions using facial expressions without any effort or delay but reliable facial expression recognition by computer interface is still a challenge. An ideal emotion detection system should recognize expressions regardless of gender, age, and any ethnicity. Such a system should also be invariant to different distraction like glasses, different hair styles, mustache, facial hairs and different lightening conditions. It should also be able to construct a whole face if there are some missing parts of the face due to these distractions. It should also perform good facial expression analysis regardless of large changes in viewing condition and rigid movement [23].

Achieving optimal feature extraction and classification is a key challenge in this field because we have a huge variability in the input data [24]. For better recognition rates most current facial expressions recognition methods require some work to control imaging conditions like position and orientation of the face with respect to the camera as it can result in wide variability of image views. More research work is needed for transformation-invariant expression recognition.

V. CONCLUSION

In this paper the automatic facial expression recognition systems and various research challenges are overviewed. Basically these systems involve face recognition, feature extraction and categorization. Various techniques can be used for better recognition rate. Techniques with higher recognition rate have greater performance .These approaches provide a practical solution to the problem of facial expression recognition and can work well in constrained environment. Emotion detection using facial expression is a universal issue and causes difficulties due to uncertain physical and psychological characteristics of emotions that are linked to the traits of each person individually. Therefore, research in this field will remain under continuous study for many years to come because many problems have to be solved in order to create an ideal user interface and improved recognition of complex emotional states is required.

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