Volume 4, Issue 3, March 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Techniques for Facial Expression Recognition

C.B. Tatepamulwar
School of Computational Sciences, S. R.T. M. University Nanded(Maharashtra), India

V.P. Pawar
School of Computational Sciences, S. R.T. M. University Nanded(Maharashtra), India

H.S. Fadewar
School of Computational Sciences, S. R.T. M. University Nanded(Maharashtra), India

Abstract: ***Facial expression recognition, emotion recognition is an interpretation attempt and often demands understanding of a given situation, together with the availability of full contextual information. This paper gives an overview of the methodology to be followed for facial expression recognition. The challenges faced by expression recognition system are also discussed with possible options.***

Keywords: Biometric Recognition, Facial Expression

I. INTRODUCTION

Biometrics is a class of Pattern Recognition problem. Biometrics is automated method of identifying a person or verifying the identity of a person based on a physiological or behavioral characteristic. Examples of physiological characteristics include hand or finger images, facial characteristics. Biometric authentication requires comparing a registered or enrolled biometric sample (biometric template or identifier) against a newly captured biometric sample (for example, captured image during a login)[1].

The identification of a person by their facial images can be done in a number of different ways such as by capturing an image of the face in the visible spectrum using an inexpensive camera or by using the infrared patterns of facial heat emission. Facial Recognition in visible light typically model key features from the central portion of the facial image using a wide assortment of cameras in visible light system extract features from the captured images that do not change over time while avoiding superficial features such as facial expression or hair. Several approaches to model facial images in the visible spectrum are Principal Component Analysis (PCA), local feature analysis, Neural Network, multi-resolution analysis etc[2].

The challenges of facial recognition in the visible spectrum include reducing the impact of variable lightning and detecting a mask or photograph. Some facial recognition systems may require a stationary or posed user in order to capture image through many systems, though many systems use a real time process to detect a person's head and locate the face automatically. Major benefits of facial recognition are that it is non intrusive, hand free, continuous and accepted by most users.

II. FACE RECOGNITION

What makes face recognition an interesting problem? Consider the importance of the face in human culture. A human face is central to social interaction. It is the main source of information by which people identify each other, and the focus during a conversation. Since the ability to identify each other is one of humanity's core ability (like the ability to speak), a natural question to ask is whether a computer could replicate this ability. The urge to build machines that are as human as possible sparks the research on face recognition. Face recognition is one of the many basic abilities that are required in order to construct a man-like machine[3,4].

For most security authentication applications where virtually any environment or situation requires a key, card, or password for access can be replaced or further enhanced by face recognition. Using face recognition instead of the aforementioned access methods will greatly increase the ease of use, ease of implementation, and overall elegance of use. If face recognition is used in parallel with existing access methods, then the level of security could be greatly increased. For example, face recognition could be used in a building's main entrance to replace the key or card entry system. This will prevent fraud access due to stolen key or card. User authentication at ATM machines is highly susceptible to fraud because due to the ease of card falsification. Enforcing face recognition will disallow such fraudulence. The widely installed base of ATM machines make them strategically advantageous to locate wanted criminals across the nation. Potentially, even criminals will need to access an ATM machine [3].

In the area of human-computer interaction (HCI), automatic logon is made possible if a workstation is installed with a camera that detects its user. Upon positive identification, the user is automatically logged on and his/her environment is automatically loaded. The computer will then be seen as a much friendly piece of hardware.

Face recognition is a non-intrusive method, and facial images are probably the most common biometric characteristic used by humans to make a personal recognition. The applications of facial recognition range from a static, controlled "mug-shot" verification to a dynamic, uncontrolled face identification in a cluttered background (e.g., airport). The most popular approaches to face recognition are based on either *(i)* the location and shape of facial attributes, such as the eyes, eyebrows, nose, lips, and chin and their spatial relationships, or *(ii)* the overall (global) analysis of the face image that represents a face as a weighted combination of a number of canonical faces. In order that a facial recognition system works

well in practice, it should automatically *(i)* detect whether a face is present in the acquired image; *(ii)* locate the face if there is one; and *(iii)* recognize the face from a general viewpoint (i.e., from any pose)[4].

III. FACIAL EXPRESSION CLASSIFICATION

Human communication has two main aspects: verbal and non-verbal. In a dialogue the exchange of information does not take place only through words but also through facial expressions. In most of the research, researchers consider the six basic emotional categories that are universally recognized according to [3] namely: happy, sadness, anger, disgust, fear and surprise. The meanings of expressions are as follows.

Anger: Anger is an emotion related to one's psychological interpretation of having been offended, wronged or denied and a tendency to undo that by retaliation. Ekman and Friesen claimed that anger is very likely the most dangerous emotion. When people are angry, they hurt others purposefully. However, according to Lazarus, although anger is commonly classified as negative emotion, people often report feeling good about their anger. On the other hand, he added that when anger is acted out, it can have harmful social or physiological consequences, especially when it is not managed.

Disgust: Disgust is a feeling of dislike and is the emotion of dislike and avoidance of anything that makes one sick [4]. People can feel disgust from any taste, a smell, a sight, a touch or a sound or even an idea. Disgust usually involves getting-rid-off and getting-away from responses.

Fear: Fear is the emotion of anticipated danger, physical or psychological harm [4,5]. Fear renders a mode of readiness to cope with danger. Thus, it promotes alertness for the feared event that can be an imagined or real.

Happy: Happiness is the emotion that most people want to experience. Oatley [8] defined happiness as the emotion or mood of achieving sub goals and of being engaged in that one is doing. It is used almost synonymous with the pleasure and excitement. However, Pleasure is defined as a product of positive physical sensations that is opposite of the physical sensation of pain. Excitement is defined as the opposite of dullness. Excitement and pleasure are different experiences, which often involve happiness.

Sad: There are many words to describe sad feelings: distraught, disappointed, dejected, blue, depressed, despairing, grieved, helpless, miserable, and sorrowful. According to Oatley and Jenkins, sadness can be described simply as the emotion of losing a goal or social role. As compared with fear that looks toward future, sadness seems to look toward the past [7 8]. Sadness is rarely a brief and passive feeling that includes mostly disappointment and hopelessness. It is one of the long-lasting emotions.

Surprise: Surprise is a brief emotional state experienced as the result of an unexpected event. Surprise can have any valence; that is, it can be neutral or moderate, pleasant, or unpleasant. If a person experiences a very powerful or long lasting surprise, it may be considered shock[9].

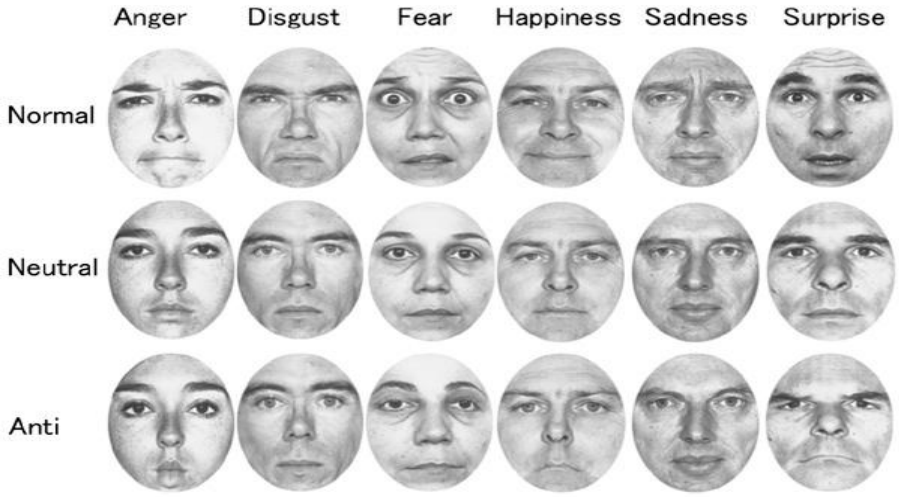


Figure .1: Six Facial Expressions(source Japanese facial expression data set)

IV. FACIAL EXPRESSION ANALYSIS

Facial expressions are the facial changes in response to a person's internal emotional states, intentions, or social communications. Facial expression analysis has been an active research topic for behavioral scientists. In this research paper, facial expression analysis refers to computer systems that attempt to automatically analyze and recognize facial motions and facial feature changes from visual information. Sometimes the facial expression analysis has been confused with emotion analysis in the computer vision domain. For emotion analysis, higher level knowledge is required. Computer facial expression analysis systems need to analyze the facial actions regardless of context, culture, gender, and so on[9,10].

The accomplishments in the related areas such as psychological studies, human movement analysis, face detection, face tracking, and recognition make the automatic facial expression analysis possible. Automatic facial expression analysis can be applied in many areas such as emotion and paralinguistic communication, clinical psychology, psychotherapy, neurology, pain assessment, lie detection, intelligent environments, and multimodal human computer interaction. The computer-based recognition of facial expression has received a lot of attention in recent years because the analysis of facial expression or

behavior would be beneficial for different fields such as lawyers, the police, and security agents, who are interested in issues concerning dishonesty and attitude.

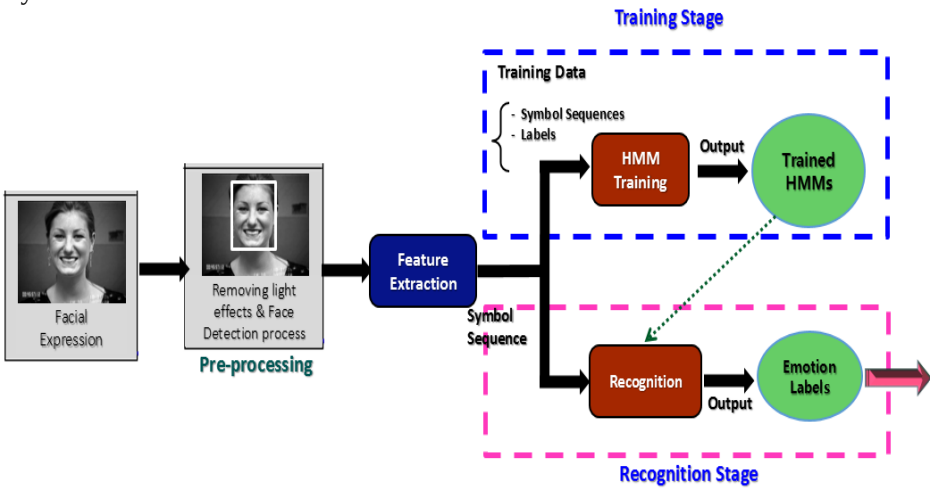


Figure 2. Facial expression recognition system overview (source paper. 15).

V. BASIC STRUCTURE OF AUTOMATIC FACIAL EXPRESSION RECOGNITION SYSTEMS

Facial expression analysis includes both measurement of facial motion and recognition of expression. The general approach to automatic facial expression analysis (AFEA) consists of [12] in three steps as shown in figure 1 face acquisition, facial data extraction and representation, and facial expression recognition or classification.

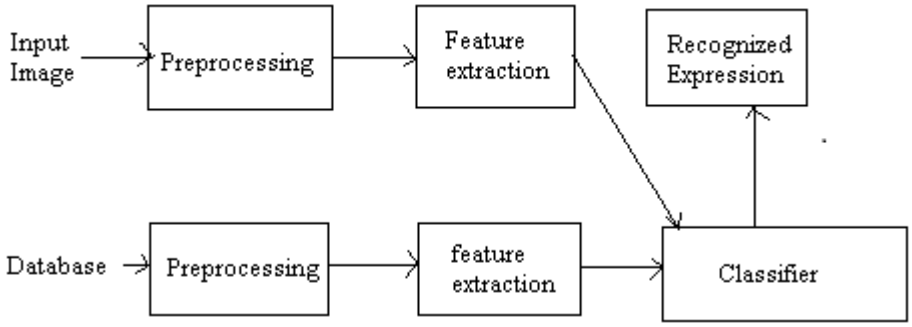


Figure 3. Basic Structure of Facial Expression Analysis Systems(Source paper 4.)

Face acquisition is a processing stage to automatically find the face region for the input images or sequences. It can be a detector to detect face for each frame or just detect face in the first frame and then track the face in the remainder of the video sequence. To handle large head motion, the head finder, head tracking, and pose estimation can be applied to a facial expression analysis system[11,12].

After the face is located, the next step is to extract and represent the facial changes caused by facial expressions. In facial feature extraction for expression analysis, there are mainly two types of approaches: geometric feature-based methods and appearance-based methods. The geometric facial features present the shape and locations of facial components (including mouth, eyes, brows, and nose). The facial components or facial feature points are extracted to form a feature vector that represents the face geometry. With appearance-based methods, image filters, such as Gabor wavelets, are applied to either the whole-face or specific regions in a face image to extract a feature vector. Depending on the different facial feature extraction methods, the effects of in-plane head rotation and different scales of the faces can be eliminated by face normalization before the feature extraction or by feature representation before the step of expression recognition. Facial expression recognition is the last stage of automatic facial expression recognition systems. The facial changes can be identified as facial action units or prototypic emotional expressions.

VI. IMAGE ACQUISITION

The image acquisition procedure includes several issues, such as the properties and number of video cameras and digitizer, the size of the face image relative to total image dimensions, and the ambient lighting. All of these factors may influence facial expression analysis. Images acquired in low light or at coarse resolution can provide less information about facial features. Similarly, when the face image size is small relative to the total image size, less information is available. Many algorithms for optical flow assume that pixel displacement between adjacent frames is small. Unless they are tested at a range of sampling rates, the robustness to sampling rate and resolution cannot be assessed [12].

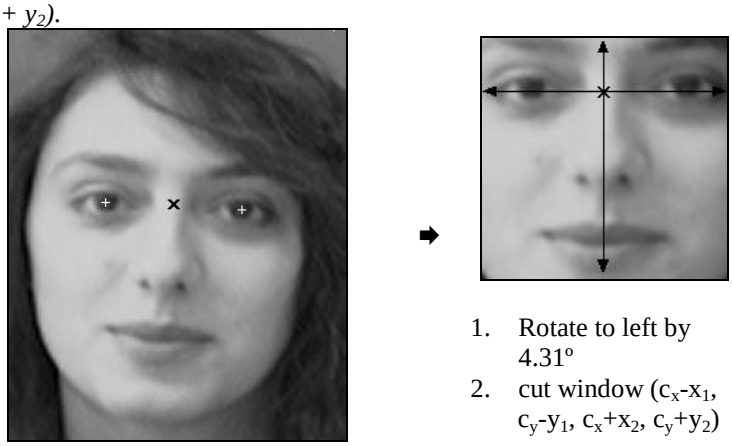
VII. FEATURE EXTRACTION

Facial expressions are generated by contractions of facial muscles, which results in temporally deformed facial features such as eye lids, eye brows, nose, lips and skin texture, often revealed by wrinkles and bulges. Researchers would like to accurately measure facial expressions and therefore need a useful terminology for their description. Of importance is the location of facial actions, their intensity as well as their dynamics. Facial expression intensities may be measured by determining either the geometric deformation of facial features or the density of wrinkles appearing in certain face regions[13]. The last step of automatic facial expression recognition systems is to recognize facial expression based on the extracted features. Many classifiers have been applied to expression recognition such as Neural Network (NN), Support Vector Machines (SVM), and Linear Discriminate Analysis (LDA), K-nearest neighbor, and Hidden Markov Models (HMM).

VIII. FACE EXTRACTION

This is essential to remove unwanted background, and to ensure the face image has consistent dimension. Using the points located from feature detection, a central reference point is derived. For example, knowing the position of the two eyes and the nose, which forms a triangle, the centre of this triangle can be used as the central reference point. In this experiment, the central point of two eyes is used[13].

A fixed size window is then applied relative to the central reference point to extract the face image of that fixed size. The dimension is set in such a way that most of the unwanted background is removed. In the event of varying hairstyle, i.e. the test face's hairstyle may differ greatly from the training face's, a part or all of the portion above the forehead is removed. Figure (image source **Error! Reference source not found.**) shows the face extraction process using the centre point of two eyes. The face is rotated to the left by 4 degrees and a window with respect to the centre point (*cx, cy*) is extracted. The window size is ($x_1 + x_2$, $y_1 + y_2$).



1. Rotate to left by 4.31º
2. cut window (c_x-x_1, c_y-y_1, c_x+x_2, c_y+y_2)

Figure 4: Face extraction that removes background and hairstyle (source face detection data set)

IX. CHALLENGES

Automatic facial expression analysis and recognition is a complex task because faces vary from one individual to another quite considerably due to different age & ethnicity. Even if recognition is done in a constraint of faces specific to some culture, several factors like presence of facial hair, glasses etc. make this task complex. Another challenge to this recognition task is the variation in size and orientation of the face in input images. This disables a search for fixed pattern in the images. Pose of the faces may differ due to angle of the camera. There may be faces which are frontal or non frontal. Faces may be at different angle which may obscure some of the facial features. Some good
preprocessing technique is required to apply on input images which have good insensitivity to translation, scaling and rotation of the head[14].

At present, many feature-based methods of facial expression recognition use local spatial analysis or geometrical information as facial features. For these methods, automatic localization of facial points is a key step to categorizing facial expressions robustly. However, in many practical applications, such as robotics, the performance of facial point extraction algorithm usually depends on the environmental factors such as lighting conditions heavily. So if the illumination is non-uniform, facial point can be detected inaccurately and hence high recognition rate of facial expression hardly expected. This factor would typically make feature extraction more difficult to perform reliably. To compensate the variation of illumination in an input image, image preprocessing methods like DCT normalization, Histogram Equalization, Rank Normalization can be applied before feature extraction.

X. CONCLUSION

In this paper we discuss the basic structure of facial expression recognition system and various methods used for facial expression recognition system. Facial expression recognition rate highly suffers due to many issues like varying lighting conditions, pose variation, presence of glasses and facial hair etc. Various challenges faced by facial expression recognition methods along with possible solutions to overcome those are also highlighted.

REFERENCES

[1]. Renuka Londhe and V.P. Pawar,"Analysis of facial expression and recognition based on statistical approach", International Journal of Soft computing and Engineering (IJSCE), vol. 2, issue-2 May 2012.
[2]. Renuka Londhe and V.P. Pawar," Analysis of facial expression using LBP and Artificial Neural Network", International Journal of Computer application Volume 44, issue 21, May-2012
[3]. Vrushsen pawar & S.C.Mehrotra, "Expression recognition system for Indian faces", IADIS international Journal of computer science & IT ,Vol.2,N.3,PP131-35,,2005
[4]. Vrushsen pawar & S.C.Mehrotra," A computational Model of FACS coding system", International Journal of computer compute vision and HCI, Vol13, No.2, 2006.
[5]. Mr. Dinesh Jain and Dr. V.P. Pawar," A Different Scenario of Neural Network Algorithms towards Face Expression in Human Computer Interaction",International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 2, issue 6, June 2012, ISSN: 2277 128X.
[6]. Yuichiro Anzai, "Human Computer Interaction: a new paradigm of research in robotics," Proceeding of the IEEE workshop on Robot and Human Communication, pp 11-17, 1991.
[7]. Fakhreddine Karray, Milad Alemzadeh, "Human – Computer Interaction: Overview On state of Art," International Journal of Smart Sensing and Intelligent System, Vol. 1, No. 1 March 2008.
[8]. Anil K. Jain, Arun Ross and Salil Prabhakar, "An Introduction to Biometric Recognition," IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image- and Video-Based Biometrics, Volume- 14, No. 1, January 2004.
[9]. Mehrabian A., "Communication without Words," Psychology Today, Vo1.2, No.4, pp 53-56, 1968.
[10]. Ekman P. and Wallace V. Friesen. "Facial Action Coding System," Psychologist Press Inc. San Francisco, California, 1978.
[11]. Ekman P., "Basic emotions," In T. Dalgleish and T. Power (Eds.), The Handbook of Cognition and Emotion Pp. 45-60. Sussex, U.K.: John Wiley & Sons, Ltd., 1999.
[12]. Z. Zeng, M. Pantic, G. I. Roisman and T. S. Hung, "A Survey of Affect Recognition Methods: Audio, Visual, and Spontaneous Expressions," IEEE Transaction on PAMI, vol. 31, no. 1, pp. 39-58, Jan 2009.
[13]. M. S. Bartlett, G. Littlewort, I. Fasel and R. Movellan, "Real Time Face Detection and Facial Expression Recognition: Development and Application to Human Computer Interaction," Proc. CVPR Workshop on Computer Vision and Pattern Recognition for Human –Computer Interaction, Volume- 5, 2003.
[14]. K. Anderson and P. W. McOwan, "A Real-Time Automated System for Recognition of Human Facial Expressions," IEEE Transactions on Systems, Man and Cybernetics Part B, Volume- 17 No. 1, pp. 96-105, 2006.
[15]. Muhmmmad Hammeed sidiqui, Sunyoung lee, young-koo lee, Adil mehmood khan, Phan Ho Truck, "Hierarchical Recognition Schemes for Human Facial expression recognition System", Open Acess Sensors, ISSN 1424-8220

