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A Survey on Facial Expression Recognition Techniques

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Abstract: ***These Human facial expressions convey a lot of information visually rather than articulately. Facial expression recognition plays a crucial role in the area of human-machine interaction. Recognition of facial expression by computer with high recognition rate is still a challenging task. Facial Expression Recognition usually performed in three-stages consisting of face detection, feature extraction, and expression classification. This paper presents a survey of the current work done in the field of facial expression recognition techniques with various face detection, feature extraction and classification methods used by them and their performance.***

Keywords: Facial Expression Recognition, Support Vector Machine, Principal Component Analysis, Neural Network, LBP

1. Introduction

In recent years, although much progresses has been done in the field of human-computer interaction (HCI) but facial expression recognition with high recognition rate is still a very challenging problem and become a core topic in the field of computer science and HCI. Facial behavior is the source of information to determine person's mood and emotions. Facial expressions have been categorized in early 1970s by Ekman's studies. He has stated that humans have six senses where each sense represents a specific emotion such as anger, happy, sad, fear, surprise and disgust [13]. There are many application that uses Facial expression recognition such as Robotics, security, health-care, human machine communication, human behavior detector etc.

Mostly, Facial Expression Recognition basically performed in three major steps:

- Face detection
- Feature Extraction
- Facial Expression Classification

The primary need of Face Expression Recognition system is Face Detection which is used to detect the face. The next phase is feature extraction which is used to select and extract relevant features such as eyes, eyebrow, nose and mouth from face. It is very essential that only those features should be extracted from image that have highly contribution in expression identification. The final step is facial expression classification that classifies the facial expressions based on extracted relevant features.

There are different methods of features extraction such as appearance based method, geometric based method, texture based method etc. and in the current research mostly used methods are geometric based method and appearance based method. Geometric based feature extraction method, extract feature information using shape, distance and position of facial components and appearance based feature extraction method uses appearance information such as pixel intensity of face image. After getting the features, classification methods are applied to recognize facial expression.

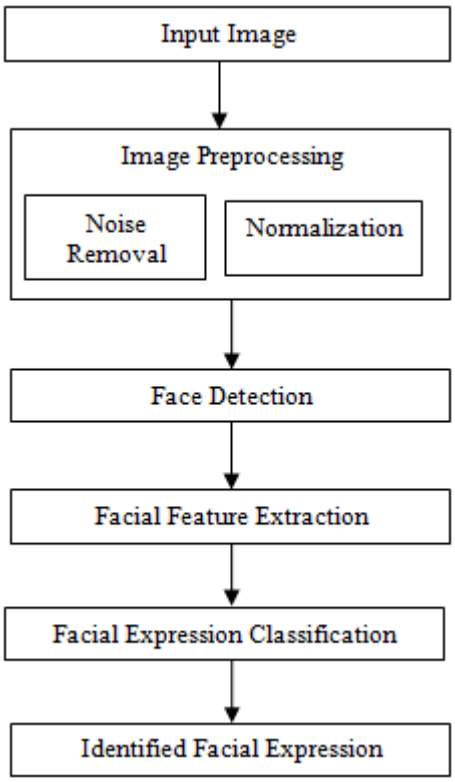

Figure 1: Steps involved in Facial Expression Recognition System

2. Literature Review

Majumder, A.; Behera, L.; Subramanian, V.K. et al. [1], have presented an appearance feature based facial expression recognition system using Kohonen Self-Organizing Map (KSOM). Appearance features are extracted using uniform Local binary patterns (LBPs) from equally sub-divided blocks applied over face image. The dimensionality of the

LBP feature vector was reduced using principal component analysis (PCA) to remove the redundant data that leads to unnecessary computation cost.

Jizheng Yi; Xia Mao; Lijiang Chen; Yuli Xue; Compare, A. et al. [2] have proposed a novel FER algorithm by exploiting the structural characteristics and the texture information hiding in the image space. Firstly, the feature points were marked by an active appearance model. Secondly, three facial features, which are feature point distance ratio coefficient, connection angle ratio coefficient and skin deformation energy parameter, were proposed to eliminate the differences among the individuals. Finally, a radial basis function neural network was utilized as the classifier for the FER.

Kai-Tai Song; Chao-Yu Lin et al. [3], presented a temporal-reinforced approach to enhancing emotion recognition from facial images. Shape and texture models of facial images were computed by using active appearance model (AAM), from which facial feature points and geometrical feature values were extracted. The extracted features were used by relevance vector machine (RVM) to recognize emotional states. they have proposed a temporal analysis approach to recognizing likelihood of emotional categories, such that more subtle emotion, such as degree and ratio of basic emotional states can be obtained.

Lisai Li; Zilu Ying; Tairen Yang et al. [4] have proposed a novel algorithm for Facial Expression Recognition (FER) which was based on fusion of gabor texture features and Local Phase Quantization (LPQ). Firstly, the LPQ feature and gabor texture feature were respectively extracted from every expression image. LPQ features are histograms of LPQ transform. Five scales and eight orientations of gabor wavelet filters are used to extract gabor texture features and adaboost algorithm was used to select gabor features. Then they obtain two expression recognition results on both expression features by Sparse Representation-based Classification (SRC) method. Finally, the final expression recognition was performed by fusion of residuals of two SRC algorithms.

Li Xia et al. [5] proposed the expression classification method based on SVM for the defects of the traditional classification methods. It realizes fast classification with a relatively small sub-classifier combination, reducing the classification error. Experiments shown that the multi-classification method based on SVM can obviously reduce the training and testing time and improve the classification performance.

Abdulrahman, M.; Gwadabe, T.R.; Abdu, F.J.; Eleyan, A. et al. [6] proposed a facial expression recognition approach based on Gabor wavelet transform. Gabor wavelet filter is first used as pre-processing stage for extraction of the feature vector representation. Dimensionality of the feature vector is reduced using Principal Component Analysis (PCA) and Local binary pattern (LBP) algorithms. K-Nearest Neighbour with Euclidean distance (L_2) used as the classifier.

Sobia, M.C.; Brindha, V.; Abudhahir, A. et al. [7], have generated a model of a wheelchair command interface that does not require the other's hands. It includes 3 major modules. They are face detection, facial expression recognition and command generation. The software contains digital image processing for face detection, principal component analysis for facial expression recognition and generating a command signals for interfacing the wheelchair.

Myunghoon Suk; Prabhakaran, B. et al. [8] have developed system uses a set of Support Vector Machines(SVMs) for classifying 6 basic emotions and neutral expression along with checking mouth status. The facial expression features for emotion recognition were extracted by Active Shape Model (ASM) fitting landmarks on a face and then dynamic features were generated by the displacement between neutral and expression features.

Singh, M.; Majumder, A.; Behera, L.et al. [9] have presented a facial expressions recognition system using Bayesian network. They have train the network using probabilistic modeling that draws relationship between facial features, action units and finally recognizes six basic emotions. They have also proposed features extraction methods to get geometric feature vector containing angular information's and appearance feature vector containing moments extracted after applying gabor filter over certain facial regions. Both the feature vectors are further used to draw relationships among Action Units (AUs).

Mu-Chun Su, Chun-Kai Yang, Shih-Chieh Lin, De-Yuan Huang, Yi-Zeng Hsieh, and Pa-Chun Wang et al. [10], have presented an automatic facial expression recognition system based on self-organizing feature maps. First of all, Viola and Jones was used to detect a face from an image. After a human face is detected, a composite method was proposed to locate pupils so that the located face image can be rotated, trimmed, and facial features, we propose the use of SOMs. Finally, a multi-layer perceptron (MLP) was adopted for the classification of the seven expressions including six basic facial expressions.

Navdeep Kaur, Er. Varinderjit Kaur et al. [11], have proposed KNN Regression algorithm with SURF feature for facial expression detection. Initially the eigenspace was created with eigenvalues and eigenvectors. From this space, the eigenfaces are constructed, and the most relevant eigenfaces have been selected using Principal Component Analysis (PCA).

Ping Liu; Shizhong Han; Zibo Meng; Yan Tong et al. [12], have presented a novel Boosted Deep Belief Network (BDBN) for performing the three training stages iteratively in a unified loopy framework. Through this BDBN framework, a set of features, which is effective to characterize expression-related facial appearance/shape changes, can be learned and selected to form a boosted strong classifier in a statistical way. As learning continues, the strong classifier is improved iteratively and more importantly, the discriminative capabilities of selected features are strengthened as well.

Ameen, R.; Oztoprak, H.; Yurtkan, K. et al. [13] have developed a method for the facial expression recognition based on Local Binary Patterns (LBP) extracted from the

texture information. The LBP operator and its extensions were applied to different color models which are gray-scale, RGB, oRGB, YCbCr and HSV. Frontal face images among six basic facial expressions which are anger, disgust, fear, happiness, sadness and surprise were considered. Support Vector Machine (SVM) was employed as the classifier.

Happy, S. L; Routray, A. et al. [14] proposed a novel framework for expression recognition by using appearance features of selected facial patches. A few prominent facial patches, depending on the position of facial landmarks, was extracted which are active during emotion elicitation. These active patches are further processed to obtain the salient patches which contain discriminative features for classification of each pair of expressions, thereby selecting different facial patches as salient for different pair of expression classes. One-against-one classification method is adopted using these features. The appearance features from these patches are fed to a multi-class classifier to classify the images into six basic expression classes.

Meher, S.S.; Maben, P.et al. [15], have analyzed the method of Principal Component Analysis (PCA) and its performance when applied to face recognition and used to identify various facial expressions.

Urvashi Bakshi, Rohit Singhal [16], have introduced a new technique to recognize human face artificially using DCT, PCA and SOM neural network. Principal component analysis (PCA) is a classical and successful method of dimension reduction. Discrete Cosine Transform (DCT) is a well known compression technique and Self Organize Map (SOM) act as a classifier and has been used for face space representation.

Kumar, V.; Basha, A.S.A.et al. [17] have presented a new approach to facial expression recognition, which uses Wavelet for reducing the high dimensional data of facial expression images into a relatively low dimension data and then uses K nearest neighbor(KNN) as the classifier for the expression classification afterwards.

Wang, Xun; Liu, Xingang; Lu, Lingyun; Shen, Zhixin et al. [18], have proposed a new FER system, which uses the active shape mode (ASM) algorithm to align the faces, then extracts local binary patterns (LBP) features and uses support vector machine (SVM) classifier to predict the facial emotion.

3. Conclusion

In this survey paper various facial expression recognition techniques and its associated areas is been overviewed. In previous facial expression recognition system, performance is analyzed on the basis of accuracy, computational time and recognition rate. In most of the current system remains some problem in terms of recognition efficiency and recognition time requirement. The recognition rate of the system can be enhanced by combination of existing techniques or new method can also be used. Optimum recognition rate depends on feature extraction phase in which relevant features need to be extracted and classified based on classification method.

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