A Modified Feature Trained Discriminative Classifier For Facial Expression Recognition

Rakesh Sharma, Sukhjinder Kaur

Abstract: Recognition of the human facial feature using technology is being emerged widely. In the recent times, many image processing techniques have been developed with the different approaches in order to recognize the expressions or human emotions from the image. This paper has presented a novel approach which used different components of the human face that includes pair of eyes, and mouth as the essential parameters to recognize the gesture or the expression of the face. The features are extracted using LDP (Local Direction Pattern) and LPQ (Local Phase Quantization) techniques of feature extraction. These techniques outweigh the techniques used in the traditional work (LBP and LTP). The complexity is reduced and Support vector machine is deployed for classification and recognition of the particular tasks. Simulation is performed using MATLAB and results demonstrated that the proposed system to recognize facial expressions has less complexity and more efficiency as compared to the traditional FER.

Index Terms: Facial Expression Recognition, Local Phase Quantization, Local Direction Pattern, Support Vector Machine

1 INTRODUCTION

Human beings feel a certain emotions which reside in the person as an inborn quality. Mostly, these emotions are expressed through the facial expressions. These emotions are observed by analyzing the expressions on the face. These expressions can be comprehended due to deforming facial muscular movements and relative displacement between the movements [2]. Generally, non verbal communication consists of these expressions which can be explained as the gentle signals of the larger communication. Non-verbal communication is delineated as the interaction between human, animals etc. via eye contact, gestures, facial expressions, paralanguage, and body language [3]. Complex Human computer interface has become very prominent to work with the expressions [4]. The human communication domain shows a report with the information of facial expressions and nonverbal things as significant elements to express human emotions [5], [6]. A significant number of researches have been performed facial expression recognition (FER) in the recent time [7]. The face expressions are recognized to analyze the regions of human face with different perspective. These expressions are affected by the movements and deformation of the facial muscles and wrinkles on skin. The creation of face characteristics from these skin wrinkle and displacement information lead to efficient FER. The most significant and primary job in facial expression analysis is to locate, identify and pick the distinct characteristics of the facial image in attempt to see the eyes, nose, eyebrows, lip, etc.FER comprises of two imperative processes- feature extraction and classification. Geometric based and Appearance based extractions are the two different types of feature extraction. Eye, mouth, neck, eyebrow and other bodily elements are included in the geometrically oriented feature extraction, and the appearance-based decomposition is the exact part of the face. Classification plays an important role in which the analyzing different expressions (shown in figure 1) such as smile, sad, anger, disgust, surprise, and fear are categorized [8].

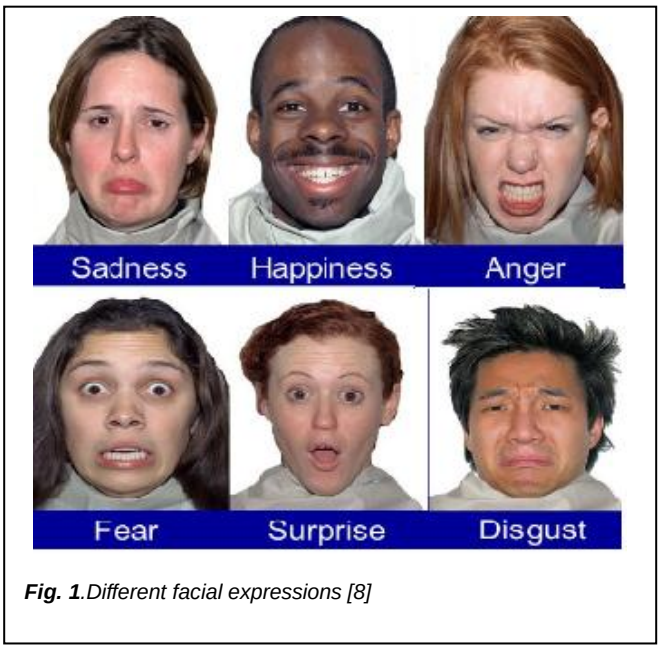

***Fig. 1**.Different facial expressions [8]*

In general, three distinct patterns like static, slow and fast signals are offered by face. The static signals are skin color that contains various permanent elements of body skin pigmentation, greasy particles on the face, face structures, bone structure, cartilage and shape, place and size of the facial characteristics like eyes, nose and mouth. The slow signals are constant wrinkles that include alterations in face shape, such as tone of the muscle and alterations in texture of the skin, which occur smoothly with the passage of time.

2 RELATED WORK

In the field of image processing, many researchers have performed different studies and come up with significant number of approaches for FER. This section presents the literature study of some researches made to examine the facial expressions of human.Khadija Lekdioui, Yassine Ruichek et al. [1], proposed an FER method based on a new facial decomposition. Author took seven regions of interest

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(ROI) of face namely, left eyebrow, left eye, right eyebrow, right eye, between eyebrows, nose and mouth. Author used IntraFace algorithm to identify the facial landmarks which then extorts the above mentioned elements of the face. Feature extraction was performed using LBP, CLBP, LTP and Dynamic LTP. Eventually, multiclass support vector machine was used for images and the recognition of expressions was attained. This approach surpassed the state of the art methods which were derived from other facial decompositions.Some approaches [9] had proposed hybrid methods by amalgamation of combined geometric and appearance features to achieve effective outcomes of each other and in fact, also to attain efficient results in particular cases. Also, several approaches [2, 10, 11], in the sequence of the video were proposed to determine the geometrical displacement of facial landmarks between the current and previous frame as temporal features.Szwoch et al. [12] predicted the emotions and human face expressions on the basis of depth channel from the Microsoft Kinect sensor only without usage of camera. Features were depicted as the local movements in the facial region. Facial expressions were analyzed by utilizing the correlation between particular emotions.Sarbani Ghosh and Samir K. Bandyopadhyay [13]: Authors delineated an easy facial feature selection approach which is based on template matching. Facial expressions were identified on the basis of distances between facial features which were achieved using a set of image databases. Pre Processing, Facial Feature Extraction and Distance Calculations were the phases of this approach. Author recognized the facial expressions through the measurement of Euclidean distances, such as, distance between pairs of eyes and distance between eyes and mouth etc.

3 IMAGE PROCESSING

In FER system, image pre-processing procedure lays a significant role. The objective of this phase is to achieve images with normalized intensity, uniform size and shape, and depict only a face expressing certain emotion. Figure 2 represents the block diagram of the general process of image processing. However, there are two processes involved in image processing and these processes are known as feature extraction and classification which are delineated in this section given below:

3.1 Feature Extraction

It is a process in which pixel data is converted into a higher level representation of motion, texture, shape, color, and spatial configuration of the face or its elements. In general, the dimensionality of the input space is decreased using the methods of feature extraction. Important information is maintained by the reduction procedure as it plays a significant role in pattern recognition system. Some of the feature extraction techniques used to implement FER is as follows:LDP: Local Direction Pattern descriptor is an eight bit binary code which is assigned to every pixel of an input image. This code can be computed by evaluating the pixel's relative edge response (ER) value in distinct directions. LDP descriptor is comprised of detailed data of an image that includes spots, edges, corner, and other local textures [14]. However, during LDP computation over the whole face image, micro-pattern occurrences are only taken into account without knowing their location and spatial relationship. It generally presents the image with the better content.

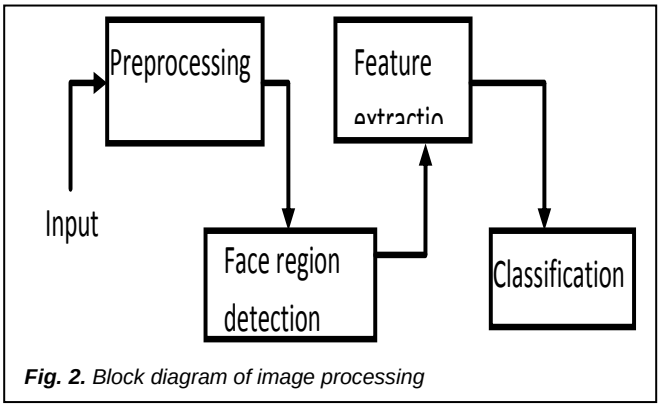

Fig. 2. *Block diagram of image processing*

LPQ: Local Phase Quantization is a descriptor with blur tolerance texture. LPQ has been further scrutinized for FR. It has a great performance as compared to Gabor wavelets based and LBP methods and dealt with the problem of texture classification, specifically when using blurred images. The results obtained using LBP made researchers to perform more studies and thus, they investigated the use of LPQ for FR. LPQ is particularly work efficiently as a blur insensitive [15], therefore, it further offered better results during the analysis of blurred face images [16, 17].

3.2 Feature Classification

After feature extraction, an inadequate number of feature vectors will be obtained, and if these features are directly utilized, on the one hand a good classifier may work ineffectively; on the other hand many features increase time and complexitiesSVM: Support Vector Machine is a justifiable statistical learning theory that has its thriving applications in different classification tasks in computer image [18-20]. Data is implicitly mapped by SVM into a feature space with high dimensions. SVM stumble on a linear separating hyper-plane with maximum margin for data separation.

4 PROBLEM FORMULATION

The Facial expression is an important mode of expressing and interpreting emotional states and mental states of human beings. Facial expression recognition (FER) aims to develop an automatic, efficient, accurate system to distinguish facial expression of human beings so that human emotions can be understood through facial expression, such as happiness, sadness, anger, fear, surprise, disgust, etc. In traditional research work, the author had implemented the face recognition by using the concept of face regions. For this purpose, author implemented feature extraction using LPB, CLBP and LTP mechanism and feature classification using SVM. However, the system lacks in some aspects which are:

- Increased complexity due to extraction of five regions to recognize the facial expression. The selection of these regions were done on the basis of the facial area that highly shows facial expressions such as eyes, mouth, eyebrows, the space between eyebrows etc.
- The techniques used for extracting feature are old which might not be compatible with advanced technology and did not analyze the image deeply. Along with this another pitfall of LBP is its liability to local intensity variations such as noise and small wearable ornaments. Many local features based on histogram attempt to alleviate the impact of noises

5 PROPOSED WORK

The proposed work aims to implement the concept of region of interest and for this, the regions that are highly influenced by the facial expressions, i.e. eyes, mouth and eyebrows are considered. The proposed work considers the eyes and eyebrows as a single region and mouth as an individual region. And the regions like nose, center area of the eyebrows are eliminated, as these are likely affected areas to pretend the feelings and emotions of the human.In proposed work, the traditional feature extraction techniques (LBP,CLBP and LTP) aim to replace with the most prominent feature extraction mechanism, i.e. LDP (Local Direction Pattern) and LPQ (Local Phase Quantization). LDP is a gray-scale texture pattern which characterizes the spatial structure of a local image texture. An LDP operator computes the edge response values in all eight directions at each pixel position and generates a code from the relative strength magnitude. Since the edge responses are more illumination and noise insensitive than intensity values, the resulting LDP feature describes the local primitives including different types of curves, corners, and junctions, more stably and retains more information [20]. The advantage of these feature extraction techniques is that these mechanisms can work on multiple selections in order to analyze the deep features to increase the accuracy level. The feature classification is done by using SVM classification technique. The novel work is proposed in order to reduce the complexity of the existing approach by taking into account the relevant facial regions.

6 EXPERIMENTAL RESULTS

Facial expression recognition mechanism is proposed by using LDP and LPQ feature extraction techniques. These techniques are used as the replacement of LBP and CLBP due to their better performance. The features of the face that are determined to be selected are pair of eyes and mouth. These features are selected to reduce the complexity of the traditional system. Moreover, it is believed that instead of other facial elements, eyes and mouth plays a significant role in expressing emotions. After feature selection, the classification of the features is done using multiple SVM in terms of accuracy. Multiple SVM is implemented due to the recognition of more than one expression such as happy, sad, anger, disgust etc. Simulation results are performed using MATLAB and are examined in terms of accuracy. This section explained the results obtained for the proposed system and also presents the comparative analysis.

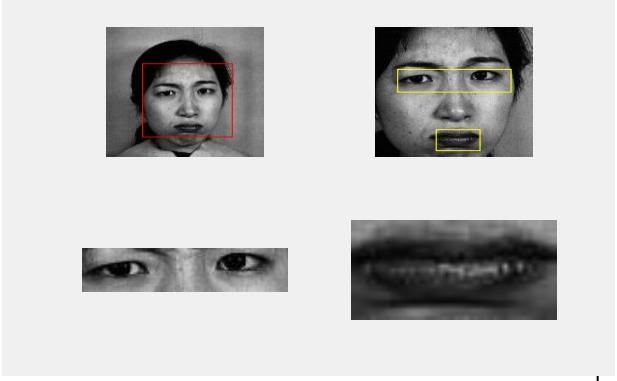

Fig. 3. *Feature selection of an image*

In order to implement this mechanism, one image showing some facial expression is taken and FER first detect the face in the image, then, the described features are selected which are shown in the figure 3. Eyes and mouth are extracted from the image in order to identify the expressions given be them.

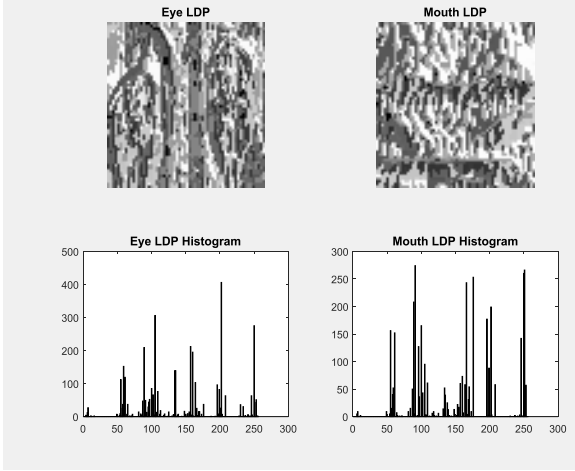

Fig. 4. *Histogram of facial features using LDP*

The simulation results show the feature extraction of eyes and mouth using different techniques. Figure 4 represents the output obtained from LDP (linear direction Pattern) technique to extort the patterns of the features. LDP shows the patterns of eyes and mouth along with their respective histograms. The range of histogram is 0 to 255 which shows the details of image in terms of different patterns.

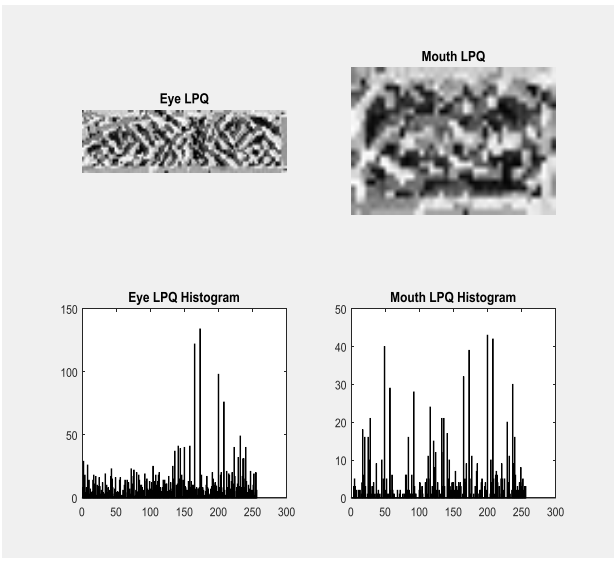

Fig. 5. *Histogram of facial features using LPQ*

Quantization) is presented in the fig. 5. LPQ extracts the pattern in terms of texture classifications. It represents the histogram in which the maximum occurrence of a texture is near to 150 and mouth consists of many patterns whose values are near to 40.Feature classification is performed using support vector machine (SVM). The classification is done in terms of the accuracy of the system. Experimental results are carried out for

proposed as well as existing FER systems. The efficiency of the system is system is measured in percentages. Accuracy of the FER systems is recorded in the tabular chat (TABLE 1).The proposed system has highest accuracy than other existing systems which accounts to 98.333% and LBP has minimum accuracy with 92.09% only.Results showed the better and effective performance of the FER system by replacing the feature extraction techniques with LDP and LPQ. The complexity of the system is also reduced by decreasing the parameters (facial regions) to detect the expressions.

7 CONCLUSION

A novel approach to recognize the facial expressions is developed. It overcomes the limitations of traditional method in which LBP and CLBP techniques were used for feature extractions. These techniques are replaced by LDP and LPQ which are implemented along with multiple support vector machine (SVM). The feature selected for recognitions are reduced to only a pair of eyes and a mouth. Simulation results are carried out and using MATLAB software, the efficiency of system is measured in terms of accuracy. The accuracy of the proposed system is 7% more than the existing system using (LBP and CLBP). The developed system outperformed the limitations of traditional system.

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TABLE 1
ACCURACY OF DIFFERENT METHODS OF FER SYSTEMS

Techniques	Accuracy (%)
LBP	92.09
CLBP	90.53
LTP	94.11
PROPOSED	98.333