International Journal of Engineering Research and General Science Volume 3, Issue 3, May-June, 2015
ISSN 2091-2730

An approach to recognize facial expressions using local directional number pattern

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Abstract— A scheme i.e. a Local Directional Number Pattern (LDN) is introduced for face and expression recognition. LDN is used to extracts the local features from facial textures and using the directional and sign information encodes it in quite compact code which provides more detailed and discriminated information. The sign information is probably used to evaluate the intensity variations due to presence of similar structural patterns. The LDN acts as a face descriptor which concatenates all the extracted local features into a single feature vector for the face recognition. Furthermore, support Vector Machine (SVM) classifier is used in order to evaluate the performance of the method. Various approaches have been proposed for the FER in the past several decades. The current-state-of-art techniques for classification of facial expression mainly focus on gray-scale features of the images. For more robust classification results we take into account the color feature data. Recent research reveals that the color information of the face helps to improve the face recognition and the image retrieval information.

Keywords— Local Directional Number Pattern, face recognition, expression recognition, face descriptor, SVM classifier, kirsch mask, derived Gaussian mask

I. INTRODUCTION

Facial Expression Recognition (FER) is one of the rapidly growing research area in the vision of Computers. The most recent advancement of both software and hardware technologies has created more demand for the personalized interaction. There are many of the applications to evaluate human expression which uses Facial Expression. Evaluating and recognizing the Human Facial Expression is not a simple task because of certain circumstances which are facial occlusions, illumination etc. Finding efficient facial features to represent face appearance is one of the most critical aspects in face recognition. Its wide range of applications is emotion analysis and image retrieval. Local Directional Number Pattern (LDN) is a face descriptor used for recognizing faces which encode the information related to face's texture's intensity variations. The structure of the neighbourhood is encoded by retrieving its directional information where, the edge responses in the neighbourhood is computed with the help of compass mask in eight different directions and then from all the eight directions, the top positive and negative direction values are chosen in order to produce a descriptor for the similar structural patterns with different textures which leads to distinguish between different intensity changes from dark to bright and bright to dark. Furthermore, this descriptor mainly uses the information of entire neighbourhood in the texture, rather than using dispersed points for its computation. Hence, using this approach more information can be extracted into the code, hence it is six bit long and more compact. An extension using different methods can be applied to this approach in order to improve recognition accuracy. The Local Directional number pattern uses different structural face textures hence, it encodes efficiently in compact code.

II. LITERATURE SURVEY

In [1], Local Directional Number Pattern, has been proposed on the basis of encoding scheme which extracts the local information from image and encodes it with the help of coding Scheme in a compact form in order to distinguish between similar structure patterns indicating the different intensity variations in face's texture. In order to overcome the noise and distinct illumination problems, other information have been used by the methods FER. Local Directional Number Pattern (LDN) introduces a method which encodes a pattern which helps us to retrieve the directional information in the neighbourhood[13]. This scheme uses an eight bit binary code which can be assigned to each and every pixel of an input image. LDP is obtained by comparing a pixel values in different directions and then produces a pattern with more stability even in the presence of illumination and noise. The main reason behind gaining the popularity extensively by LBP is its better performance than previous existing methods. [9]There were many newer methods that tried to overcome the disadvantages of LBP are like Local Ternary Pattern (LTP). This is proved as an extension of the LBP features which were designed originally for description of textures applied for the purpose of face recognition. Local Binary Pattern (LBP), a paper that represents feature descriptor designed for mainly for texture analysis. LBP is actually defined as a tool which models texture images and a grey scale invariant measure. LBP analyses facial expressions and recognize face images which can be viewed as a collection of the micro-patterns. In February 2010, Zhang, Gao, S. Zhao and J. Liua introduced local derivative pattern (LDP) which is a high-order local pattern descriptor. LDP is a general framework in order to encode directional pattern features based on the local derivative variations, which gives out more detailed information than local binary pattern (LBP). Apart from LBP encoding the actual relationship between the centre and its neighbours, the LDP templates helps to extracts high-order local information by encoding various spatial relationships which exists in a given local region. The high-order LDP consistently performs quite better compared to LBP for both face recognition and verification under various conditions. Similarly, in May 2010, Xie, Shan, Chen, proposed the local Gabor XOR patterns (LGXP), helps to encode the Gabor phase. Later, they introduced a block-based Fisher's linear discriminant (BFLD) in order to reduce the dimensional occurrence and to enhance its discriminative power of the proposed descriptor. Atlast, by using BFLD, they fused the local patterns of Gabor magnitude and the phase for face recognition purpose.

III. PROPOSED WORK

The proposed methodology for face and expression recognition is as represented in the figure 1. Firstly, the image is taken as input and detect whether the input image is a face or not a face. Further, if input image is a face then later pre-processing techniques are imposed. The input image used for the purpose of face and expression recognition can be acquired from standard databases depicting various facial expressions indicating anger, joy, disgust, fear, sad and happiness and for this purpose standard JAFFE database has been used and further pre-processing techniques are applied. Later, various local features from an image are extracted using different coding schemes and edges are detected using Gaussian Derivative and Kirsch Masking. Extracted local features are normalized and classified using Support Vector Machine Classifier. Then, the obtained results of expression recognition are analysed and compared with the color database. Various approaches have been proposed for the FER in the past several decades. The current-state-of-art techniques for classification of facial expression mainly focus on gray-scale features of the images. For more robust classification results we take into account the color feature data. Recent research reveals that the color information of the face helps to improve the face recognition and the image retrieval information [2]-[4].

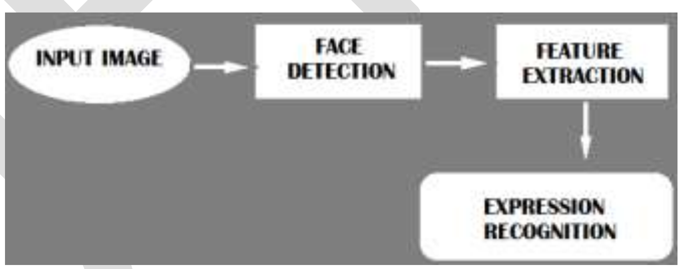

Fig 1. Flow of Proposed Work

A. Input Image

The JAFFE Dataset images are used as input for processing is taken from web available sources. The dataset images contains ten female subjects with different facial expressions reflecting various emotions like anger, joy, disgust, sad, fear and happiness. The expression images are labeled according to the predominant expression in that particular image. Consistently, low resolution images are used 256×256 with the number of subjects equal to ten. Figure 2 shows the examples of images from the JAFFE DATASET and Figure 3 shows the example of color images of Indian faces.

Fig 2. Examples of images from the JAFFE Dataset

Fig 3. Examples of color images

B. Face Detection

The image which is given as input is recognized whether that particular input image is a face or not a face. If it is a face, then with the help of feature-based method, where the local features of the input image such as the nose, eyes and mouth are first extracted and their location and local statistics i.e. geometric or the appearance are collected into a structural classifier. And if face is not detected, it will display the message that input image is not a face. Figure 4 and 5 represents the detection of facial image and retrieving its local feature from the gray and color images. The facial area of the image is detected using the Viola-Jones Method which is completely based on the AdaBoost learning Algorithm and the Haar-like features.

Fig 4. Local-feature face detection of gray image

Fig 5. Local-feature face detection of color image

C. Feature Extraction

Input images are used for further pre-processing techniques. The compass mask schemes is used for computing edge responses i.e., mainly Kirsch masking. Kirsch masking is basically used to extract edge responses and is rotated 45° apart to obtain mask in eight different directions. Further, Gaussian smoothing is used to stabilize the code using derivative Gaussian mask. This mask helps to overcome the noise and illumination variations resulting into strong edge responses. Input images are decomposed resulting into directional information. Figure 6 and 7 shows the processed image which is obtained after processing in all the eight directions this is done with the help of compass mask i.e. kirsch mask and derivative Gaussian mask. Local Directional Number Pattern is used for extracting features from the pre-processed images. The proposed Local Directional Number Pattern (LDN) represents a six bit binary code which can be assigned to each and every pixel of an input image representing the texture structures and intensity transitions. The coding scheme is actually based on directional numbers, rather than bit strings encoding information related to the neighbourhood in a more efficient way. The implicit utilization of sign information encodes more information in comparison to the previous directional and derivative methods in less space as well as simultaneously discriminating more textures. The method is actually more robust against illumination changes and noise due to the use of gradient information. In a coding scheme, LDN code is generated by analysing the overall edge response of the each applied mask, i.e. {M0. . . M 7}, which represents the edge significance. Therefore, the code is given as, $LDN(x, y) = 8i_{(x,y)} + j_{(x,y)}$

where, (x, y) = the central pixel of the neighbourhood being coded,

$i_{x,y}$ = directional number(maximum positive response) ,

$i_{x,y}$= directional number(minimum negative response).

Since, the edge responses are not equally important therefore the presence of the highest positive or negative value indicates prominent dark or bright area. Therefore, in order to encode these prominent regions, the sign information is used and top positive directional number is assigned as the most significant bits of the code as well as the top negative directional number is assigned as the three least significant bits. Figure 6 represents the output of kirsch mask.

Fig 6. Kirsch mask on gray image

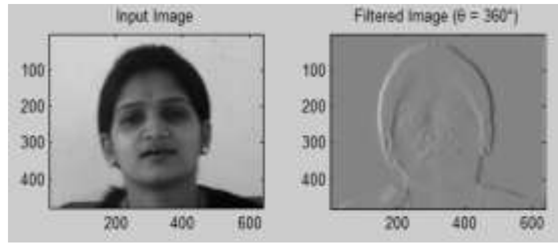

Fig 7. Kirsch mask on color image

D. Expression Recognition

LDN acts as a face descriptor and every face is represented by an LDN histogram (LH) which contains information of an image including spots, edges, corners, etc. and other local textures. Without using any of the location information, the occurrence of certain micro-patterns can be encoded. The location information is aggregated to the descriptor by dividing the face image into small regions $\{R^1, \ldots, R^N\}$ and with those small regions a histogram H^i is extracted from of the each region R^i. Finally, all the histograms which are obtained from all the spots, corners, edges, and other local textures due to different intensity variations are concatenated for the purpose of face recognition. The face can be recognised using both of the LH and M LH during the face recognition process and its main objective is to compare an encoded feature vector of a subjective person with other persons feature using chi-square dissimilarity measure. Facial Expressions can be recognized using Support Vector Machines. SVM is one of the supervised machine learning technique that not only makes binary decisions but also maps the data; multi-class classification can be achieved by adopting the one- against-one or one-against-all techniques. By using SVM, for facial expression recognition the accuracy of object can be maximized. Figure 8 and 9 shows LDN Histogram of an input image and its equalized histogram image.

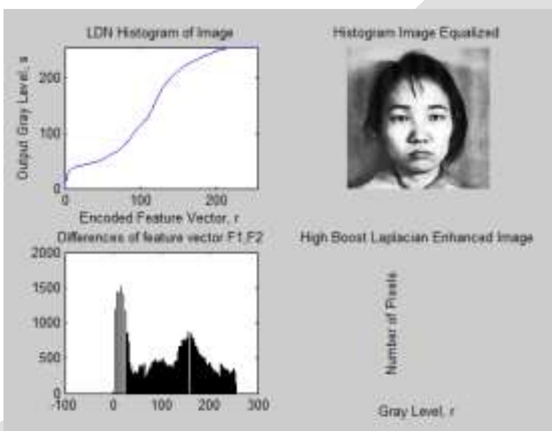

Fig 8. Histogram of gray image

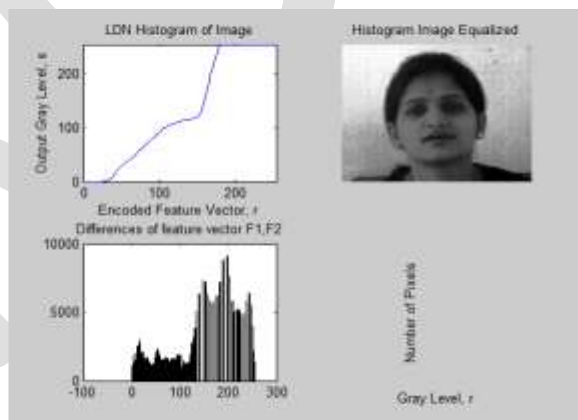

Fig 9. Histogram of color image

E. Database Combination Experiments

The images are chosen from both JAFFE and color databases and combined together for testing using LDN method .Table I Illustrates the recognition rate of the LDN on gray and color facial images for different expressions. Each class consists of nearly 50 set of images of all the expressions such as anger, disgust, fear, happy, sad, surprise. For each class the recognition rate has been calculated in percentage. It can be seen that the expressions are affected by the subject's characteristics. Mainly, the LDN method on color images outperforms the gray-scale images.

COMPARISON OF THE COLOR AND GRAY DATASET

Expression	**Gray Images**	**Color Images**
Class 1	34.21	46.34
Class 2	15.79	45.12

Class 3	34.21	34.15
Class 4	18.42	47.56
Class 5	34.48	30.38
Average Rate	**27.42**	**40.71**

ACKNOWLEDGMENT

I wish to express my sincere thanks and deep sense of gratitude to respected mentor and guide Mr. P.S. Mohod Professor in Department of Computer Science and Engineering of G. H. Raisoni Institute of Technology and Engineering for his advice, encouragement and overall constructive criticism.

CONCLUSION

Local Directional Number Pattern Method is referred as one of the leading encoding scheme that uses directional information to code different patterns from facial textures. The LDN code is calculated with the compass mask, that is the combination of Kirsch Mask and derivative Gaussian mask. Mainly, the Support Vector Machine (SVM) is used to classify the data and retrieve the facial expression. LDN is one of the best face descriptor which effectively performs the pixel computation and mainly overcomes the problems which were faced in previous methods such as local binary pattern, local ternary pattern, etc. Hence, LDN produces better results than other existing methods. . The current-state-of-art techniques for classification of facial expression mainly focus on gray-scale features of the images. So, for more robust classification results we take into account the color feature data. The Recent research reveals that the color information of the face helps to improve the face recognition and the image retrieval information.

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