AN EMOTION RECOGNITION FRAMEWORK THROUGH LOCAL BINARY PATTERNS

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Abstract: Communication can be of two types verbal and non-verbal. Non-verbal communication is performed through the emotions of a person. Emotion detection has gained wide spread popularity in the field of image processing. Emotions can be classified into six main categories; disgust, anger, happiness, fear and surprise. These emotions can be concluded from human's facial jargons and expressions. Emotions are developed through feature extraction from facial expressions in various facial postures and categorizing the expression features. Making computerized system for recognition of human emotion is an astonishing and exciting problem. This application has been extensively used in area like abnormal behavior of a person, security and robotics. This article specifically defines procedure of emotion recognition of human face pictures. We have designed an improved Local binary pattern (LBP) procedure based framework for the determination of human emotion in an effective manner. It is consequential into a method to have finest presentation for the persistence of emotion recognition.

Keywords: Emotion Recognition Framework, Local Binary Pattern, face recognition, Computer Vision

Introduction: In the current day situation, there is extensive research work is being accomplished in the area of face recognition [1]. The key purpose of face recognition is to tally the input image with the image kept in database [2]. Face recognition has performed a crucial part in resolving the challenges of offender identification, human computer communication. The process of size lessening is a vital stage in face recognition process in which the stored data have an intrinsic huge size. To reduce the size of image space PCA is applied [3]. The depiction of face through Gabor characters has produced great awareness in computer vision, image processing, and pattern detection. The Gabor filter is used due to its biological importance. The available field outline of neurons in the main pictorial peridium of humans is concerned with the characteristics of longitudinal regularities. It may also utilize noticeable pictorial characteristics like spatial occurrence, orientation discrimination and spatial localization.

Face expresses emotions far quickly than human grasp their moods. Facial expression discloses one's feelings and delivers vital outgoing signs through communal interaction [4-5]. This reveals that facial expression records a leading process. This investigation proved increasingly extra appreciated in the area of computer vision and robotics. Face identification have usages such as image recovery, observation and automatic access regulator. The examination of facial expressions has widespread variation of areas like image comprehension, psychosomatic face animatronics, human computer interaction (HCI), etc.

In humans, communication is performed through verbally and non-verbally. The programmed facial expression acknowledgment includes three key modules for achieving this goal. Initially, the face is identified and established. Facial features are mined from the recognized face area. Finally, the facial expression class is categorized according to mined features. To identify face parts from an image, numerous methods have been employed in recent years [6]. A human face has essential and special characteristics and hence the discovery of expressions is a feasible process. The conversion that occurs in response to the person's inner emotive condition is stated as facial expression recognition (FER). It uses the dissimilar applications of HCI such as video facial observation structures, facial animatronics and face image managing in the field of AI, digital image processing and computer vision. Since last decade, the programmed recognition of expressions has become very popular and also it is a tough job. The face expression recognition is based on feature extraction stage.

Facial expression expresses sufficient statistics concerning emotions of human and performs crucial part in human interactions. They control and easy the task of better logical communication. Consistent facial expression identification normally includes three basic phases: face procurement, facial feature mining and facial expression organization. The Face procurement is a preparation stage to observe or verify face from a set of provided facial images. The utmost widely used face detector is the actual time face identification procedure. Dissimilar classifiers with Harr-wavelet features are used to solve this purpose. After the face has been recognized from the set of images, the corresponding face parts are regularly consistent to have the similar color level and eye measurement. The facial features extraction attempts are performed to determine the best appropriate design of facial images for discovery. There are basically two main tactics: look based feature structures and geometric based features structures.

Related Work:

Authors in [7] have used LBP to recognize a face from a set of faces. On the basis of vigorous uniform local binary pattern and k-nearest neighbor, they have projected face identification structure. To recognize a face is a challenging issue. Because an unidentified face image perceived in the mining stage is generally dissimilar from the face image perceived in the categorization stage. The key purpose of this technique is to resolve the recognition issue by face images which may simply under the effect of posture, lighting, and appearance. The face image has been separated into a lattice of little non-overlying areas in which the universal LBP histogram of a certain face picture is attained through merging the histogram series of every non-overlying area. The universal characteristics are gathered in one vector and consequently categorized through the k-nearest neighbor method. The Euclidean distance discovers the smallest distance among histogram pictures. Once the two separate histograms are compared and if there is some resemblance that signifies they are linked otherwise not.

Authors in [8] have proposed LBP based face recognition procedure. The proposed method is based on the arrangement of three deviations of LBP: ELBP, MB-LBP, and LTP. It is known as elongated Multi-Block Local Ternary Pattern (EMBLTP). In this prototype, the processing is performed through the amounts of block sub-regions instead of distinct pixels. A multi-scale unit pattern is attained reflecting the elliptic neighborhood description; afterwards a ternary design has been received from the multi-scale unit pattern. Actually, the computation of 3*n* valued ciphers is extra tough than the processing of 2*n* valued ciphers. Authors have broken every ternary into its positive and negative sections to lessen the execution time and attain the negative and the positive EMB-LTP ciphers. In case of positive ciphers, the negative values were kept zero whereas the others values remains same. In case of the negative ciphers, the positive values of LTP as well as zero values were kept zero, and the negative values were fixed to one. Following this manner, the MBLTP cipher can be separated into two LBP ciphers. The EMB-LTP process enciphers the microstructure and the anisotropic operational information and macrostructure of face image designs.

Authors in [9] have proposed LBP and FPGA based face recognition system. According to them, the requirement of facial recognition structures that are quick and precise is increasing on a daily basis. They have implemented a face recognition System on Chip (SoC), combined with an FPGA. This employment makes use of LBP Histograms to mine attributes from test face pictures and Manhattan distance to recover the exact tally from the database of the face. It utilizes Zynq-7030. The feature mining and the distance calculations among the database have been employed on the FPGA. The ARM CPU of the SoC receives the inputs and presents the outcomes through the learned distances.

Authors in [10] have described that facial emotions are an indispensable resource of information normally employed in human interaction. For peoples, the recognition is spontaneous and is performed through the actual time differences of facial descriptions. Though, the repetition of this ordinary method through computer vision mechanism is a complex issue. As computerization and actual time structure necessities are cooperated to attain precise emotion recognition. The authors have proposed and confirmed a new procedure for facial features mining to mechanically recognize facial emotions, attaining a precise level of identification. This procedure makes use of an actual time face tracker result to express and mine two fresh features: eccentricity and linearity. Afterwards, these characteristics are employed to instruct a machine learning classifier. As result, we obtain a processing pipeline that allows categorization of the six basic Ekman's emotions in actual time and does not need any physical interference or previous info of facial features.

Local Binary Pattern (LBP): The LBP is a kind of visual descriptor which is being used for categorization of images in computer vision. It is a specific instance of the Texture Spectrum prototype and initially defined as a prevailing trait for texture classification [11]. When the LBP is united with the Histogram of oriented gradients (HOG) descriptor, it increases the recognition enactment significantly over few databases. Figure 1 illustrates the pixel measurements in LBP.

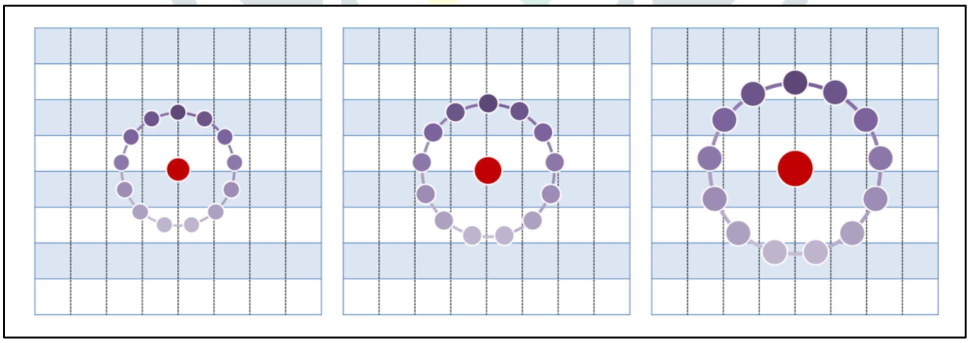

Figure 1: Computation Process of LBP

In its simplest type, the LBP feature vector can be generated as follows:

Step 1: Split the examined window into cells (e.g. 8 x 8 pixels for every cell).

Step 2: Compare each pixel of a cell with its 8 nearby pixels (left-top, left-middle, left-bottom, right-top, right-middle, right-bottom etc.). Assume a circular path along these pixels and move on trajectory either in anti-clockwise or clockwise direction.

Step 3: If the value of midpoint pixel is more than the value of any nearby pixel, mark 0. Else mark 1. It delivers a 1 byte binary number which is normally transformed into decimal number.

Step 4: Calculate the histogram (256-dimensional feature vector) for cells of the regularity of every number arising (every arrangement pixels, either smaller or greater than the midpoint). Step 5: Normalize the histogram.

Step 6: Connect and normalize histograms of each cell. This provides a feature vector for the complete window.

The so obtained feature vector may be now prepared through the support vector machine or any another machine-learning procedure which can categorize the images. Such classifiers can be used for face recognition or texture analysis. The uniform pattern is a valuable extension to the original LBP operator and it may be used to decrease the extent of the feature vector and apply a plain alternation invariant descriptor. As few binary patterns arise more frequently in texture images than others. Example of a LBP descriptor has been shown in the figure 2.

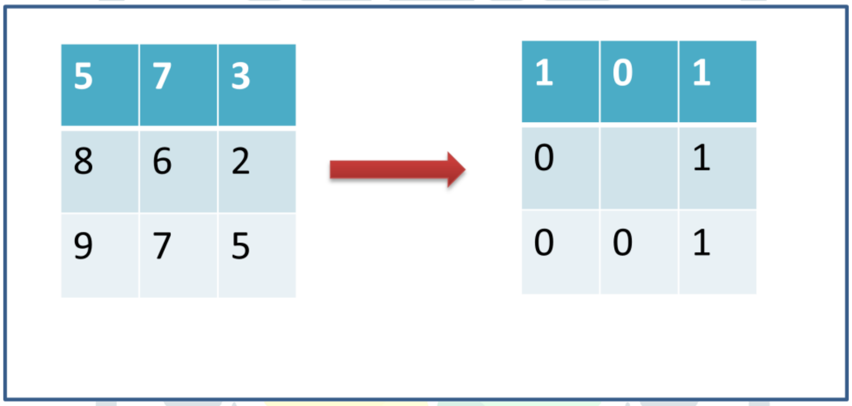

Figure 2: Computation of LBP threshold

To generate the LBP descriptor, transform the picture into a gray scale. For all pixels in the gray scale picture. Choose a locality of dimension r nearby the middle pixel and compute a LBP value for this middle pixel and save in the 2D output array of equal width and height as of the input picture. According to figure 2, the value of the middle pixel is 6. We have considered 8 neighbor pixels around this middle pixel. If the intensity of the adjacent pixel is greater than middle pixel than it is marked as 0, otherwise 1. E.g. the intensity of the left pixel is 8, it is marked as 0 in the output array and the intensity of right pixel is 2 which is marked as 1. Due to 8 adjacent pixel values, number of total possible combinations are 256. It helps in calculating intensity value of the middle pixel as shown in figure 3. The computed LBP value is saved in an output array as shown in figure 4. By these pixel values, we can generate histograms corresponding to the intensity of different pixels in the image. Each histogram can be in the range of (0-255).

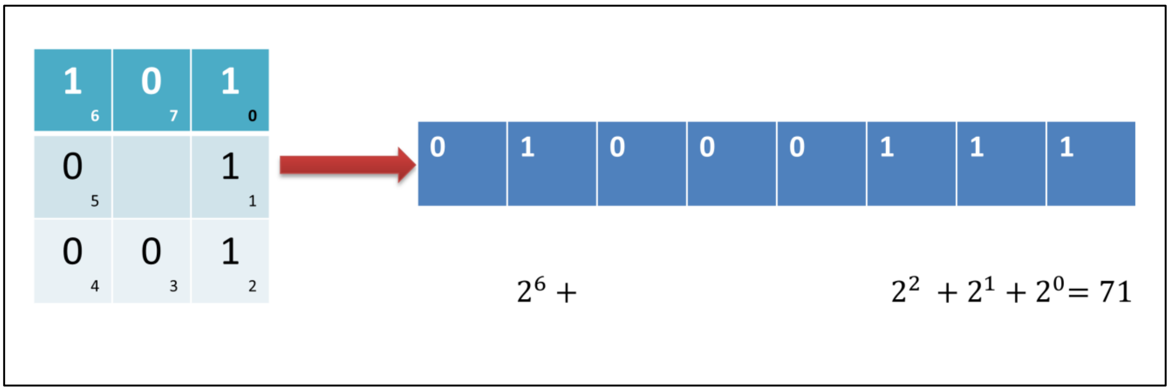

Figure 3: Computation of middle pixel Intensity

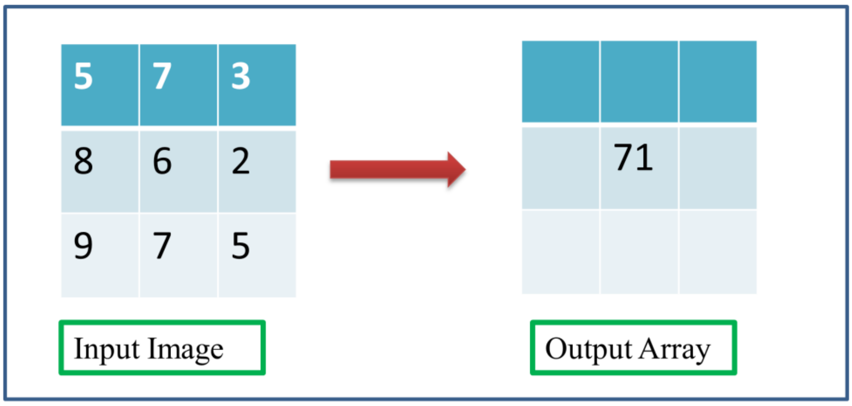

Figure 4: Intensity stored in output Array

Execution of face recognition: Till now the method is trained, i.e. one histogram is generated corresponding to every image using the training dataset. Therefore, provided an input image, perform the following stages for the fresh image and generates a histogram that depicts the image.

- Thus to discover the image which tally the input image, two histograms are compared and yield the image with the nearest histogram.
- The Euclidean distance, chi-square, absolute value, etc. can be used to match two histograms. The Euclidean distance between two histograms can be represented by equation1:
- $D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$ (1)
- The algorithm produces the ID of image with the nearest histogram. The procedure also yields the computed distance known as confidence value.
- The threshold and the confidence value describe the properly recognized image. The procedure has positively identified the image if the confidence is lower than the defined threshold.

Proposed Method: We have used modified LBP to create histograms of the input image. Instead of using a circular neighborhood pixel trajectory, we have considered oval shape trajectory around the middle pixel position. LBP is generated and a threshold is used to eliminate the face which does not match a face in the trained database as shown by equation 2:

$$outcome = \begin{cases} Math, & if\ distance\ is\ less\ than\ threshold \\ no\ match\ , & otherwise \end{cases} \quad (2)$$

Next we have used support vector machine (SVM) to identify the expressions of a person, i.e. disgust, fear, happiness, anxiety, angry, sad, surprise and neutral.

Experimental Analysis: Figure 5 illustrates that recognition rate of images which contain anxiety expression. Figure 6 shows the proposed framework which loads an image, train it and then identify its emotions.

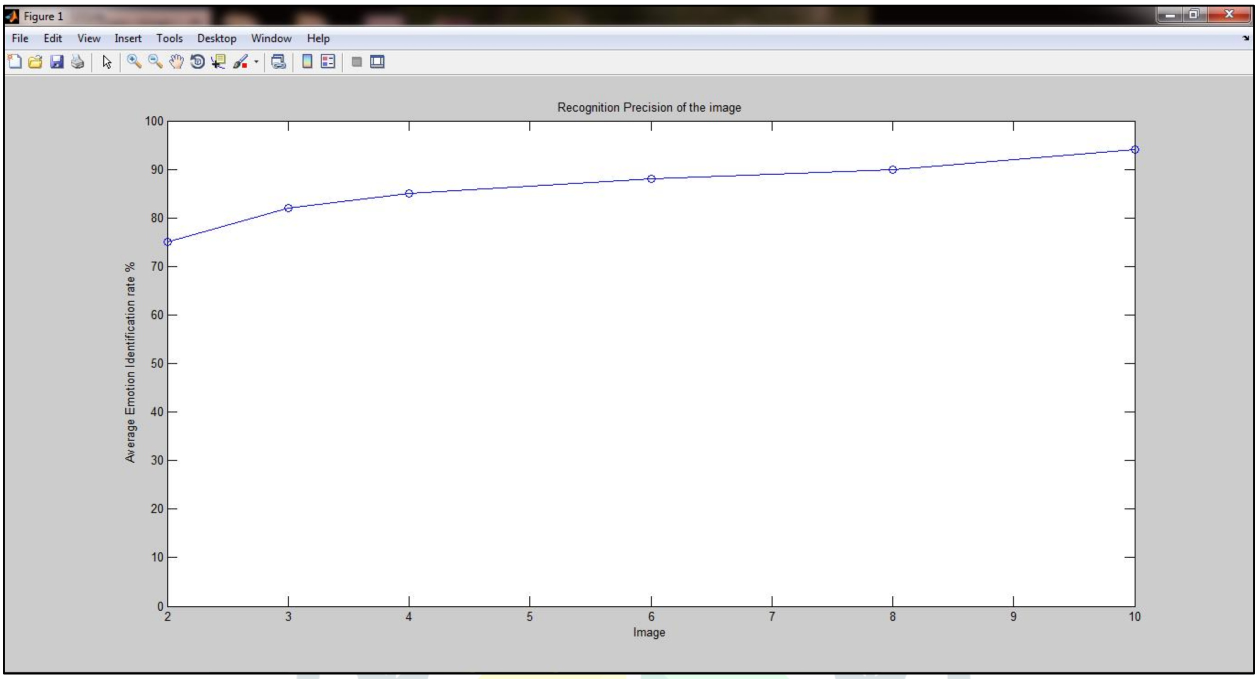

Figure 5: Recognition rate of images with anxiety expression

Figure 7 illustrates the recognition rate of images with happy expression and figure 8 shows its framework output. Figure 9 illustrates the recognition rate of images with fear expression and figure 10 shows its framework output. Figure 11 illustrates the recognition rate of images with disgust expression and figure 12 shows its framework output.

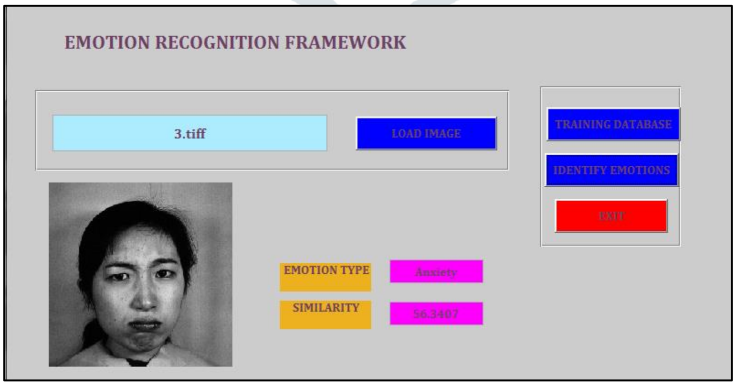

Figure 6: Detection of anxiety expression

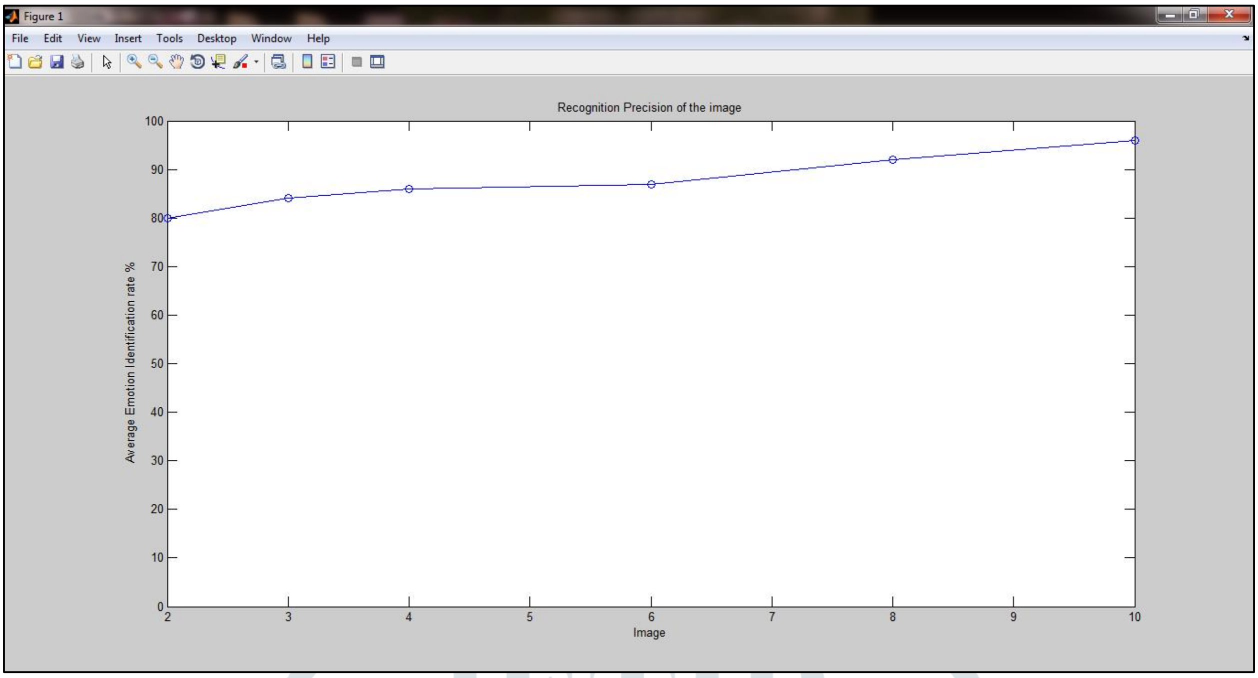

Figure 7: Recognition rate of images with happy expression

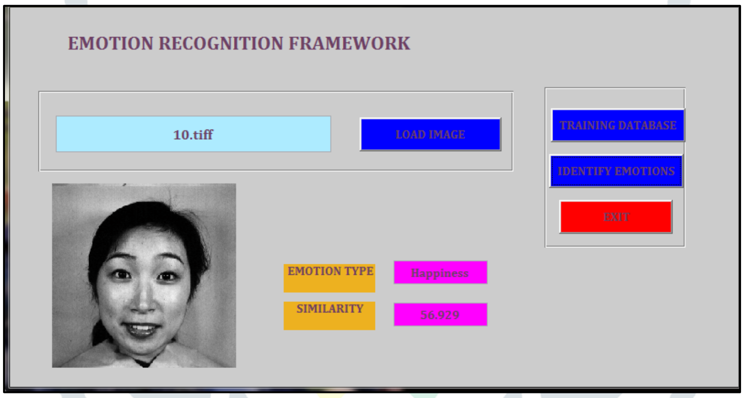

Figure 8: Detection of happiness expression

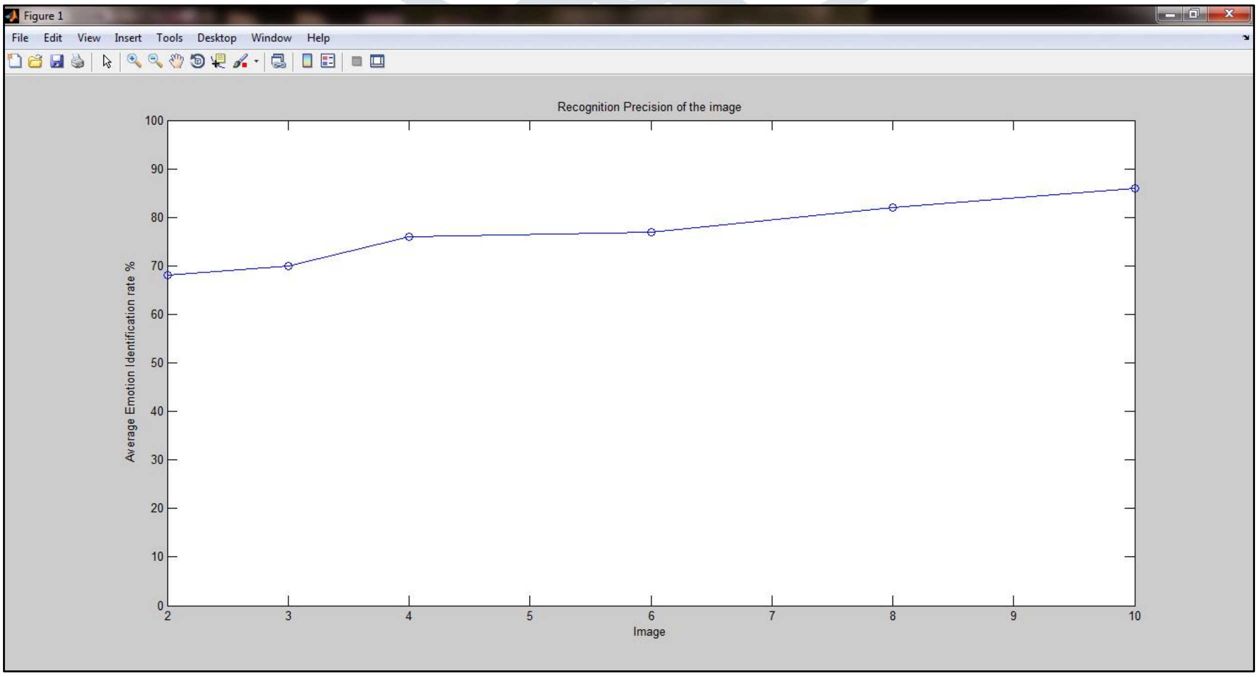

Figure 9: Recognition rate of images with fear expression

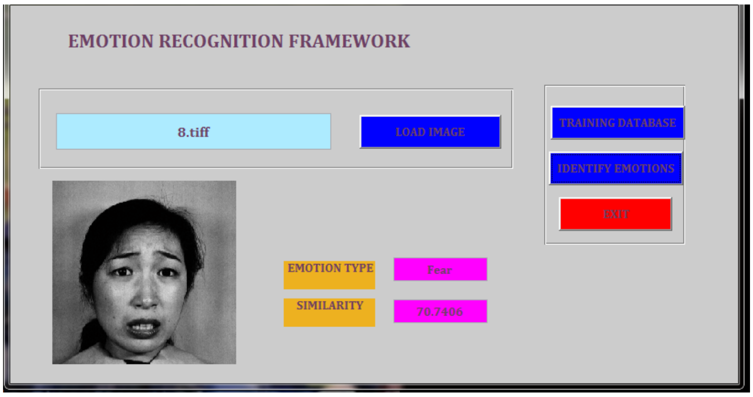

Figure 10: Detection of fear expression

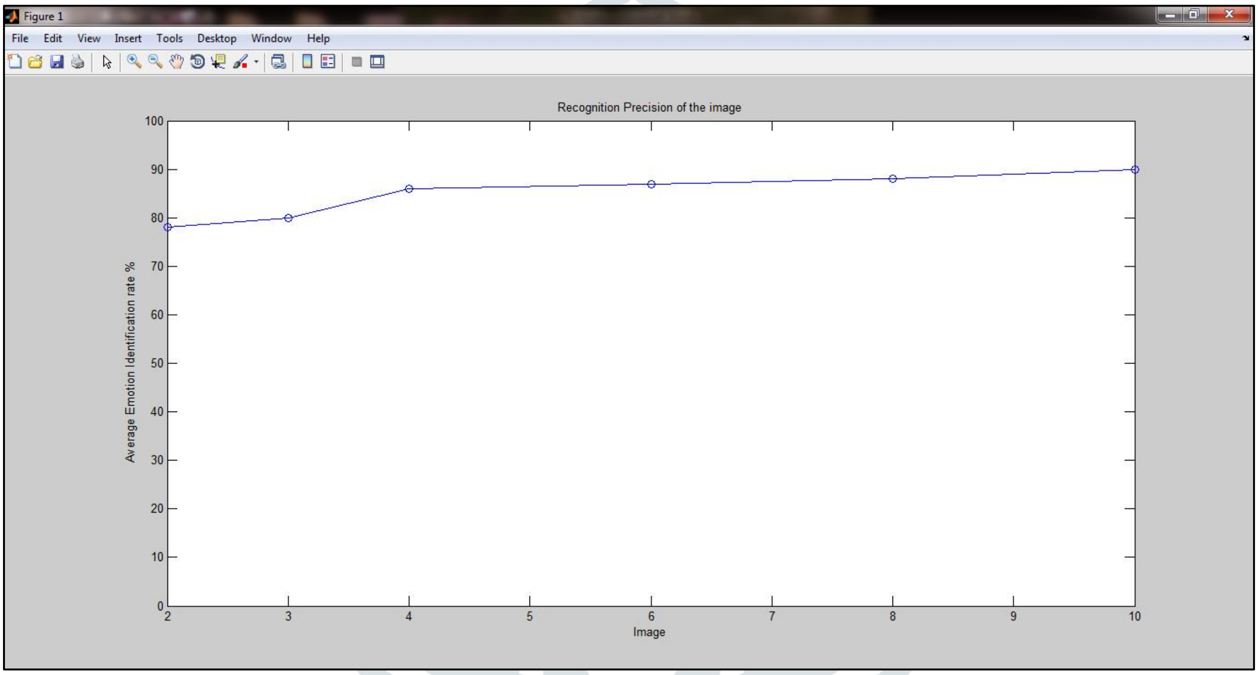

Figure 11: Recognition rate of images with disgust expression

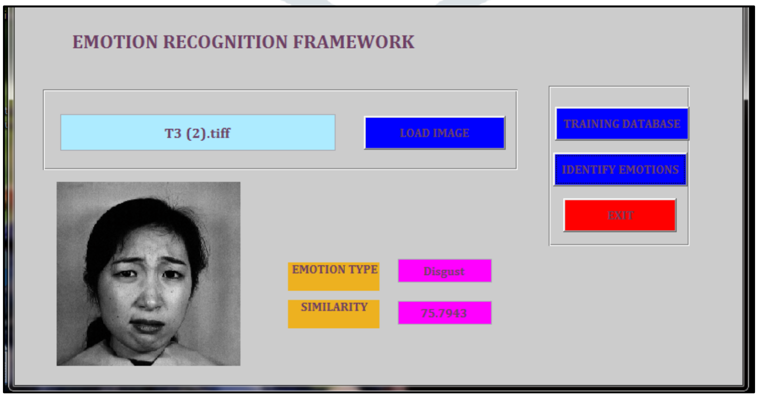

Figure 12: Detection of disgust expression

Table 1 shows classification outcomes and Table 2 recognition accuracy of expressions.

Table 1: Classification Outcomes

Characteristics	Emotions
Histogram descriptions	35 %
Face markers	42 %
Face markers + Histogram	55.09 %
Face markers + Histogram on sliding window	59 %

Table 2: Accuracy of recognition rate of emotions

Emotions	Recognition Rate
Fear	82-90 %
Disgust	79 % - 91 %
Sadness	80 – 91 %
Happiness	80 – 97 %
Surprise	75 – 79 %
Angry	71 – 85 %
Anxiety	73- 84 %

CONCLUSIONS

The local binary patter is a simple face identification method. It can demonstrate local traits in the images. It delivers accurate outcomes specifically in a controlled environment. It is vigorous for monotonic gray scale conversions. The presented work provides a complete experimental investigation of facial emotion recognition according to features of the LBP. It mainly consists of three parts, i.e. LBP descriptor determination, database training, and emotion recognition. Face illustration exhibits the layout of the face and decides the subsequent procedure of recognition. The characteristic of face images are mined in the feature extraction stage. In the process of classification of emotions, the distance between two histograms (present in dataset) is evaluated and compared against a threshold value. The resulting match is classified through SVM process. Accuracy rate of aacial emotions recognition of six emotions lies in range from 71 – 97% .

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