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Facial Emotion Recognition Using Eigenface and Feature Optimization

Hamad Almohamedh[1], Sultan Almotairi[2, *]
[1]National Centre for Aeronautical Technology
King Abdulaziz City for Science and Technology (KACST)
Riyadh, Saudi Arabia
[2]Department of Natural and Applied Sciences, Community College
Majmaah University, Al- Majmaah 11952, Saudi Arabia
*Corresponding author: almotairi@mu.edu.sa

ABSTRACT

There is lot of communications between individuals using emotions as it plays important role in information transferring. Broad studies are carried out to explore the dealings between human sentiments and machine interactions. In this paper an efficient approach using feature extraction and optimization is proposed for facial emotion acknowledgment in the form of Eigenfaces. It is an adjusted strategy which begins with the human vision as a standard reference point – by making utilization of the standard database and processes the look contained by the picture of a test confront. It is a novel approach which specifically orders a test picture as having a place with one of the five standard expressions - anger, fear, happy, sad or surprise in a precise manner. In this paper, exploratory verification was given in terms of accuracy, false acceptance rate, false rejection error rates and exchange on further approaches to enhance it.

Key words : Facial emotions, Feature extraction, Feature optimization, Emotion recognition.

1. INTRODUCTION

In real time scenarios, facial recognition based on emotions has raised a significant research area. Expressions are the natural and instant means for an individual to communicate through emotions and intensions. Real time emotion classification has significant applications in various research areas like interaction between human and machine, medical applications, video broadcasting, image retrieval, personality development etc. Psychologists have established different schemes to designate and enumerate facial behaviors. [1][2] Emotion recognition provides an explanation of all likely and visually demonstrable facial dissimilarities in terms of features. In [3], a survey of methods for facial expression analysis are presented which are based on universal emotions defined by P. Liu [4] specifically; happiness, disgust, fear, anger, surprise, and sadness. But a neutral appearance is measured as a seventh appearance. In this paper more attention is given in the classification and optimization of feature vector and performance evaluation in terms of accuracy, FAR and FRR.

2. STAGES OF FACIAL EMOTION DETECTION SYSTEM

A. Feature Extraction

The first step is to pre-process the image and then extract features at different orientations. The output is computed as

$$Z(i) = D(i) \times IG \times I, \qquad (1)$$

where I stand for two dimensional input face array, Z (i) is the response if i^{th} filter, D and G are the filter coefficients which is done by using two dimensional convolution pixel-wise[5, 6].

To extract fundamental facial features in diverse directions, D kernel is expressed as the M^{th} order Gaussian derivative. Its coefficients is defined as

$$Gs(x, y) = G^s(x) * G^s(y), \qquad (2)$$

where $G^s(x)$ and $G^s(y)$ are Gaussian functions in one variable such as:

$$G^s(x) = \frac{1}{s\sqrt{2\pi}} \exp\left(-\frac{x^2}{2s^2}\right)$$

The fractional derivative with respect to length x or y can be figured as the product of the Hermite polynomial and the Gaussian function,

$$\frac{\partial G}{\partial x}(x,t) = \sum_{n=1}^{\infty} He'_n(x)\frac{t^n}{n!} = \sum_{n=0}^{\infty} He_n(x)\frac{t^{n+1}}{n!} = tG(x,t), \quad (3)$$

where H is the Hermite polynomial.

B. Optimization

The second stage is to select the robust or optimize features which will be used for classification at the testing phase [7, 8, 9]. The output which is produced by each filter in first step is processed by two filters in second stage: one filter is used for the on-response and the second filter is used for the off-response.

The process of sub-sampling is performed across sets of output maps which are the outcome of adaptive filter in the region of non-overlapping block equal pixel size into single output signal. This sub-sampling procedure is repeated in iterative manner for adaptive filter which will generate optimize feature vector.

C. Classification

The third step is classification which will classify on the basis of features extracted. Classification will evaluate the feature matching. In this step the extracted trained features are matched with the extracted features in testing phase for the recognition of correct emotion.

3. RELATED WORK

Principal component analysis is one of the main feature extraction procedures in dimension reduction which will find the eigenvectors or Eigen faces. The objective is to find vectors that are best designated for the distribution of facial images in image space. These trajectories define the facial space of the image sample. Each vector consists of length N, which is described with N-by-N image, and also it is a linear arrangement of original emotion images and due to facial appearance they are also called Eigen faces.

Lets consider M emotion images training set be S_1, S_2,….,S_M. The mean training set is defined by average face.

- Each facial image varies from the normal face by the average vector.
- Then the rearrangement of these vectors is done in a matrix X having N by M dimension
- The next process is to figure out a set M-by-1 orthogonal vectors, which designates the dispersal of input data in least squares which consists of less error probabilities which means the Euclidian projection error is reduced. The next step is to find the covariance matrix of each uploaded emotion. The covariance matrix C concludes the N square eigenvectors which is a difficult task for each facial emotion image.

Then, the PCA defined output is fed into optimization process which is done by the particle swarm optimization, each particle is measured as a potential outcome to the optimization difficulty in a search space. However, all individual has a velocity and a location in this search space. The exact position of the particle unit is signified by $Y_i = y_1, y_2, \ldots, y_n$. The rapidity of a particle is given as $V_i = v_1, v_2, \ldots v_n$. (pBest) is a local memory to keep the best position that is experienced by the particle [10, 11, 12]. However, flying velocity of each particle is calculated using the following equation:

$$v_i = v_i + \varphi 1 * rand(pbest_i - x_i) + \varphi 2 * rand * rand * (gbest - x_i) \quad (8)$$

$$xi = xi + vi \quad (8)$$

Where, $\varphi_1$and φ_2 are constants defining the relative effects of the personal.

Ralph and Vladimir [10] shown that the outline of an inertia issue to the above equation (Eq.8) improves performance, because it adjusts the rate over time and increase the search accuracy of the particles. However, Eq.8 can be rewritten as:

$$vi = Q * vi + \varphi 1 * rand * (pbesti - xi) + \varphi 2 * rand * (gbesti - xi) \quad (9)$$

Where θ is the inertia factor. Whereas, *rand* is a uniformly distributed random between 0 and 1. For more efficient controlling of particles velocity Eq.8 was modified as:

$$vi = K * (vi + \varphi 1 * rand * (pbest - xi) + \varphi 2 * rand * (gbest - xi) \quad (10)$$

Here *K* can be expressed as:

$$\frac{2}{|\,2-\varphi-\sqrt{\varphi^2-4\varphi}} \quad (11)$$

Where $\varphi = \varphi_1 + \varphi_2$. The value $\varphi > 4$.

4. PROPOSED METHOD

The proposed method is divided into two main phases. The first phase is the training phase and second one is the testing phase. The extraction of features is taken place in the form of locality and shapes. In classification module, we test images and then the identification of large number of features in the form of feature vector in x, y coordinates takes place [13]. Training phase consists of large feature points from each emotion of JAFEE database. The proposed algorithm in conjunction with component analysis and optimization approach identified various relevant structures which are helpful in classifying the right emotion on the basis. High recognition rate was achieved in this method. Figure 1 summarize our approach.

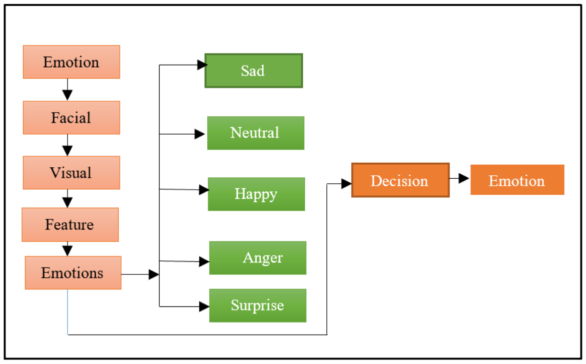

Figure 1: The proposed model

Our aprouch:

A. Feature Extraction

Training feature is used to extract unique vector of features that can identify a given human motion.

B. Feature Optimization

Feature Optimization will be used to optimize regular and irregular ellipse characteristics. In proposed algorithm each particle is shown as a proposed solution. In this algorithm each particle has a fitness value. These values are calculated from fitness functions in order to optimize. Each particle has a velocity that will show direct the particle. The global best, local best, personal best, particle velocity vector, particle position vector and a random number in range (0,1) respectively gbest, lbest , pbest ,v , x and rand() are shown. To update the position and velocity of particles the following relations were used.

$$v[j] = v[j] + c1 * rand() * (pbest[j] - x[j]) + c2 * rand() * (gbest[j] + v[j]) \quad (13)$$

Learning factor is typically in range of values 0 and 2 and with c1 and c2 are shown.

C. Feature Matching

To achieve matching between two dissimilar identifiers B1 and B2, the distance of each identifier signifies N and the normalized distance is defined as:

$$H(B1, B2) = 1/N(B1 * B2) \quad (14)$$

Where * signifies XOR operation.

5. EXMPERIMETS AND DISCUSSIONS

Real time experiment is done with Japanese facial database in which each image consist of size 256 × 256. The well-established framework that uses distinct emotions offers instinctive emotion explanations. In proposed work five emotional categories have been utilized i.e. sad, neutral, happy, surprise and anger for facial emotion analysis. The simulation has been done in MATLAB 2016a environment. The uploaded file for the testing can be random emotion and based on this proposed approach the developed system will automatically recognize the uploaded emotion.

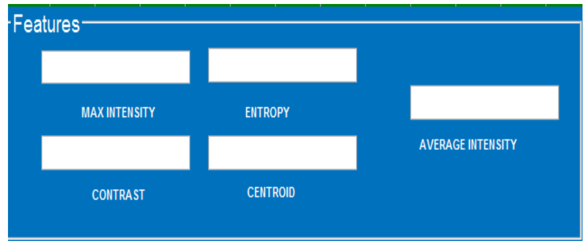

Figure 2: Main panel

In Figure 2., we describe the various features that will be extracted when matching of emotions will be done like max intensity, entropy, intensity, contrast and centroid.

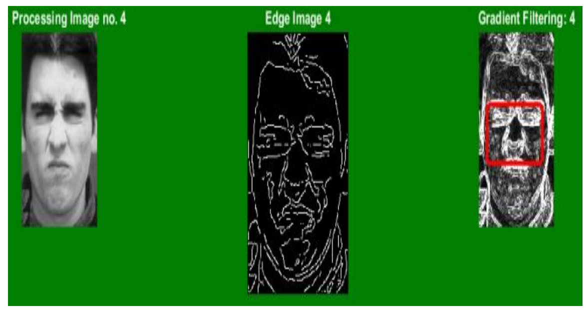

Figure. 3: Categorical operations

Various Feature extraction steps before pre- processing has been shown in Figure 3., like reading of image using *imread* function, edge detection using canny and gradient filtering.

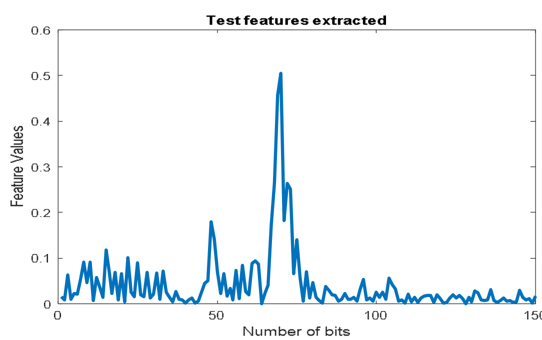

Figure 4: Test features extracted for the test sample

Figure 4 shows the total number of test features extracted from test samples and then below table shows the classification results.

Table 1: Aggressive recognized emotion

Accuracy	*FAR*	*FRR*
90.3007	0.92155	0.0075071
93.2160	0.2154	0.0064886
90.0012	0.4216	0.002770
95.2190	0.8190	0.005236
98.0463	0.24608	0.003451
93.1926	0.42169	0.0031183
94.2991	0.34625	0.0043299
96.8133	0.54352	0.005192
90.1940	0.2196	0.0030014
92.0546	0.75017	0.0018213

Table 2.: Happy recognized emotion

Accuracy	*FAR*	*FRR*
90.00213	0.9519	0.023
91.9829	0.21892	0.0085
97.8329	0.3409	0.025
99.0012	0.6215	0.05
92.1109	0.2365	0.0043
97.6086	0.1447	0.0064
90.4635	0.49993	0.03156
93.8175	0.24927	0.0056
96.0425	0.95145	0.00421
91.9216	0.2516	0.0054

Table 3:Neutral recognized emotion

Accuracy	*FAR*	*FRR*
90.763	0.63973	0. 000819
99.8995	0.27092	0.008292
93.5763	0.15796	0.039
97.2970	0.76542	0.0065
97.7245	0.82191	0.0095
99.9025	0.2560	0.017
91.4310	0.3901	0.0493
90.0935	0.2979	0.0249

Table 4: Sad recognized emotion

Accuracy	*FAR*	*FRR*
91.7461	0.75071	0. 0022
95.0956	0.64886	0.0092
98.1738	0.02770	0.0190
94.0845	0.5236	0.0035
95.0921	0.3451	0.00125
97.7749	0.31183	0.0019
91.2199	0.43299	0.0043
96.1293	0.5192	0.0029
99.8012	0.30014	0.0095
94.37	0.18213	0.00360

Table 5:Surprise recognized emotion

Accuracy	*FAR*	*FRR*
93.8088	0.89817	0.000422
92.9516	0.62583	0.000194
95.9869	0.54069	0.000273
98.3679	0.15298	0.000521
93.5098	0.41607	0.000041
96.7709	0.21510	0.000058
94.2312	0.62901	0.000595
96.2651	0.55219	0.000472
99.2019	0.95165	0.000290
97.3024	0.8417	0.000272

From Table 1 to Table 5, performances are evaluated in terms of high recognition rates and less error probabilities for different human emotions. Error metrics values are inversely proportional to accuracy rate in order to have good efficiency. Values of accuracies for different emotions has been shown and the average accuracy has been found to be between 95 to 98%.

6. CONCLUSION

In this proposed work, an efficient method is defined for human facial emotions classification and it is shown that the proposed approach is able to detect high accuracy rates with less error probabilities. The proposed system is mainly divided into three phases. The first phase is image feature extraction. The second one is optimization and the final step is the expression classification. The results have shown that feature extraction and optimization of face images combined with component analysis is able to achieve high recognition rate. From the above experimental view and results discussion, the proposed method shows better performance on different emotion recognition. The future work can be the hybridization of two extraction or optimization techniques which can be other challenging tasks for the researchers.

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