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STUDY AND ANALYSIS OF STATISTICAL FEATURES OF FACE EXPRESSION IN NOISY ENVIRONMENT

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Abstract – This paper presents a new approach for the recognition of emotions in noisy environment. The approach presents the cascading of Wiener filter and Mutation based bacteria optimization technique (MBFO) to remove the noise from the highly corrupted face image .After removing the noise by the combination of wiener filter and MBFO technique and then detects the local , global and statistical feature form the image. Bacterial foraging optimization algorithm (BFOA) is inspired by the social foraging behavior of *Escherichia coli*. BFOA has already drawn the attention of researchers because of its efficiency in solving real-world optimization problems arising in several application domains**.** In this research paper seven emotions namely anger, fear, happiness, surprise, sad, disgusting and neutral will be tested from database in noisy environment of speckle noise. facial expressions recognition system is based on a representation of the expression, learned from a training set of pre-selected meaningful features. However, in reality the noises that may embed into an image document will affect the performance of face recognition algorithms. Finally, emotion recognition will be performed by giving the extracted eye, lip and mouth blocks as inputs to a feed-forward neural network trained by back-propagation.

Keywords*—Wiener filter; bacteria foraging optimization ;feature detection; facial expression; Biometrics, speckle noise.*

I. INTRODUCTION

A biometric is an automated method of recognizing an individual based on measurable biological (anatomical and physiological) and behavioral characteristics that can be used to differentiate that organism as an individual. Biometric data is captured when the user is an authenticated by the system. This data is used by the biometric system for real-time comparison against biometric samples. When image is transmitted over the network noise is added as unwanted variations in the image [22]. It causes a wrong conclusion in the identification of images in authentication and in pattern recognition process. So First noise should be removed from the image and features are detected Noise in imaging systems is usually either additive or multiplicative.

II. RELATED WORK

There is a vast body of literature on emotions. Recent discoveries suggest that emotions are intricately linked to other functions such as attention, perception, memory, decision making, and learning. This suggests that it may be beneficial for computers to recognize the human user's emotions and other related cognitive states and expressions. Ekman and Friesen [1] developed the Facial Action Coding System (FACS) to code facial expressions where movements on the face are described by a set of action units (AUs) .Ekman's work inspired many researchers to analyze facial expressions by means of image and video processing. The AAM approach is used in facial feature tracking due to its ability in detecting the desired features as the warped texture in each iteration of an AAM search approaches to the fitted image. Ahlberg [7] use AAM in their work. In addition, ASMs - which are the former version of the AAMs that only use shape information and the intensity values along the profiles perpendicular to the shape surface are also used to extract features such as the work done by Votsis et al. [9]. Many algorithms have been developed to remove speckle noise in document images with different performance in removing noise and retaining fine details of the image, like: Simard and Malvar [10] shows image noise can originate in film grain, or in electronic noise in the input device such as scanner digital camera, sensor and circuitry, or in the unavoidable shot noise of an ideal photon detector. Beaurepaire et al. [2] tells the identification of the nature of the noise is an important part in determining the type of filtering that is needed for rectifying the noisy image. Noise Models from Wikipedia [11] shows the noise in imaging systems is usually either additive or multiplicative. Image Noise [12] shows in practice these basic types can be further classified into various forms such as amplifier noise or Gaussian noise, Impulsive noise or salt and pepper noise, quantization noise, shot noise, film grain noise and nonisotropic noise. Al-Khaffaf [13] proposes several noise removal filtering algorithms. Most of them assume certain statistical parameters and know the noise type a priori, which is not true in practical cases. Prof. K. M. Passino [8] proposed an optimization technique known as Bacterial Foraging Optimization Algorithm (BFOA) based on the foraging strategies of the E. Coli bacterium cells. Until date there have been a few successful applications of the said algorithm in optimal control engineering, harmonic estimation in [15], transmission loss reduction in Ref [16], machine learning in [14] and so on. Its performance is also heavily affected with the growth of search space dimensionality Kim *et al* [17] proposed a hybrid approach involving GA and BFOA for function optimization. Biswas *et al* [18] proposed a hybrid optimization technique, which synergistically couples the BFOA with the PSO. In this paper hybridized technique for the detection of emotions in noisy Environment is used .In this experiment only speckle noise has been considered.

2.1 Organization of the Paper

The rest of the paper is organized as follows: Section 3 describes the materials and methods of proposed technique, experimental results on JAFFE data base has been shown in section 4 and future scope has been discussed in section 5.

III. MATERIAL AND METHODS OF PROPOSED TECHNIQUE

The proposed method is divided into three parts:

- Image preprocessing
- Training of images using neural network.
- Testing of images results in classification of facial expression.

A. Image preprocessing

Image preprocessing parts includes the acquisition of noisy images , filtering , region of interest clipping , quality enhancement of images and features extraction .first images are taken from the JAFFE databases and noises are added . wiener filter is used to remove the noise and mutation based bacteria foraging technique has been applied to remove the remaining noise after applying the wiener filter. The region of interest is eyes, lips, mouth (eyes and lips) that are independently selected through the mouse for identification of feature extraction. Statistical analysis is has been done by calculating the mean, median and standard deviation of the noisy frame, restored frame, cropped frame and enhanced frame .

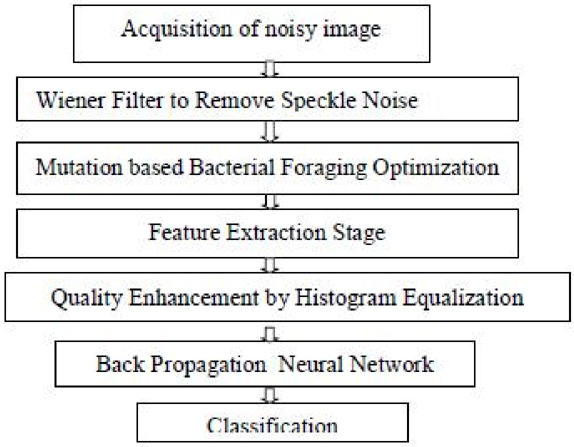
B. Training of Neural Network

Back Propagation Neural network will be used for training of the neurons and for classification of expression. Back Propagation algorithm is most widely used neural network. This is applied at input to hidden layer, due to its relative simplicity and its universal approximation capacity. The learning algorithm is performed in two stages: feed-forward and feed- backward. In the first phase the inputs are propagated through the layers of processing elements, generating an output pattern in response to the input pattern presented. In the second phase, the errors calculated in the output layer are then back propagated to the hidden layers where the synaptic weights are updated to reduce the error.

C. Testing

The third phase will be testing of expressions that will shows the classification for seven different expression like happy, sad, neutral ,disgusting, surprise, fear and anger.

Implementation Overview of Facial Expression Recognition System



A. Image acquisition

The first module is the acquisition of noisy face image .to acquire the noisy image spackle noise is passed as the input . Input image sample are considered from JAFFE database.

B. Wiener filter

Wiener2 lowpass-filters an intensity image that has been degraded by constant power additive noise. wiener2 uses a pixelwise adaptive Wiener method based on statistics estimated from a local neighborhood of each pixel. It estimates the local mean and variance around each pixel.

$$\mu = \frac{1}{MN}\sum_{n1,n2\in} a(n1,n2) \text{………………..(1)}$$

$$\sigma^2 = \frac{1}{NM}\sum_{n1,n2\in} a^2(n1,n2) - \mu^2 \text{……..(2)}$$

where is the N-by-M local neighborhood of each pixel in the image A. wiener2 then creates a pixelwise Wiener filter using these estimates.

$$b(n1,n2) = \mu + \frac{\sigma^2 - v^2}{\sigma^2}(a(n1,n2) - \mu \text{………..(3)}$$

C. Mutation Bacteria Foraging Optimization

In the first stage Wiener filter is used to remove the speckle noise. In the second stage, both the noisy and Wiener filter output images will be passed as search space variables in the BFO technique [15] to minimize errors due to differences in filtered image and noisy image. Bacterial Foraging Optimization with fixed step size suffers from two main problems

I. If step size is very small then it requires many generations to reach optimum solution. It may not achieve global optima with less number of iterations.

II. If the step size is very high then the bacterium reach to optimum value quickly but accuracy of optimum value gets low. Similarly, in BFO, chemotaxis step provides a basis for local search, reproduction process speeds up the convergence, elimination and dispersal helps to avoid premature convergence. To get adaptive step size, increase speed and to avoid premature convergence, the mutation by PSO is used in BFO instead of elimination and dispersal event by equation 4.

$(j+1,k) = \theta^i(j+1,k) + * r_1 * C_1(\theta^i(j+1,k) - \theta_{global}$ …..4

θ^i(j+1,k)= Position vector of *i*-th bacterium in *j*-th chemotaxis step and *k*-th reproduction steps.

θ_{global}= Best position in the entire search space .The BFpfPSO follows chemotaxis, swarming, mutation and reproduction steps to obtain global optima.

The step by step algorithm of BF-pfPSO is presented below.

Initialize Parameters *p, S, Nc, Ns, Nre, Ned, Ped* and *C (i), i*= 1, 2...*S* Where,

p = Dimension of search space

S = Number of bacteria in the population

Nc = Number of chemotaxis steps

Ns = Number of swimming steps

Nre = Number of reproduction Steps

Pm = Mutation probability

C (i) = Step size taken in the random direction specified by the tumble θ(i ,j,k)=Position vector of the *i*-th bacterium, in *j*-th chemotaxis step, in *k*-th reproduction step and in l-th elimination and dispersal step

Step 1: Reproduction loop: *k = k+1*

Step 2: Chemotaxis loop: *j = j+1*

a) For *i*= 1,2…*S*, take a chemotaxis step for bacterium i as follows

b) Compute fitness function *J (i, j, k, l)*

c) Let *Jlast =J (i, j, k,)* to save this value since we may find a better

cost via a run.

d) **Tumble**: Generate a random vector $\Delta(i) \in R^p$ with each element

$\Delta_m(i)$ m= *1, 2…p*, a random number on [-1 1]

e) Move: Let

$$(j+1,k,l) = \theta^i(j,k,l) + c(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}}$$

f) Compute *J (i, j+1, k, l)*

g) **Swim**

i) Let *m =0* (counter for swim length)

ii) While *m < Ns* (if have not climbed down too long)

Let *m = m+1*

If *J (i, j+1, k, l) < Jlast* (if doing better),

Let *Jlast = J (i, j+1, k, l)* and let

$$(j+1,k,l) = \theta^i(j,k,l) + c(i)\frac{\Delta(i)}{\sqrt{\Delta^T(i)\Delta(i)}}$$

And use this $\theta^i(j+1,k,l)$to compute the new J(j+1,k)

Else, let *m = Ns*. This is the end of the while statement

h) Go to next bacteria *(i+1)* if *i ≠S*

Step 3: Update $\theta_{best}(j,k)$ *and* θ_{global} If *j <Nc*, go to step 3. In this case, continue chemotaxis, since the life of bacteria is not over.

Step 4: **Reproductions:**

(a) For the given *k* and *l*, and for each *i* = 1, 2…*S*, let

$$J^i_{health} = \sum_{j=1}^{Nc+1} J(i,j,k)$$

be the health of bacterium *i* . Sort bacteria and chemotaxis parameter *C (i)* in order of ascending cost *Jhealth* (higher cost means lower health).

b) The *Sr* =*S*/2 bacteria with the highest *Jhealth* values die and other *Sr*=*S*/2 bacteria with the best values split.

Step 5: (New step): Mutation

For *i* = 1, 2…*S*, with probability *Pm*, change the bacteria position by pfPSO.

Step 6: If k < Nre, go to step 2. We have not reached the specified number of reproduction steps. Therefore, we have to start the next generation in the chemotaxis loop.

The mean square error expressed in equation (5) between the noisy image and the wiener filter image has to be used as cost function in Mutation based bacterial Foraging technique to optimize the peak signal to noise ratio.

Error=$\frac{1}{mn}\sum_{i=1}^{mn}\left(z(x,y) - p(x,y)\right)^2$ ……………….5

Where MN is the size of the both noisy image and wiener filtered image. Performance of the MBFO technique is evaluated based on the Peak Signal to Noise Ratio (PSNR) and Mean Absolute Error(MAE) given by[10].

$$PSNR=10\log_{10}\frac{255^2}{Error} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

$$MAE=\frac{1}{MN}\sum_{i=1}^{M,N}\left(f'_{i,j}-f_{i,j}\right)^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where $f'_{i,j}$ and $f_{i,j}$ represents the pixel value of restored image and original image respectively.

D. Pre-Processing and Feature Extraction

The face image is resized to uniform dimension, the data type of the image sample is transformed to double precision and passed for feature extraction. The region of interest (ROI) of a lip , an eye and mouth have been selected independently in the acquired images through the mouse. Statistical features like mean ,median and standard deviation has been calculated for noisy frame, restored frame . cropped frame and enhanced cropped frame by using the following formula in programming language MATLAB 7.0.

Mean: Average or mean value of face image has been calculated using following equation:

$$x_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

Median: Meadian of face image has been calculated using following equation:

$$x_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

$$x_k = \frac{1}{n}\sum_{i=1}^{n} x_j \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

Standard Deviation: Standard Deviation of face image has been calculated using following equation:

$$s\frac{1}{n-1}\sum_{i=1}^{n} x_j\ x \ldots\ldots\ldots\ldots\ldots\ldots\ldots 11$$

E. Histogram Equalization

A histogram equalization method has been applied to improve the quality of cropped lip, eye and mouth region. Histogram equalization improves the contrast in the grayscale and its goal is to obtain a uniform histogram.

F . Back Propagation Neural Network

For the training of dataset ANN has been used. The features that have been extracted from face images has to fed as an input to an Artificial Neural Network using feed forward back propagation. . In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes and to the output nodes. Feed forward neural network begins with an input layer. The input layer may be connected to a hidden layer or directly to the output layer. In order to train the neural network, a set of training face image samples of various expressions will be required. During training, the connection weights of the neural network will initialized with some random values. The training samples in the training set will input to the neural network classifier in random order and the connection weights will be adjusted according to the error back-propagation learning rule.

IV. EXPERIMENTAL RESULTS

The proposed algorithm is applied on the sample face images. The simulations has been performed using the Image Processing Toolbox and the Neural Network Toolbox of Matlab 7.0. The images were obtained from the JAFFE databases available in the World Wide Web . The 70 images from JAFFE database without adding any noise are taken as the prototype image set. Speckle noises are added with variance varying from 0.02 to 0.9. The results consist of sample face images taken from the JAFFE database and results of image preprocessing and feature extraction stage.

4.1 Image preprocessing and feature extraction results

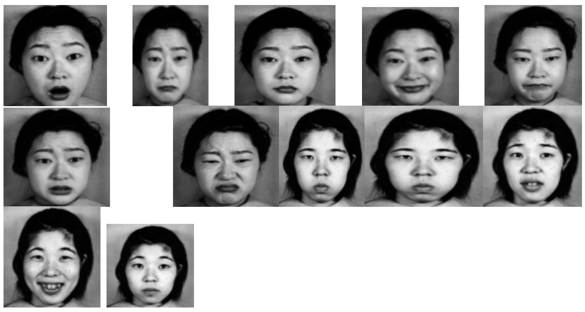


Fig -4(a) Sample images from JAFFE Database

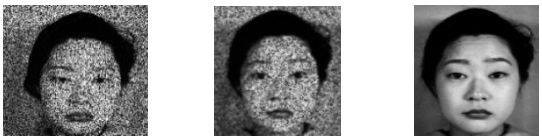


Fig-4(b) Noisy image (c) wiener filtered image (d)) Restored image from Noisy image by using median filter & MBFO

A *Preprocessing result of eye feature*

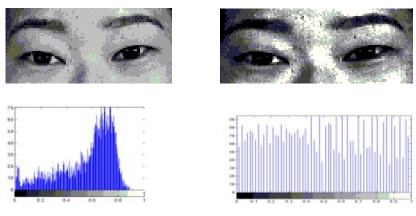


Fig-5(a), (b), (c) (d)

Figure 5 (a) Cropped Eye Region in restored image (b Enhancement of cropped Eye region by Histogram Equalization (c) Histogram of cropped eye region (d) Histogram after enhancement

B. *Preprocessing result of lip feature*

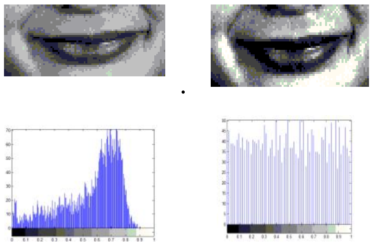


Fig-6(a),(b),(c),(d)

Figure 6 (a) Cropped lip Region in restored image (b Enhancement of cropped lip region by Histogram Equalization (c) Histogram of cropped eye region (d) Histogram after enhancement

C. *Preprocessing result of mouth feature*

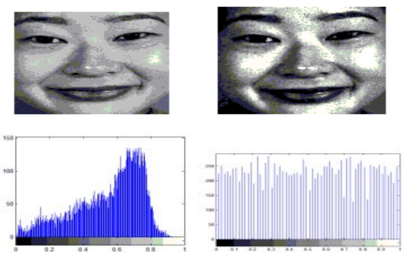


Fig-7(a),(b),(c),(d)

Figure 7 (a) Cropped Eye Region in restored image (b Enhancement of cropped Eye region by Histogram Equalization (c) Histogram of cropped eye region (d) Histogram after enhancement

Table-I STATISTICAL FEATURES FOR EYES

Statistical Features	Noisy frame	Restored frame	Cropped frame	Enhanced frame
Mean	0.5016	0.5014	0.5002	0.4996
Median	0.5514	0.5468	0.5077	0.4523
Standard deviation	0.4581	0.2226	0.3030	0.2934

TABLE-II STATISTICAL FEATURES FOR LIPS

Statistical Features	Noisy frame	Restored frame	Cropped frame	Enhanced frame
Mean	0.5020	0.5014	0.5002	0.4996
Median	0.5467	0.5430	0.4918	0.4217
Standard deviation	0.4576	0.2228	0.2129	0.2012

Table-III STATISTICAL FEATURES FOR MOUTH

Statistical Features	Noisy frame	Restored frame	Cropped frame	Enhanced frame
Mean	0.5022	0.5016	0.5003	0.5002
Median	0.5510	0.5469	0.5077	0.5076
Standard deviation	0.4583	0.2227	0.2936	0.2934

V. CONCLUSION

In this work cascading of wiener filter and Bacteria Foraging Optimization with mutation is used to remove highly corrupted speckle noise with variance up to 0.9. Region of interest such as eyes, lips and mouth are selected trough mouse. Statistical features are calculated to recognize the different emotions.

FUTURE WORK

In future statistical features will be used to train the neural network to recognize the different emotions like happy, sad, angry, disgusting, surprise fear and neutral.

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