Backpropagation Neural Network Experiment on Human Face Recognition

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Abstract- In Artificial Neural Network (ANN) experiments, the system of face recognition consists of image preprocessing, image segmentation, detection and feature extraction, localization and normalization and ANN. First, the process of preprocessing for human face is an improvement of the image data and image segmentation is the first step of image analysis that seeks to simplify an image to its basic component elements or objects. Then, the detection and feature extraction is the process of local feature and global feature for human face to extract features in localization and normalization. Finally, a back-propagation ANN is used and trained to recognize the actual human face images.

Index Terms- image preprocessing, image segmentation, detection and feature extraction, backpropagation ANN

I. Introduction

The human face recognition is solved by using many methods. The images of human faces are made for many orientations and positions due to human faces position and the camera. Due to light source, the background and the appearance of human faces are dependent on the camera. There are important characteristics in the human faces and they are skin color, eye, mouth, nose, hair and other things. In the process of preprocessing, the human face images are preprocessed with standard algorithms to improve the overall brightness and contrast in the face images from lighting or camera to reduce variation. The image segmentation is the first step of image analysis that seeks to approach for edge detection, thresholding and feature extraction. In detection and feature extraction, the local feature is the information of eye, nose, and mouth that easily affected by irrelevant information and the global feature is to extract feature, such as face, from the whole image. In this research, the global feature extraction is used for human face.

III. Survey of research

Now it is the time to articulate the research work with ideas gathered in above steps by adopting any of below suitable approaches:

A. Main Method

First, the face view is seen from preprocessing and the face pixel view is performed from image segmentation. Then, the face pixel feature from feature extraction and localization is extracted. For localization and normalization, the local view method for eigenface (use of a machine learning) approaches to deal with scaling variation. The image processing and computer vision have investigated the number of issues related to face recognition by human beings and machines. Face recognition is the identification of individuals from images of human faces by using a stored database of faces labeled with people's identities. This task is complex and is decomposed into the smaller steps of detection of faces in a cluttered background, localization of human faces followed by extraction of features from the face regions and finally recognition and verification is used by neural network.

Neural network is a parallel processing structure that has general large number of processors and many interconnections between them. The main characteristics of neural networks are to learn complex nonlinear input-output relationships, use sequential training procedures, and adapt themselves to the data. The research on human face recognition is important due to its application for security, information and observation.

II. Survey of research on human face

The algorithm in human face recognition mainly consists of five procedures and they are (i) capture the image of human face from camera, (ii) preprocessing of human face for face view, (iii) segmentation of human face for face pixel view, (iv) feature extraction and localization of human face for face pixel feature and face feature location, and (v) ANN for target face classification.

Finally, the sample information from face feature location is trained for target face classification at neural network.

B. Systems for human face recognition

The general work for human face recognition is to implement face image recognition system. For pattern recognition techniques, there are three methods to perform the human face recognition. These methods are the principal component analysis, the back-propagation neural network and counter propagation neural network. In this research, the back-propagation neural network is used for human face recognition

IV. FACE IMAGE PREPROCESSING AND SEGMENTATION

The image preprocessing stage is the most important part of the recognition system. This means that the remainder of recognition task is straightforward when the preprocessing is successfully performed. For face image preprocessing, human face photos are taken from CCD or digital camera and the shape of human face is scaled so that it has the same areas. The human face shapes must also be aligned for area of overlap to a significant metric.

The image segmentation is the process of the face image to subdivide an face image into its constituent regions or objects. For face image, segmentation algorithms are generally based on one of two basic properties of image intensity values. These two basic properties are discontinuity and similarity where the first category is to partition an image based on abrupt changes in intensity such as edges in an image and the second category is based on partitioning an image into regions that are similar according to a set predefined criterion. In this research, the first category is used for edges.

A. Lighting compensation and skin tone color

In face image preprocessing, the appearance of the skin tone color from CCD or digital camera can change due to different lighting conditions and the lighting compensation technique uses "reference white" to normalize the color appearance. The Figure (1) shows the background and human face and Figure (2) is shown to capture the face image by camera.

Figure (1) the background and human faces

Figure (2) the capture of human face

B. Color models

The color is represented by the following three components: (1) a component that measures the grayscale, or luminance, from to white, (2) a component that measures a "red to green" component and (3) a component that measures a "yellow to blue" component. However, there are other color spaces whose use in some applications. These colors include the NTSC, YCbCr, HSV, CMY, CMYK, and HIS color spaces. The conversion functions provide from RGB to the NTSC, YCbCr, HSV and CMY color spaces, and back. Several color models have been defined for the purpose of measuring or reproducing color.

C. Color transformation for human face

The color image processing of human face has three principal areas. They are color transformations, spatial processing of individual color planes and color vector processing. The color transformations techniques deals with processing the pixels of each color plane based strictly on their values and not on their spatial coordinates.

The techniques are based on processing the color components of a color image or intensity component of a monochrome image within the context of a single color model. For color images, the transformations of the form is

$$s_i = T_i(r_i), i = 1,2, \ldots., n$$

where $r_i$and s_i are the color components of the input and output images, n is the dimension of the color space of r_i and the T_i are referred to as full-color transformation (or mapping) functions.

The gray scale transformations of the human face from color image are independent of the gray level content of the image being transformed. In Figure (3) is shown as the gray scale transformation of face image.

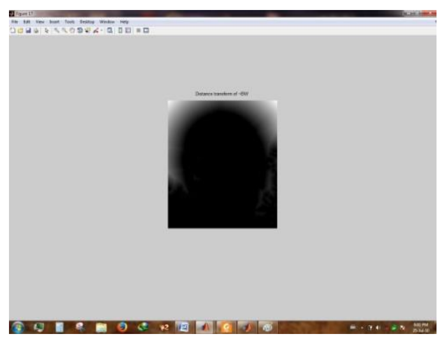

Figure (3) the gray scale transformation of face image

D. Human Face Segmentation

Face segmentation is the process of partitioning a face image into meaningful regions, in simple term it is to isolate a face from its background. The general approaches for segmentation are edge detection, thresholding, and relaxation. The morphological system is used to segment the human face. Morphology relates to the structure or form of face. The two principal morphological operations are dilation and erosion. These operations are customized for an application by the proper selection of the structuring element, which determines exactly how the face will be dilated or eroded.

Dilation allows objects to expand, thus potentially filling in small holes and connecting disjoint objects. The dilation process is performed by laying the structuring element on the image and sliding it across the image in a manner similar to convolution. The difference is performed in the operation of a sequence steps. In dilation process, there is no change and move to the next pixel when the origin of the structuring element coincides with a "0" in the image. But, it performs the "OR" logic operation on all pixels within the structuring element when the origin of the structuring element coincides with a "1" in the image. In Figure (4) is shown as the dilation of face image.

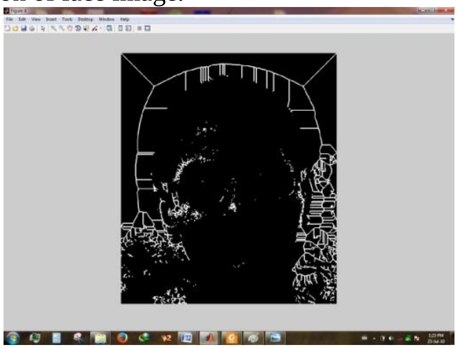

Figure (4) the dilation of face image

Erosion shrinks faces by etching away (eroding) its boundaries. The erosion process is similar to dilation, but the structuring or moving element turns to "0" rather to '1". As before, slide the structuring element across the image and then follow two steps. In first step, there is no change and move to the next pixel if the origin of the structuring element coincides with a "0" in the image. In second step, it changes the "1" pixel in the image to "0" if the origin of the structuring element coincides with a "1" in the image and any of the "1" pixels in the structuring element extend beyond the face ("1' pixels) in the image. In Figure (5) is shown as the erosion of face image.

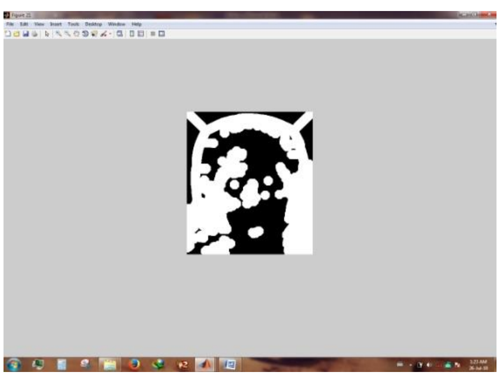

Figure (5) the erosion of face image

V. PATTERN CLASSIFICATION TECHNIQUES

There are many attempts proposed for recognition of human face and others objects in different areas and different techniques. There are three basic approaches. These approaches are (1) statistical pattern classification, (2) syntactic pattern classification and (3) artificial neural networks. The statistical approach depends on defining a set of decision rules based on standard statistical theory and the syntactic approach is to decompose a complex image pattern into a hierarchy of interrelated sub-patterns. But the neural network approach seeks to use artificial neurons that constructed from electronic devices, to form large interconnected networks. The main characteristics of neural networks are that have the ability to learn complex nonlinear input-output relationships, use sequential training procedures and adapt themselves to the data. However, the back-propagation neural networks are the useful technique for face recognition. The various architectures have been used with respect on the number of hidden layers and the number of neurons.

A. *Backpropogation neural network*

Backpropagation is the generalization of the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it approximates a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by the face image. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

There are many variations of the backpropagation algorithm. The simplest implementation of backpropagation learning updates the network weights and biases in the direction in which the performance function decreases most rapidly, the negative of the gradient. One iteration of this algorithm can be written

$$x_{k+1} = x_k - \alpha_k g_k$$

where x_k is a vector weights and biases, $g_k$is the current gradient, and α_k is the learning rate.

The structure of the backpropagation network has multiple layers of neurons with nonlinear transfer functions allow the network to learn nonlinear and relationships between input and output vectors are defined by log-sigmoid equation. Figure (6), Figure (7) and Figure (8) are shown to design the backpropagation network.

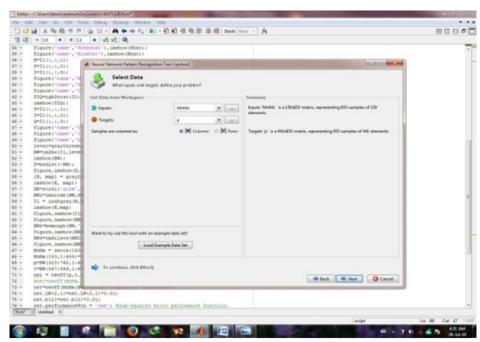

Figure (6) the selection of data

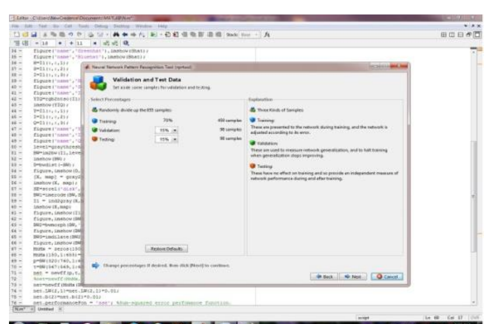

Figure (7) validation and test data

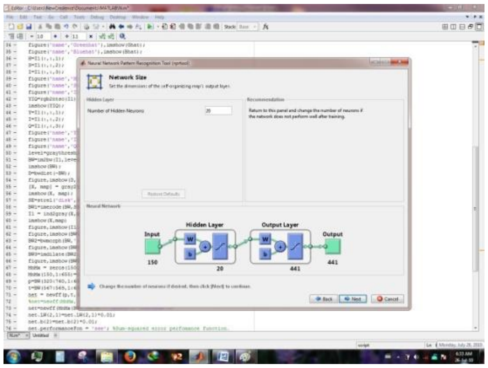

Figure (8) the neural network

Once the network weights and biases are initialized, the network is ready for training. The network can be trained for function approximation (nonlinear regression), pattern association, or pattern classification. The training process requires a set of examples of proper network behavior--network inputs p and target outputs t. During training the weights and biases of the network are iteratively adjusted to minimize the network performance function net.performFcn. The default performance function for feedforward networks is mean square error mse--the average squared error between the network outputs a and the target outputs t. Figure (9) is shown as the training network and Figure (10) is the results of network.

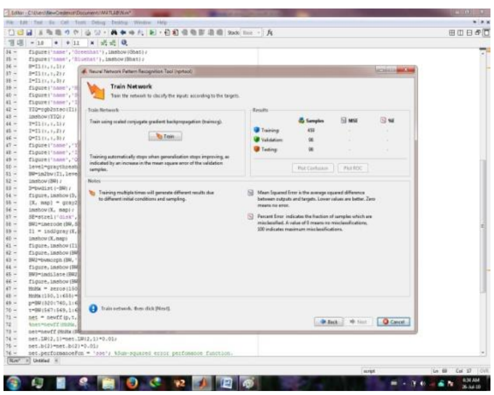

Figure (9) the training network

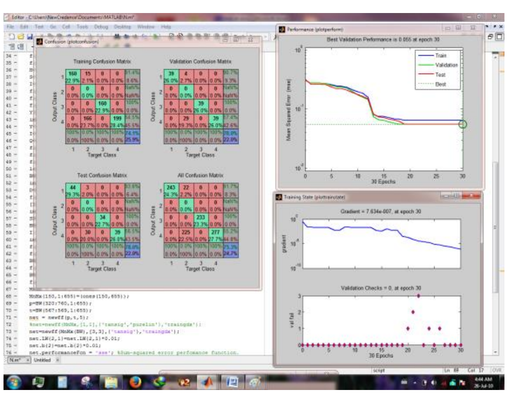

Figure (10) the results of network

VI. CONCLUSION

The purpose of the research is to measure overall progress in face recognition that determine the maturity of face recognition algorithms and have an independent means of comparing algorithms. And moreover, it is to recognize a person from an image containing the person's face, provided that another image of the same person exist in the system database. It is to apply an application area where computer vision research is being utilized in both military and commercial products. Some of the application areas include building security systems, verification of person identification documents, crowd surveillance systems, criminal purposes, and human computer interaction.

APPENDIX

```
CLEAR ALL;
CLOSE ALL;
I = IMREAD('C:\USERS\NEWCREDENCE\DESKTOP\N.JPG');
IMSHOW(I);
I1=IMCROP(I,[1671.5 639.5 654 762]);
IMSHOW(I1);
[X, MAP] = GRAY2IND(I, 16);
IMSHOW(X, MAP);
H_IM = IMSHOW(I1);
E = IMELLIPSE(GCA,[83.1846965699204 150.923482849604 528.678100263852 564.915567282322]);
BW = CREATEMASK(E,H_IM);
I2=IMCROP(BW,[83.1846965699204 150.923482849604 528.678100263852 564.915567282322]);
IMSHOW(I2);
I1=IMCROP(I,[1671.5 639.5 654 762]);
IMSHOW(I1);
T=EYE(1);
R=I(:,:,1);
G=I(:,:,2);
B=I(:,:,3);
FIGURE('NAME','RED'),IMSHOW(R);
FIGURE('NAME','GREEN'),IMSHOW(G);
FIGURE('NAME','BLUE'),IMSHOW(B);
YCBCR=RGB2YCBCR(I1);
IMSHOW(YCBCR);
Y=I1(:,:,1);
CB=I1(:,:,2);
CR=I1(:,:,3);
FIGURE('NAME','Y'),IMSHOW(Y);
FIGURE('NAME','CB'),IMSHOW(CB);
FIGURE('NAME','CR'),IMSHOW(CR);
RHAT=MEDFILT2(R,[5 5]);
GHAT=MEDFILT2(G,[5 5]);
BHAT=MEDFILT2(B,[5 5]);
FIGURE('NAME','REDHAT'),IMSHOW(RHAT);
FIGURE('NAME','GREENHAT'),IMSHOW(GHAT);
FIGURE('NAME','BLUEHAT'),IMSHOW(BHAT);
H=I1(:,:,1);
S=I1(:,:,2);
I=I1(:,:,3);
FIGURE('NAME','HUE'),IMSHOW(H);
FIGURE('NAME','SATURATION'),IMSHOW(S);
FIGURE('NAME','INTENSITY'),IMSHOW(I);
YIQ=RGB2NTSC(I1);
IMSHOW(YIQ);
Y=I1(:,:,1);
I=I1(:,:,2);
Q=I1(:,:,3);
FIGURE('NAME','Y'),IMSHOW(Y);
FIGURE('NAME','I'),IMSHOW(I);
FIGURE('NAME','Q'),IMSHOW(Q);
LEVEL=GRAYTHRESH(I1);
BW=IM2BW(I1,LEVEL);
IMSHOW(BW);
D=BWDIST(~BW);
FIGURE,IMSHOW(D,[]),TITLE('DISTANCE TRANSFORM OF ~BW');
SE=STREL('DISK',25);
```

```
BW1=IMERODE(BW,SE);

FIGURE,IMSHOW(BW1);

BW2=BWMORPH(BW,'SKEL',INF);

FIGURE,IMSHOW(BW2);

BW3=IMDILATE(BW2,SE);

FIGURE,IMSHOW(BW3);

MNMX = ZEROS(150,655);

MNMX(150,1:655)=(ONES(150,655));

P=BW(320:760,1:655);

T=BW(567:569,1:655);
```

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