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Classification of Image by Combining Wavelet Transform and Neural Network

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Abstract*—Image classification plays an important role in many tasks, which is still a challenging problem in organizing a large image database. However, an effective method for such an objective is still under investigation. In this paper, we propose a supervised method for image classification based on combination of wavelet transform and Neural Network (NN). Neural network has been increasingly used in image classification in the last few decades. The proposed scheme for successful classification is combination of a wavelet domain feature extractor and back propagation neural networks (BPNN) classifier. For achieving a suitable way for classification of image here we first use wavelet transform. In present day wavelet transform is most popular and widely used method for image classification. Wavelet transform is a well-known tool for signal/image analysis. It provides a time–frequency representation of the data as well. Wavelet transform first takes image from given data base, analysis this image and decompose main image into sub image and gives information about texture and shape from given image. In this proposed method of image classification first we divide all given image into six parts. For obtaining the necessary and required information from each part of the given divided image we use first order color movements and daubechies4 (db4) types of wavelet transform. This proposed method for classification of image is fully based on back propagation. Information about the color movement is used as a first input for NN. Second input is a deubechies4 transform of wavelet is used for NN.Final step of classification is based on back propagation neural network (BPNN) with one hidden layer. Back propagation, an abbreviation for "backward propagation of errors", is a common method of training artificial neural networks.backpropagation is based on weight of input and output neurons. In neuroscience and computer science, synaptic

Weight refers to the strength or amplitude of a connection between two nodes, corresponding in biology to the amount of influence the firing of one neuron has on another. The term is typically used in artificial and biological neural network research this new approach of classification of image is based on the texture, information of color and shape.170 aircraft color image were used for training and 200 for testing. Resulting data consist of 98% and 90% efficiency for training and testing respectively.

Index Terms. Back Propagation, Color Moment, Neural Network, Wavelet Transform.

I- INTRODUCTION

Classification base of an image from a given large data base plays an important role in many computer vision applications such as biomedical image processing , remote sensing application, automated visual inspection , content based image retrieval. Image classification algorithms can be designed by finding essential features which have strong discriminating power, and training the classifier to classify the image. Last tow decked Scientists ,researchers and practitioners have made great efforts in developing advanced classification approaches and techniques for improving classification accuracy [1], [2], [3], [4], [5], [6].from given large data base classification of image is particularly very difficult for mention traditional learning algorithms. The main region behind this difficulty is high number of image and a lot of information detail that classified given image successfully. Only due to this region this mention technique is not highly suitable to classify images from a database. Another region long time requirement for classification is another biggest limitation of all traditional method. One of the existing methods for Classification, recognition, and retrieval of images is based on Neural Networks (NN).In this we use image which have paper have700.□¢ pixels thus, image includes 35,000 RGB pixels if we use such image as a main input for neural NN, the number of input unit of NN are going to increasing and cause to The size of the NN also are increasing. Due to increasing size of NN and high number of input unit, the classification is very complicated. To attend this high complicity of classification due to large no of input unit and size of NN, mention image classification method use a pre-processing step to reduce the information of images with maintain image quality. Wavelet transform is widely use as a pre-processing steps for classification of an object especially when data base is very large. In present day Wavelet transforms is the most popular method to Analysis images and gives information from an image such as a shape and texture. Wavelets are mathematical functions which help in describing the original image into an image in frequency domain, which can further divided into sub band images of different frequency components. Each component is studied with a resolution matched to its scale. Wavelet transform has advantages over traditional Fourier method in analyzing physical situations where the signal contains discontinuities and sharp spikes. In this paper, we are interested in determining if a photo of a given aircraft belongs to one of the six categories shown in Figure 1.

Fig.1 Six categories of plane for classification. (1) Commercial plane in land, (2) commercial plane in air, (3) war plane in land,(4) war plane in air, (5)Helicopter in land, and (Class6) helicopter in air.

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II-RELETEDWORK

In this section, we describe about previous works for classification of image was based on wavelet transform and neural network. In this previous work back propagation neural network was based on Harr wavelet transform [18] for classification of 600 image (image for testing is 300 and image for training is 300).81.7% efficiency is recorded for training and efficiency for testing was 79.6%. In our proposed method we use a Daubechies wavelet transform [19] in place of Harr for increasing classification efficiency 98%(for training) and 90%(testing) respectively. Our proposed method is based on deubechies wavelet transform with back propagation neural network.

III- REPRESENTATION OF IMAGE CONTENT

Main requirement for an image classification is content and features of given image. This content are receive by finding color moment and wavelet coefficient form given image of data base. all images which present in data base is originally have 700*500 pixel. To minimize size of neural network we have to reduce this pixel (700*500) size of image. For this purpose we use downsempling, which reduce image size from 700*500 to 256*256.for obtaining color features we use three RGB color band which divide the original image into 128*128 pixel of six part.

A. Color Moment

Compare how similar two images are based on color. Once calculated, these moments provide a measurement for color similarity between images. Usually one image is compared to a database of digital images with pre-computed features in order to find and retrieve a similar image. [3]Since color moments encode both shape and color information they are a good feature to use under changing lighting conditions, but they cannot handle occlusion very successfully. [12]Color moments can be computed for any color model. Sticker and Orengo [11] use three central moments of a image's color distribution. They are Mean, Standard deviation and Skewness. Color moments are measures that can be used differentiate images based on their features of color.. These values of similarity can then be compared to the values of images indexed in a database for tasks like image retrieval.

B. Mean

The first color moment can be interpreted as the average color in the image, and it can be calculated by using the following formula..

$$E_i = \sum_{j=1}^{N} \frac{1}{N} p_{ij}$$

where N is the number of pixels in the image and p_{ij} is the value of the j-th pixel of the image at the i-th color channel.

C. Standard Deviation

The second color moment is the standard deviation, which is obtained by taking the square root of the variance of the color distribution.

$$\sigma_i = \sqrt{\left(\frac{1}{N}\sum_{j=1}^{N}(p_{ij} - E_i)^2\right)}$$

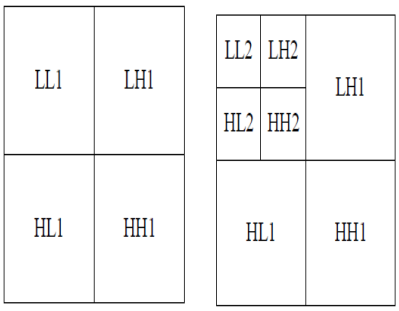
D. Skewness

The third color moment is the skewness. It measures how asymmetric the color distribution is, and thus it gives information about the shape of the color distribution. Skewness can be computed with the following formula:

$$s_i = \sqrt[3]{\left(\frac{1}{N}\sum_{j=1}^{N}(p_{ij} - E_i)^3\right)}$$

E. Wavelet Transform

The Fourier transform is a useful tool to analyze the frequency components of the signal. However, if we take the Fourier transform over the whole time axis, we cannot tell at what instant a particular frequency rises. Another problem exists: The length of window limits the resolution in frequency. Wavelet transform seems to be a solution to the problem above. Wavelet transforms are based on small wavelets with limited duration.The computation of the wavelet transform of a2D signal involve s recursive filtering and sub sampling[13]. If the scaling and wavelet functions are separable, the summation can be decomposed into two stages. First step is along the x-axis and then calculate along the y-axis.. A schematic diagram is shown in Fig. 3.4. The two dimensional signal (usu-ally image) is divided into four bands: LL(left-top), HL(right-top), LH(left-bottom) and HH(right-bottom) n is the level of decomposition (n=1). The HL band indicated the variation along the x-axis while the LH band shows the y-axis variation.. The power is more compact in the LL band.. A famous algorithm, named Embedded Zerotree Wavelet (EZW) proposed by Shapiro [15] and some modi ed versions in [16] and [17] are popul



(a) 1-level decomposition. (b) 2-level decomposition.

Fig.2 low and high frequency component

IV. PROPOSED METHOD

Our objective is classification of an image from a large data base by using the information of shape and color. For obtaining mention goal we use wavelet transform, Mean (first order color moment) and neural networks .there are so many types of neural network method are available for image classification. One is the most widely used neural network method is Back propagation neural network. Our proposed paper is based on Back propagation Neural network (BPNN) with one hidden layer.

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This method is very practical in image classification. In our starting work first we define the number of input for neural network as a first step. The pixel size is 700*500 hence number of input unit is very large for neural network so first we reduce the image size by down sampling and convert 700*500 pixels image into 256*256 pixel. Now we convert our new reduced image into three primary color band (RGB).in nest step we get six equal parts of 128*128 pixel from each color band. by using this six parts of each band we get input for neural network in following steps.

1. We first calculate Mean (first order color moment) from six parts of each R G, B band and get 18 inputs. This 18 input contain perfect color information of an image and use as neural network input.
2. In next step for getting horizontal vertical and diagonal detail of six decomposed part of each primary R,G,B band a well define db4 wavelet transform is used .which gives 72 input for neural network(24 input from each six parts).this 72 neural network input consist of information about texture and shape of given image.
3. In third step we get the information about the energy of horizontal, vertical, and diagonal components of each three R, G, and B primary component. in this third step we get 9 more neural network input,3 from each band.Fianly we get total 99 input unit for neural network.

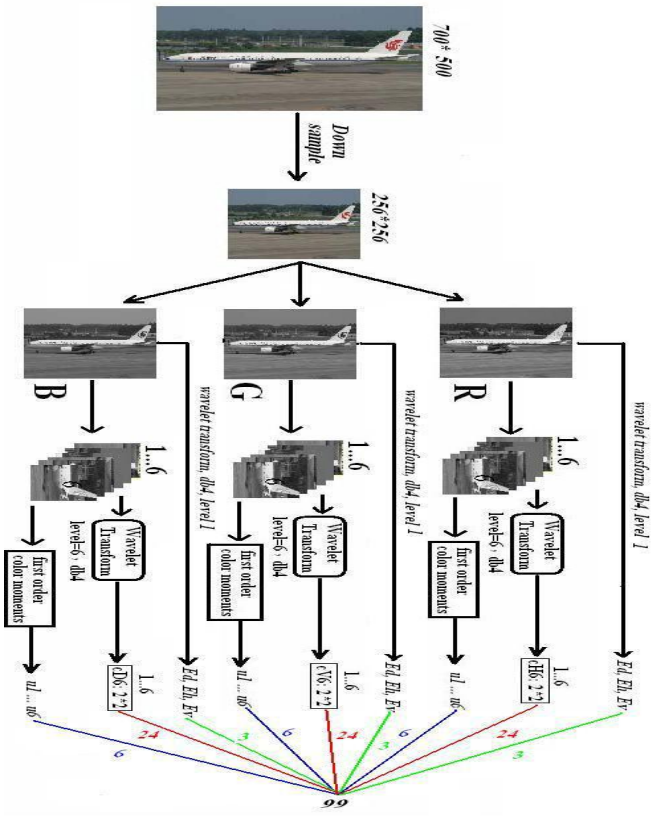

Fig.3 proposed method for NN network input

V. ARCHETRECTURE OF NEURAL NETWORK

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. . An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Two types of NN is used for classification feed forward and feedback. Proposed methodology is fully based on feed forward Feed-forward ANNs (figure 1) allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down.

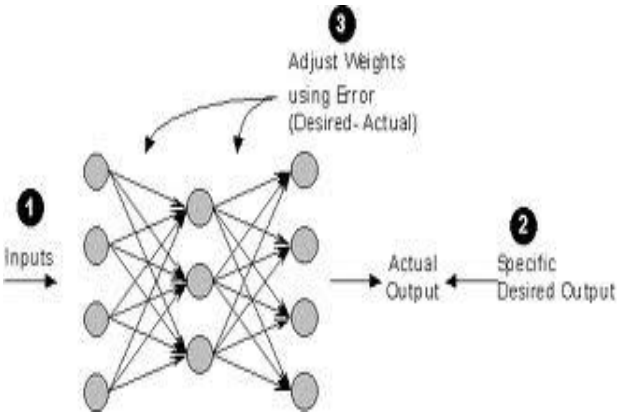

Fig.4 Architecture of Neural Network

In order to train a neural network to perform some task, we must adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivative of the weights (**EW**). In other words, it must calculate how the error changes as each weight is increased or decreased slightly. The back propagation algorithm is the most widely used method for determining the **EW**. The back propagation algorithm looks for the minimum of the error function in weight space using the method of gradient descent. The combination of weights which minimizes the error function is considered to be a solution of the learning problem. Since back propagation uses the gradient descent method, one needs to calculate the derivative of the squared error function with respect to the weights of the network. The squared error function is:

$$E = \frac{1}{2}(t - y)^2,$$

E = the squared error

t = target output

y = actual output of the output neuron

$$y = \sum_{i=1}^{n} w_i x_i$$

n = the number of input units to the neuron

w_i = the i[th] weight

x_i = the i[th] input value to the neuron

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The above formula only holds true for a neuron with a linear activation function (that is the output is solely the weighted sum of the input). In general, a non-linear, differentiable activation function, φ, is used. Thus, more correctly:

$$y = \varphi(\text{net})$$

$$\text{net} = \sum_{i=1}^{n} w_i x_i$$

This lays the groundwork for calculating the partial derivative of the error with respect to a weight w_i using the chain rule:

$$\frac{\partial E}{\partial w_i} = \frac{dE}{dy}\frac{dy}{d\text{net}}\frac{\partial \text{net}}{\partial w_i}$$

$\frac{\partial E}{\partial w_i}$ = How the error changes when the weights are changed

$\frac{dE}{dy}$ = How the error changes when the output is changed

$\frac{dy}{d\text{net}}$ = How the output changes when the weighted sum changes

$\frac{\partial \text{net}}{\partial w_i}$ = How the weighted sum changes as the weights change

The back propagation algorithm looks for the minimum of the error function in weight space using the method of gradient descent. The combination of weights which minimizes the error function is considered to be a solution of the learning problem.

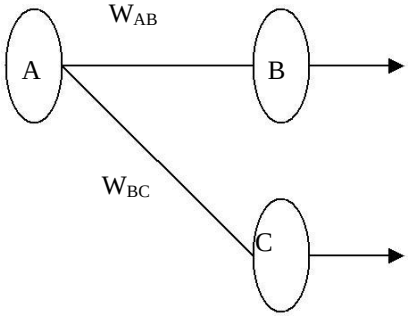

Fig.5 Adjustment of weight by Back propagation

1. First apply the inputs to the network and work out the output – remember this initial output could be anything, as the initial weights were random numbers.
2. Next work out the error for neuron B. The error is *What you want – What you actually get*, in other words:

$\text{Error}_B = \text{Output}_B (1-\text{Output}_B)(\text{Target}_B - \text{Output}_B)$

The "*Output(1-Output)*" term is necessary in the equation because of the Sigmoid Function – if we were only using a threshold neuron it would just be *(Target – Output)*.

3. Change the weight. Let W^+_{AB} be the new (trained) weight and W_{AB} be the initial weight.

$W^+_{AB} = W_{AB} + (\text{Error}_B \times \text{Output}_A)$

Notice that it is the output of the connecting neuron (neuron A) we use (not B). We update all the weights in the output layer in this way.

4. Calculate the Errors for the hidden layer neurons. Unlike the output layer we can't calculate these directly (because we don't have a Target), so we *Back Propagate* them from the output layer (hence the name of the algorithm). This is done by taking the Errors from the output neurons and running them back through the weights to get the hidden layer errors. For example if neuron A is connected as shown to B and C then we take the errors from B and C to generate an error for A.
5. $\text{A Error}_A = \text{Output}_A (1 - \text{Output}_A)(\text{Error}_B W_{AB} + \text{Error}_C W_{AC}$ Again, the factor "*Output (1 - Output)*" is present becauseof the sigmoid squashing function.
6. Having obtained the Error for the hidden layer neurons now proceed as in stage 3 to change the hidden layer weights. By repeating this method we can train a network of any number of layers.

VI. EXPERIMENTAL RESULT

These part of paper show the testing outcomes of described method. 250 color aircrafts image is select for testing purpose and 150 aircraft image is use for training. All this image is taken from http://www.airplane-pictures.net. The best efficiency of 98%

Method	[6]	[9]	Our Proposed method
Training Image Number	120	300	250
Testing Image Number	120	300	150
Classification percentage (%)	88	89	93

TABLE I
COMPARISON OF CLASSIFICATION METHODS

VII. CONCLUSION

In our proposed paper we mention an new idea for classification of an image from a large database by using wavelet transform and back propagation Neural network (BPNN).by using color moment ,entropy, and daubechies wavelet transform, the input for neural network is generated .finally we get 95% efficiency for training set and 93 % efficiency for testing set of data.

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