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Face Recognition using Wavelet Transform and ANN

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ABSTRACT

This paper proposes a human face recognition system using Wavelet Transform and Artificial Neural Network. Pre-processing, feature extraction and classification are three crucial steps involved in face recognition. A hybrid model is used to approach these steps by combining wavelet transform and artificial neural networks. For feature extraction, wavelet transform is used which is based on varying frequency in limited duration and among all the other classifiers used for face recognition, Artificial Neural Network acts as a reliable classifier to achieve a robust decision when there are a wide variety of facial angles.

KEYWORDS

Wavelet transform, preprocessing, feature extraction, neural network.

1. INTRODUCTION

Face recognition is one of the most exciting and interesting fields to work on and till now various approaches have been proposed. It has played an important role in many applications such as security systems, payment systems, healthcare, etc. A face recognition system in which the input of an image will search in a trained model to see how accurate or fit the model is. Faces are complex and have a wide variety of features and how those features appear at different angles so developing a model can be a difficult task when we have to consider all these factors [8]. The extraction of relevant facial features from a face is the first process for the face recognition model. Relevant facial features means how to quantize these facial features so that our model can recognize a face with the given set of features and that too precisely [3]. Generally there are three major steps involved in the process of an automatic face recognition system namely preprocessing, feature extraction and classification [6]. These steps are shown by using a block diagram in figure1.

At first all the input images are loaded in the system required for training and testing our model. Next is the preprocessing step which enhances the image quality and it is done due to the external factors that can affect the quality of an image. So it is necessary to remove the noise and normalize the images as their quality may be degraded with noise and poor illumination.

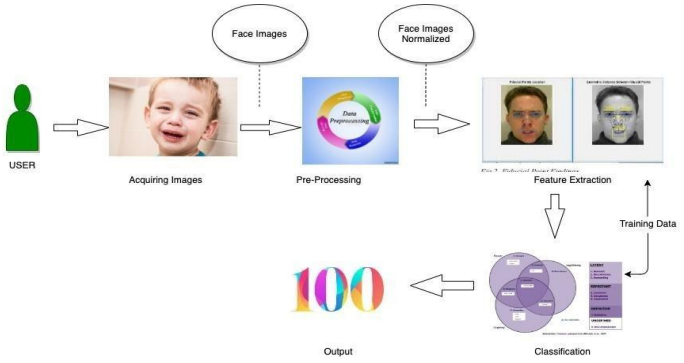


Figure 1: Architecture diagram of facial recognition system

The next step is used to reduce the dimensions and extract important features from face images and use those features for classification which will be done by wavelet transform [2]. The final step is the classification part which decides whether the image belongs to the face or non-face class based on information learned from during training where a reliable artificial neural network classifier is used.

2. LITERATURE REVIEW

Wang Yuanzhi1 and Luo Xiao [1] proposed a hybrid model which had different techniques for each step of face recognition i.e wavelet transform for image pre-processing, PCA for feature extraction and RBF neural network as a classifier. Priti and Srikanth [2] used the wavelet transform and neural network based approach and concluded that this hybrid model has a low computation load both in training and recognising stages. Thai Hoang Le [3] in his paper

proposed a module in which face detection was carried out by a three-layer feedforward neural network with Tanh activation function which was then combined with AdaBoost for faster face detection. LathaGanesan and Annadurai [4] concluded that their proposed model had an acceptance ratio more than 90% and the execution time was also fast as they used PCA for reducing the dimensions and then applied the reduced vectors from PCA to back propagation neural network which requires a pairs of input and target vectors which are then compared with output vectors. Nandini, Bhargavi and RajaSekhar [5] extracted the features of the face by calculating the distance between the local facial features like eyes, nose etc and then back propagation network is used to compare the net output with target value in order to obtain the error factor. From this error factor the weights are updated accordingly and the result obtained is given as the input to the neural network which has a good learning speed and is used as a recogniser in the face recognition system. Abhijeet el at [6] found in his studies that both radial basis function with particle swarm optimization where centroid was calculated using reservoir sampling for RBFN and back propagation technique are accurate for the task but in the case of large training length radial basis the function network had an edge over back propagation. Omaima N [7] proposed different artificial neural network approaches and algorithms like RCNN, PCA with ANN, PNN, CNN, BPNN, Gabor wavelet with ANN, MLP and MRC to compare the efficiencies of each model under different conditions. As per comparisons of all these algorithms, the highest face detection rate was obtained by convolutional neural network with an impressive 97.6% accuracy followed by back propagation neural network with 97.3% accuracy.

3. ARTIFICIAL NEURAL NETWORK

$$y = f\left(b + \sum_{i=0}^{n} x_i w_i\right)$$

- b = bias
- x = input given to neuron
- w = weights
- n = the number of inputs from the layers coming inwards

i = a counter from 0 to n

Activation Function

Activation functions play a very vital role in the mathematical calculation that determines and gives us the output of a neural network. Neural Networks are composed of a large number of simple elements, called neurons, each of which makes simple decisions.

The activation function acts as a mediator in between the input to the current neuron and its output going to the next layer.

There are three basic types of activation function they can be given as:

1) Binary step function

2) Linear activation function

3) Non-linear activation function:

In non-linear activation functions we have seven common types and they are as follows:

i) Sigmoid / Logistic

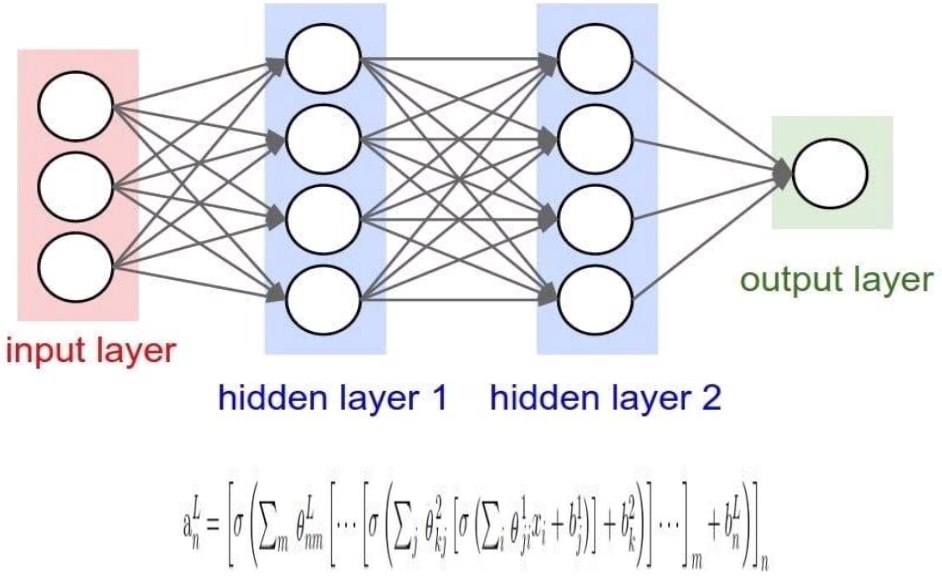
ii) TanH / Hyperbolic Tangent

iii) ReLU (Rectified Linear Unit)

iv) Leaky ReLU

v) Parametric ReLU

vi) Softmax vii) Swish



$$a_n^L = \left[\sigma\left(\sum_m \theta_{nm}^L \left[\cdots\left[\sigma\left(\sum_j \theta_{kj}^2\left[\sigma\left(\sum_i \theta_{ji}^1 x_i + b_j^1\right)\right] + b_k^2\right)\right]\cdots\right]_m + b_n^L\right)\right]_n$$

Figure2: Layers of network

Node value function where we have L layers with n nodes and L-1 layer with m nodes:

An artificial neural network is a computational model that is based on the biological neurons presents inside the human body both structural and function wise. A neural network changes as the network of information flows through it simultaneously as it learns from the input and output data just like a biological neuron works. ANNs are considered as nonlinear statistical data models where patterns are found based on the complex relationship between the inputs and the output

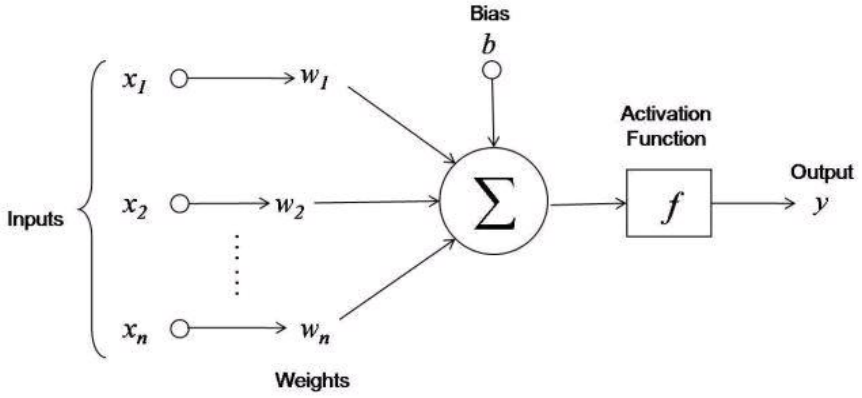


Figure 3: Operation of neuron

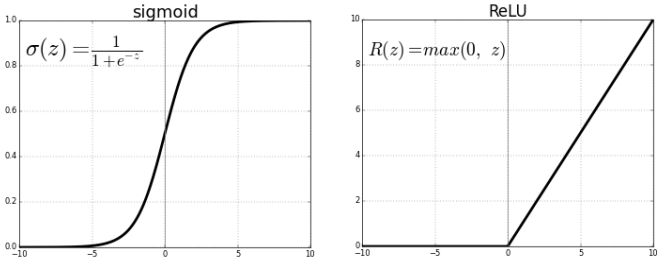
ReLU

The ReLU is an activation function which is very widely used. Since, it is used in almost all the convolutional neural networks or deep learning.

ReLU is computationally efficient and it is also non-linear. It has some issues in this process where all the negative values become zero immediately therefore decreasing the capability of the model to fit or train from the data properly. So if ReLU is provided with negative input it has the tendency to turn the value into zero immediately in the graph, which affects the resulting graph by not mapping the negative values appropriately.

Range

R(z)= ma



x(0,z)**Figure 4 - Logistic/Sigmoid v/s ReLU**

Adam Optimization

In adam optimization algorithm, the network weights are updated iteratively based on the training data and it gives an upper hand over the use of classical stochastic gradient procedure due to the following reasons:-

The benefits of implementing Adam optimization is that it is computationally efficient, requires less memory, well suited for problems that are large in terms of data and appropriate for problems with very noisy gradients. Here we have two moments, the first moment which is mean and the second moment which is uncentered variance i.e when we don't subtract mean during variance calculation.

$$m_t = \beta_1 m_{t-1} + \left(1 - \beta_1\right) g_t$$

$$v_t = \beta_2 v_{t-1} + \left(1 - \beta_2\right) g_t^2$$

Then it calculates an exponentially weighted average of the squares of the past gradients, and stores it in variables. Finally update parameters in a direction based on combining information from the above two paragraphs..

4. PROPOSED SYSTEM

This proposed system implements a human face recognition system using Wavelet transform and Artificial neural network. This research project aims to find the accuracy of the hybrid model i.e wavelet transform and artificial neural network combined for reliable face recognition.

In the proposed system each of the steps involved are clearly shown with the help of a flow chart. It will include the following steps like Image acquisition where we will get the dataset, Pre-processing this steps include removal of unnecessary data, Feature extraction in which we will extract the important features from the dataset, Training and Testing of data and the final step is Evaluation where the result is shown properly.

METHODOLOGY

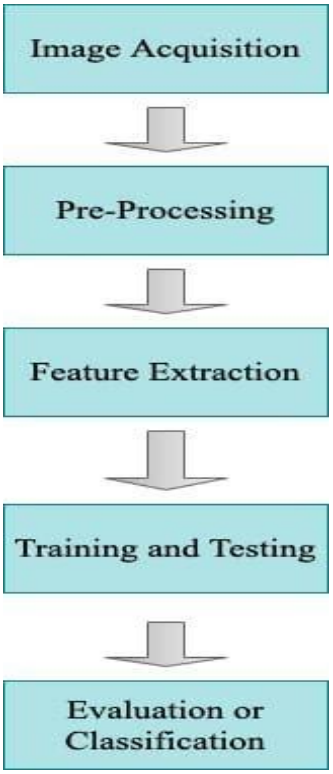


Figure 5: Flow chart of methodology

Image Acquisition

In this, several images of different people are loaded in the system at different angles in order to train the model accurately. Every person is given a unique ID, some images of a particular ID are taken for the training model in which we will apply the algorithm to train it while other images of the given unique ID will be taken as testing data which will help us to figure out how to fit the implemented model.

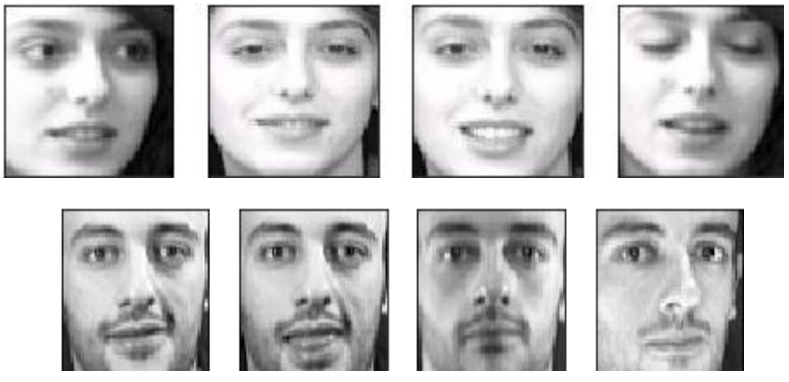


Figure 6: Images taken at various angles

Preprocessing

It is a process in which the image that we are loading in our system is preprocessed to remove unwanted noise from lighting or the external factors and normalize the image [1-4]. The given images are converted into a grayscale to reduce the dimensions of the image and it is then reshaped from a matrix format to a vector format. These vector values are then used for the machine learning model.

Feature Extraction using Wavelet

Transform

Feature Extraction plays a crucial part in face recognition as it determines what are all the relevant and important features required for a precise facial recognition model and also these features are vectors of values. The values should be in the matrix form and then we will apply Daubechies discrete wavelet to it. Also the matrix can be divided into four main components as LL, LH, HL, HH. The DWT is always implemented as a filter-bank. This means that it is implemented as a cascade of high-pass and low-pass filters. This is because filter banks are a very efficient way of splitting a signal into several frequency sub-bands. The discrete wavelet transform

Discrete Wavelet Transform of a signal is defined based on approximation coefficients, $W\varphi$ [$j0$, k], and detail coefficients, $W\psi[j, k]$, as follows:

$$W\phi\,[jo,k] = 1M\sum nx\,[n]\,\phi j0,k\,[n]$$

$$W\psi\,[j,k] = 1M\sum nx\,[n]\,\psi j,k\,[n]\,,forj \geq j0$$

and the inverse DWT is given by

$$x[n] = 1M\sum kW\phi\,[j0,k]\,\phi j0,k\,[n] + 1M\sum j = j0\sum kW\psi\,[j,k]\,\psi j,k\,[n]$$

where n = 0 to M–1, j = 0 to J–1, k = 0 to 2j–1, and M denotes the total number of samples to be transformed. This number is selected to be M = 2J, where J indicates the number of transform levels. The basis functions {$\varphi j,k[n]$} and {$\varphi j,k[n]$} are defined as

$$\phi j,k\,[n] = 2j/2\phi\,[2jn-k]$$

$$\psi j,k\,[n] = 2j/2\psi\,[2jn-k]$$

where $\varphi[n]$ is called the scaling function and $\psi[n]$ is called the waveletfunction.

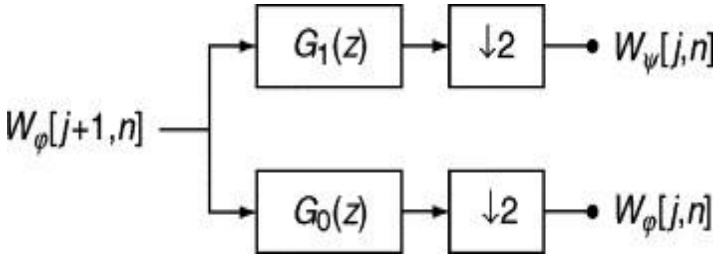


Figure 7: Discrete wavelet transform decomposition filter bank, G0 low pass and G1 high pass decomposition filters

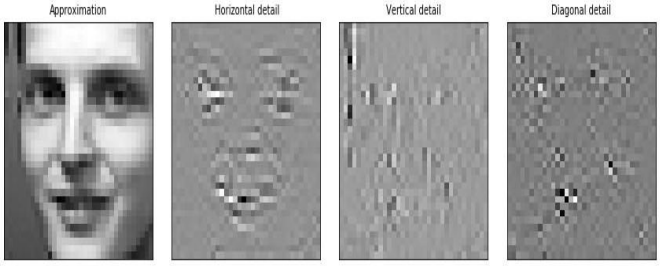


Figure 8: Wavelet figure Details

Training and Testing data

Here we categorize the input image data into two sets of data i.e training data which is shown in figure 3 a) and testing data which is shown in figure 3 b). Training data is the one which we will use to train our model that will help our model to learn about different types of angled images with respective IDs and then when we will input the test data it can compare the similarities between the training and the test data and validate the face recognition with precision.

a)

b)

Figure 9: Image data a)Training image b)Testing image

Evaluation or Classification

The classifier is an algorithm used in face recognition which decides whether the input test image matches the trained model and it belongs to the same class or not. This is dependent upon the preprocessing and the feature extraction part in terms of optimality as the mentioned steps decide the purity of the data and the relevant features that should be taken under consideration to get a fast and precise working model.

5. EXPERIMENTAL RESULT

TABLE-I: Recognition rate of different types of models.

S.No	Wavelet Type	Activation Function	Recognition Rate(%)
1	sym3	Relu + Sigmoid	90.0
2	db3	Relu + Sigmoid	88.33
3	bior1.3	Relu + Sigmoid	91.66
4	coif1	Relu + Sigmoid	88.33
5	sym3	Relu + Softmax	89.16
6	db3	Relu + Softmax	92.5
7	bior1.3	Relu + Softmax	90.83
8	coif1	Relu + Softmax	90.83
9	sym3	Relu+TanH+Sigmoid	95.33
10	db3	Relu+TanH+Sigmoid	91.33
11	bior1.3	Relu+TanH+Sigmoid	93.66
12	coif1	Relu+TanH+Sigmoid	92.99
13	sym3	Relu+TanH+Softmax	94.48
14	db3	Relu+TanH+Softmax	93.48
15	bior1.3	Relu+TanH+Softmax	93.99
16	coif1	Relu+TanH+Softmax	92.49

6. CONCLUSION

Wavelet theory is a novel mathematics and is also a powerful tool with rich mathematical contents and great applications. Its applications are abundant, and pattern recognition is just one of the applications. For example, image analysis, signal processing, communication systems, time frequency analysis are also applications of wavelet theory. To apply the DWT on a signal, we start with the smallest scale. As we have seen before, small scales correspond with high frequencies. This means that we first analyze high frequency behavior. At the second stage, the scale increases with a factor of two (the frequency decreases with a factor of two), and we are analyzing behavior around half of the maximum frequency. At the third stage, the scale factor is four and we are analyzing frequency behavior around a quarter of the maximum frequency. And this goes on and on, until we have reached the maximum decomposition level. There are few challenges that we faced while doing this project, like it was really challenging while dividing the signals into low pass and high pass frequencies. Wavelet theory along with ANN can be used very widely in the future, as they provide a huge number of libraries for face recognition or any other image processing method. It is also very easy to implement and has a very high accuracy rate with upto 95%.

7. REFERENCES

[1] Wang Yuanzhi, Luo Xiao, "Research on Face Recognition Based on Wavelet Transform and PCA-ANN", Journal of Digital Information Management, January 2012.

[2] Priti D.Neulkar, Srikanth Herekar, "Human Face Recognition Using Wavelet Transform And Artificial Neural Network", International Journal of Engineering Research and Applications ISSN: 2248-9622, International Conference on Industrial Automation and Computing, April 2014.

[3] Thai Hoang Le, "Applying Artificial Neural Networks for Face Recognition", Hindawi Publishing Corporation, July 2011.

[4] P.Latha, L.Ganesan, Dr.S.Annadurai, "Face Recognition using Neural Networks", Signal Processing: An International Journal (SPIJ) Volume (3): Issue (5).

[5]M.Nandini, P.Bhargavi, G.Raja Sekhar, "Face Recognition using Neural Networks", International Journal of Scientific and Research Publications, Volume 3, Issue 3, March 2013.

[6]Abhijeet Sekhon, Pankaj Agarwal, "Face Recognition Using Artificial Neural Networks",International Journal of Computer Science and Information Technologies, Vol.7(2),2016.

[7]Omaima N. A. AL-Allaf, "REVIEW OF FACE DETECTION SYSTEMS BASED ARTIFICIAL NEURAL NETWORKS ALGORITHMS", The International Journal of Multimedia & Its Applications (IJMA) Vol.6, No.1, February 2014.

[8] Manisha M. Kasar, Debnath Bhattacharyya1 and Tai-hoon Kim, "Face Recognition Using Neural Network: A Review", International Journal of Security and Its Applications Vol. 10, No. 3 (2016).