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Review on Face Recognition Using Fuzzy Logic and Neural Techniques

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Abstract
In the past days face recognition done by the help of biometrics. But now the face recognition has done by the artificial neural network and fuzzy logic techniques. In this paper we will study the different method of the neural network by which face recognition can be done and the different methods which are used by the different peoples.
In this paper we explain the basic units of the neural and fuzzy logic. We have the five steps for face recognition first is edge detection, feature extraction, feature normalization, system training, and comparison. For the edge detection we use the canny filter and feature extraction and feature normalization will be done by the fuzzy logic linguistic method and training will be done by the help of BPN and RBN.

Keywords
Image processing, artificial neural network, Edge detection, Feature Extraction.

I. Introduction

In today's networked world, the need to maintain the security of information or physical property is becoming both increasingly important and increasingly difficult. From time to time we hear about the crimes of credit card fraud, computer break-in by hackers, or security breaches in a company or government building. In most of these crimes, the criminals were taking advantage of a fundamental flaw in the conventional access control systems: the systems do not grant access by "who we are", but by "what we have", such as ID cards, keys, passwords, PIN numbers, or mother's maiden name.

A problem of personal verification and identification is an actively growing area of research. Face, Voice, Lip Movements, Hand geometry, Odors, Gait, Iris, Retina, Fingerprint are the most commonly used authentication methods. All of these behavioral and psychological characteristics of a person are called biometrics. The biometrics have a significant advantage over the traditional authentication techniques due to the biometric characteristics of individuals are not easily transferable, are unique of every person, and cannot be lost, stolen or broken. Face Recognition is one of the methods to identify the features of face of every individual. Research in this area has been conducted for more than 30 years, using a pre-stored image database, the face recognition system is able to identify or verify one or more persons in the database. The face is recognized by considering features viz., eye distance, nose distance, lip distance etc.

A. Literature Review

Advanced image processing or computer vision techniques will enhance the quality of symbolization of faces in video corpus. Robust face detection and tracking in videos is still challenging. The advantage of using neural networks for face detection is the feasibility of training a system to capture the complex class conditional density of face patterns. However, one drawback is that the network architecture has to be extensively tuned (number of layers, number of nodes, learning rates, etc.) to get exceptional performance. Many research efforts have been made in face detection, especially for surveillance and biometrics. In a comprehensive survey for face detection is presented. In addition to face detection and recognition, behavior analysis is also helpful, especially to associate the behavior with person's activity described in text.

Ramesha K, et al. [1] presented Feature Extraction based Face Recognition, Gender and Age Classification. This process involves three stages: Pre-processing, Feature Extraction and Classification. The geometric features of facial images like eyes, nose, mouth etc. were located by using canny edge operator and face recognition was performed. Based on the texture and shape information gender and age classification were done using Posterior Probability and Artificial Neural Networks respectively. It observed that Gender classification was 95% and Age classification was 90%.

Virendra P Vishwakarma, et al. [2] presented Fuzzy based Pixel wise Information Extraction for Face Recognition. They applied a fuzzification operation to extract the pixel wise association of face images to different classes. They obtained the average reduction in error rate as 38.43% with Correlation Coefficient and 37.12% with Principal Component Analysis.

Zong X Lin et al. [3] proposed Fast Vertical Pose Invariant Face Recognition Module for Intelligent Robot Guard. This method evaluates the angle of vertical pose variation simply from a single 2D image view and thereby recovers the vertical-rotated face to the nearly frontal view. Experimental results show the proposed method was quite effective in raising both face recognition rate and recognition confidence, and was better than conventional Statistical Affine Transformation for the vertical pose variation issue.

Kiranpreet Kaur, et al.[4] proposed Fuzzy Logic based Edge Detection Algorithm in MATLAB to detect the edges of input image by scanning it throughout by using 2*2 pixel window. Also, a Graphical User Interface in MATLAB has been designed to aid the loading of image, and to display the resultant image at different intermediate levels of processing. Comparisons were made with the various other edge detection algorithms. Displayed results had shown the accuracy of edge detection using fuzzy rule based algorithm over the other algorithms.

Neha Aggarwal and Rishabh Aggarwal [5] proposed Fuzzy Edge Filter Edge Detection and Feature Extraction Technique for Any JPEG Image. They highlighted the ways to detect edges at five different levels which will help in pattern recognition and feature extraction with the use of fuzzy logic. The fuzzy edge filter technique is operator introduce to simulate at a mathematical level. By applying the variable threshold value to get the new output image, edges were formed in all arbitrary directions. Feature Extraction of an image was very well extracted by fuzzy edge filter 45 and -45 degree at specified threshold.

J.Sheeba Rani and D Devraj [6] proposed A Novel Feature Extraction Technique for Face Recognition. The proposed method involves deriving an illumination insensitive image using Integral Normalized Gradient Image INGI and extraction of invariant face features using discrete orthogonal Tchebichef moment. Experimental results show the finite number of order for successful feature extraction, the recognition rate under different strategies, the insensitivity of tchebichef moments to noise and the improvement in recognition rate with tchebichef shift invariant.

Guillaume Heusch, et al. [7] proposed Local Binary Patterns as An Image Pre-processing for Face Authentication. A texture representation is derived from input face before being forwarded to the classifier. The efficiency of the proposed approach is empirically demonstrated using both an appearance based Linear Discriminate Analysis (LDA) and a feature based Hidden Markov Models (HMM) face authentication systems on two databases. Conducted experiments show significant improvement in terms of verification error rates and compared with state of the art pre-processing techniques.

Yuehui Chen, Shuyan Jiang, and Ajith Abraham presented a theory on face recognition using DCT and hybrid flexible neural tree classification model. DCT has some fine properties i.e. de-correlation energy compaction, separability, symmetry and orthogonality DCT coefficient matrix of an image covering all the spatial frequency components of the images. The DCT convert high-dimensional face image into low dimensional space in which more significant facial feature such as outline of hair and face position of eye, nose and mouth are maintained. FNT model is union of function set (F) and terminal instruction set T and the end give the comparison result between different approach for e.g. Principal Component Analysis (PCA) and RBFN (Radial Basic Function Network), LDA (Linear Discriminant analysis) and RBFN, FS and RBFN and last approach is DCQ and FNT. The size of input image should be 92×112.

Srinivasa K G, et al. [8] presented Generic Feature Extraction for Classification Using Fuzzy C Means Clustering. The raw data is pre-processed, normalized and then data points are clustered using Fuzzy C means technique. Feature vectors for all the classes are generated by extracting the most relevant features from the corresponding clusters and used for further classification. An important observation is that the classification accuracy obtained using Fuzzy C-Means clustering for generic feature extraction is very close to the accuracy of classification obtained by using problem-specific feature extraction such as ANN, SVM, BC, etc.

Yongsheng Gao and Maylor K. H. Leung [9] proposed Face Recognition Using Line Edge Map. A compact face feature, Line Edge Map, is generated for face coding and recognition. A thorough investigation on the proposed concept is conducted which covers all aspects of human face recognition; Controlled/ideal condition and size variation, Varying lighting condition, Varying facial expression and Varying pose. It provides a new way for human face coding and recognition, which is robust to lighting condition changes and size variations. It is a very attractive finding that the proposed face recognition technique has performed superior to the well-known eigenface method in most of the comparison experiments.

Rein-Lien Hsu, Mohamed Abdel-Mottaleb, and Anil K. Jain proposed a face detection algorithm for color image in which two modules are contain. In first modules face localization for finding face candidates and in second modules facial feature detection for verifying detected face candidate. The facial feature detection modules rejected face candidate regions that do not contain any facial feature such as eyes, mouth and face boundary map done and finally we utilize the hough transform to extract the best fitting ellipse. Their system arbitrates between multiple networks to improve performance over a single neural network. Capable of correctly locating upright frontal faces in gray level images, the detector proved to perform well with varying lighting conditions, and relatively complex backgrounds. Presented here is a summary of the detector, its unique features, and an evaluation of its performance.

Javad Haddadnia et al. [10] proposed Neural Network based Face Recognition with Moment Invariants. They applied Pseudo Zernike Moments (PZM) for recognition human faces in two dimensional images, and we compare their performances with other type of moments. The PZM of order of 6 to 8 with %1.3 error rate are very good features for human face recognition that we have proposed.

Kyoung-Man Lin, et al. proposed A Face Recognition System Using Fuzzy Logic and Artificial Neural Network. They developed a method that extracts a feature vector that is very important to recognise the facial image. They used the eye blinking method to get the location of eye roughly. They have gotten feature vector using locations and distances between feature points, that is, eyes, nose, mouth and the outline of the face.

B. Neural Network

In many task such as recognizing human faces and understanding speech, current AI system cannot do better than humans. It is estimated that the structure of the brain is somehow suited to these task and not suited to tasks such as high-speed arithmetic calculation. Neural networks [10] have emerged as a field of study within AI and engineering via the collaborative efforts of engineers, physicists, mathematicians, computer scientists, and neuroscientists. Although the elements of research are many, there is a basic underlying focus on pattern recognition and pattern generation, embedded within an overall focus on network architectures.

The intelligence of a neural network emerges from the collective behaviour of neurons, each of which performs only limited operation. Even though each individual neuron works slowly, they can still quickly find a solution by working in parallel. This fact can explain why humans can recognize a visual scene faster than a digital computer, while an individual brain cell responds much more slowly than a digital cell in a VLSI circuit. Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the connections between elements largely determine the network function. You can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. The strength of the interconnections between neurons is implemented by means of the synaptic weights used to store the knowledge. Typically, neural networks are adjusted, or trained, so that a particular input leads to a specific target output.

The figure 1 illustrates such a situation. There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically, many such input/target pairs are needed to train a network.

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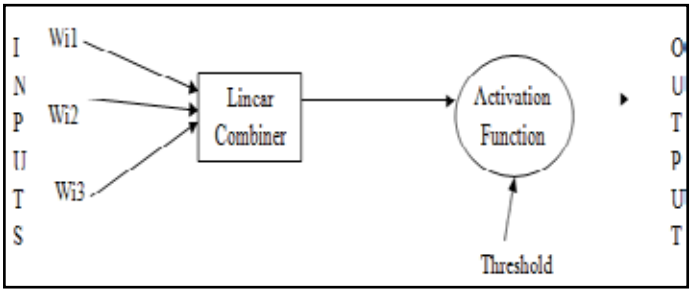

Fig.1: Basic Neural Network

1. Neurons

Neural network thus is an information processing system. In this information processing system, the elements called as neurons, process the information. A biological neuron or a nerve ell consists of synapses, dendrites, the cell body and the axon. In neural network it consist input weights or interconnection and output. The comparison is shown in fig 2.1 and fig 2.2.

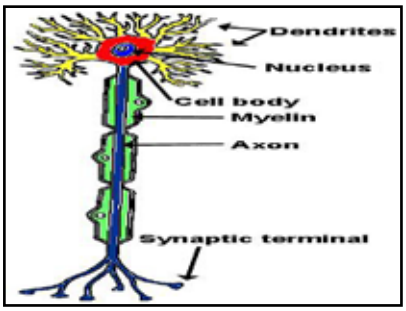

Fig 2.1 Biological Neuron

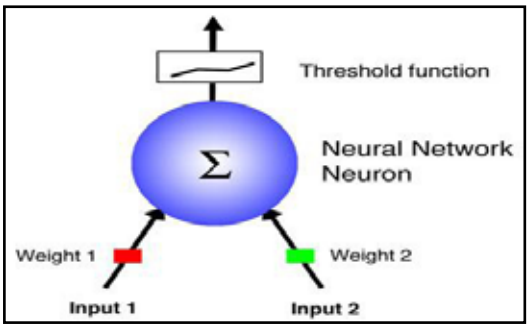

Fig 2.2 Artificial Neuron

C. Basic concepts of Neural Networks

Construction of a neural network involves the three tasks:

- Determine the network properties: the network topology, the type of connection, the order of connection, and the weight range.
- Determine the node properties: the activation range and the transfer function.
- Determine the system dynamics: the weight initialization scheme, the activation calculating formula, and the learning rule.

D. Network Properties

The topology of a neural network refers to its framework as well as it does inter connection scheme. The number of layer often specifies the framework and the number of nodes per layer includes:

- *The input layer:* The nodes in it are called input units, which encode the instance presented to the network for processing.
- *The hidden layer:* The nodes in it are called hidden units, which are not directly observable and hence hidden. They provide non-linearity for the network.
- *The output layer:* The nodes in it are output units, which encode possible concepts (or values) to be assigned to the instance under consideration.
- *Feed-forward networks:* All connections point in one direction (from the input toward the output layer).

Types of neural network:

1. *Fully Recurrent Networks:* All units are fully connected to all other units an d every unit is both an input and an output. Some connections are present from a layer to the previous layer, there is no hierarchical arrangement and the connections can be bi-directional. Recurrent networks are also useful in that they allow to process sequential information. Processing in recurrent network depends on the state of the network at the last step.
2. *Symmetrical connection:* If there is a connection pointing from node i to node j, then there is also a connection from node j to node i, and the weight associated with the two connection are equal, or rotationally, $W_{ji} = W_{ij}$.
3. *Asymmetrical connection:* the connection from one node to another may carry a different weight than the connection from the second node to the first.

II. Fuzzy Rule-Based Approach

If we interpret the image features as linguistic variables, then we can use fuzzy if-then rules to segment the image into different regions. A simple fuzzy segmentation rule may seem as follows:

- If the pixel is dark and
- Its neighbourhood is also dark and homogeneous
- then it belongs to the background.

A. Fuzzy Image Processing

Fuzzy image processing is not a unique theory. It is a collection of different fuzzy approaches to image processing. These are the advantages of using fuzzy logic.

- Fuzzy logic is conceptually easy to understand.
- Fuzzy logic is flexible.
- Fuzzy logic is tolerant of imprecise data.
- Fuzzy logic can model nonlinear functions of arbitrary complexity.
- Fuzzy logic can be built on top of the experience of experts.
- Fuzzy logic can be blended with conventional control techniques.
- Fuzzy logic is based on natural language.

III. Neural Network Approaches

a. Self-Organizing Map (SOM)
b. Neural Network as a Recogniser

- Back Propagation Network (BPN)
- Radial Basis Function Network (RBF)

(a) Self-Organizing Map: Maps are an important part of both natural and artificial neural information processing systems. Examples of maps in the nervous system are retinotopic maps in the visual cortex, tonotopic maps in the auditory cortex, and maps from the skin onto the somatosensoric cortex. The self-

organizing map, or SOM [11], introduced by Teuvo Kohonen is an unsupervised learning process which learns the distribution of a set of patterns without any class information. A pattern is projected from an input space to a position in the map – information is coded as the location of an activated node. The SOM is unlike most classification or clustering techniques in that it provides a topological ordering of the classes. Similarity in input patterns is preserved in the output of the process. The topological preservation of the SOM process makes it especially useful in the classification of data which includes a large number of classes. In the local image sample classification, for example, there may be a very large number of classes in which the transition from one class to the next is practically continuous (making it difficult to define hard class boundaries).

Algorithm

We give a brief description of the SOM algorithm, for more details see. The SOM defines a mapping from an input space R^n onto a topologically ordered set of nodes, usually in a lower dimensional space. An example of a two-dimensional SOM is shown in figure 3. A reference vector in the input space, $m_i \equiv [\mu i_1, \mu i_2, \ldots, \mu i_n]^T \in R^n$ is assigned to each node in the SOM. During training, each input vector, x, is compared to all of the m_i, obtaining the location of the closest match m_c(given by $|x - m_c| = min_i \{|x - m_i|\}$ where $|a|$.denotes the norm of vector a). The input point is mapped to this location in the SOM. Nodes in the SOM are updated according to:

$$m_i(t+1) = m_i(t) + hc_i(t)[x(t) - m_i(t)] \quad (1)$$

where t is the time during learning and $h_{c_i}c_i(t)$ is the neighborhood function, a smoothing kernel which is maximum at m_c.Usually, $hc_i(t) = h(|r_c - r_i|, t)$, where r_c and r_i represents the location of nodes in the SOM output space. r_c is the node with the closet weight vector to the input sample and r_i ranges over all nodes. $h_{c_i}c_i(t)$ approaches 0 as $|r_c - r_i|$ increases and also as t approaches ∞. A widely applied neighborhood function is:

$$hc_ic_i = \alpha(t)\exp(|r_c - r_i|^2|2\sigma^2(t))(|r_c - r_i|^2|2\sigma^2(t)) \quad (2)$$

where α (t) is a scalar valued learning rate and σ (t) defines the width of the kernel. They are generally both monotonically decreasing with time. The use of the neighborhood function means that nodes which are topographically close in the SOM structure are moved towards the input pattern along with the winning node. This creates a smoothing effect which leads to a global ordering of the map. Note that $\sigma(t)$ should not be reduced too far as the map will lose its topographical order if neighboring nodes are not updated along with the closest node. The SOM can be considered a non-linear projection of the probability density, p(x).

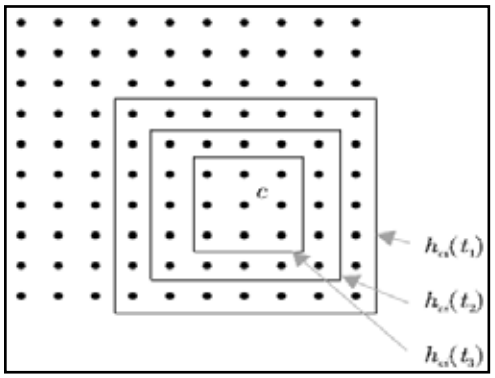

Fig. 3: A two-dimensional SOM showing a square neighborhood function which starts as hc_i(t1) Áand reduces in size to hc_i(t3) time.

(b) Neural Network as a Recognizer: After extracting the features from the given face image, a recognizer is needed to recognize the face image from the stored database. Neural network can be applied for such problems [12]. This paper proposes a recognition method, which uses two networks: Back Propagation Network (BPN) and Radial Basis Function Network (RBF) [10]. Back propagation can train multilayer feed-forward networks with differentiable transfer functions to perform function approximation, pattern association, and pattern classification. The BPN is designed with one input layer, one hidden layer and one output layer. The input layer consists of six neurons the the inputs to this network are feature vectors derived from the feature extraction method in the previous section. The network is trained using the RBF uses the gaussian function for approximation. For approximating the output of BPN, it is connected with RBF. The Radial Basis Function neural network [13] is found to be very attractive for the engineering problems They have a very compact topology.

• They are universal approximators to the right mouth end point samples.

The Back propagation training takes place in three stages:

1. Feed forward of input training pattern
2. Back propagation of the associated error and
3. Weight adjustment.

During feed forward, each input neuron (p1) receives an input value and broadcasts it to each hidden neuron, which in turn computes the activation and passes it on to each output unit, which again computes the activation to obtain the net output. During training, the net output is compared with the target value and the appropriate error is calculated. From this, the error factor is obtained which is used to distribute the error back to the hidden layer. The weights are updated accordingly. In a similar manner, the error factor is calculated for units. After the error factors are obtained, the weights are updated simultaneously. The output layer contains one neuron. The result obtained from the output layer is given as the input to the RBF.

• Their learning speed is very fast because of their locally tuned neurons [14].

The RBF neural network has a feed forward architecture with an input layer, a hidden layer and an output layer. In this paper, a RBF neural network is used as recognizer in face recognition system and the inputs to this network are the results obtained from the BPN.

IV. Conclusion

We have concluded after reviewing different techniques used for

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face recognition such as conventional approach SOM of neural network and modern approach such as BPN and RBF and fuzzy's linguistic variables and if than rules. We found that neural network approach BPN and fuzzy approaches such as linguistic variables and if than rules will provide high recognition accuracy.

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