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Fuzzy Logic in Real Time application (Face detection)

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Abstract:-

Face recognition is a pattern recognition task performed specifically on faces. It can be described as classifying a face either "known" or "unknown", after comparing it with stored known faces. Although face recognition systems are popular and highly accurate, many do not perform well in real time environment. Factors such as scale, rotation, pose and lighting prove to be limiting factors in a real time face recognition system performance. Pre processing is normally necessary in order to obtain results that are satisfactory. Here in this research paper to overcome the problem and to increase the identifying accuracy, ANN and Fuzzy logic is used for face recognition system.

Introduction:

Face recognition is a pattern recognition task performed specifically on faces. It can be described as classifying a face either "known" or "unknown", after comparing it with stored known faces. It is also desirable to have a system that has the ability of learning to recognize unknown faces. Computational models of face recognition must address several difficult problems. This difficulty arises from the fact that faces must be represented in a way that best utilizes the available face information to distinguish a particular face from all other faces. Faces pose a particularly difficult problem in this respect because all faces are similar to one another in that they contain the same set of features such as eyes, nose, and mouth arranged in roughly the same manner.

In view of the high rate of crime, fraud and terrorism in the world today, it is becoming increasingly more important to have remote monitoring systems that work well with other security devices. As security threats and frauds become increasingly rampant, it is necessary to have systems that allows recognition and monitoring of unauthorized people being in an area, using an equipment. Identity fraud starts when an individual uses multiple identification documents such as driver's licenses, passports, visas, national Identification Card (IC), etc., under assumed identities. This is possible because in most countries, documents such as birth certificates are very easy to fake. Databases may contain facial photographs and thus in principle, have the information required to prevent duplication. However, in practice, it is impossible for a human to search over millions of photos to find those duplicates. Fortunately, computers are able to do this function. Using Face Recognition, millions of images can be checked for possible matches quickly, automatically and with phenomenal accuracy. The software returns to the investigator any matches exceeding a confidence threshold and rank these matches in terms of diminishing resemblance or likelihood of a match.

Steps in Neural Network:

In the 1980's, Rumelhart and Hinton give a neural network algorithm called back-propagation and combined the method with the hidden layer to give a very good trainable and flexible neural network algorithm. Back-propagation algorithm corrects the weights in the network by looking at a misclassified event and calculating by how much the system was wrong. Then, parts of the network are changed to notice how quickly they change the error of the overall network. This is done by working from the output units back, until the best weight changes are found throughout the network to allow the correct identification of the unit. This allows the network to change its own weights to learn, and is the last piece of the common feed-forward back-propagation neural network of today (Hinton 1992).

The back propagation neural network algorithm can be divided mainly into two steps: Propagation Step and weight updating step.

Step-1: Propagation Step:

Each propagation step involves further two sub steps as discussed below:

- Forward propagation of a training pattern's input through the neural network in order to generate the propagation's output activations.

- Backward propagation of the propagation's output activations through the neural network using the training pattern target in order to generate the deltas of all output and hidden neurons.

Step-2: Weight updating Step:

For each weight-synapse follow the following steps:

- Multiply its output delta and input activation to get the gradient of the weight.
- Subtract a ratio of the gradient from the weight.
- This ratio affects the speed and quality of learning of network; it is known as learning rate. The greater the learning rate, the faster the neuron trains; the lower the learning rate, the more accurately the training is performed. The sign of the gradient of a weight indicates where the error is increasing; because of this the weight must be updated in the opposite direction.

Repeat step 1 and 2 until the performance of the neural network is satisfactory.

Software Used:

MATLAB is a matrix software developed in the LINPACK and EISPACK projects by Dr. C.Moler, chief scientist at Math Works Inc. the first version of the software was written in late 1970s for use in various sub areas of mathematics (matrix theory, linear algebra and numerical analysis). MATLAB is built on the foundation of sophisticated matrix software, in which basic data element is a matrix that does not require pre-dimensioning. At present MATLAB is an advanced interactive software package used for various scientific and engineering computations. It is a powerful, easy to use and comprehensive tool to perform computations, visualization and programming for technical computing. MATLAB is high performance language for technical computing. Typical areas of application of MATLAB include:

- Mathematics and computation
- Algorithm development
- Modeling, simulation and prototyping
- Data analysis, exploration and visualization

- Scientific and engineering graphics
- Application development including graphical user interface building

MATLAB's 2-D and 3-D graphics are object oriented. MATLAB is thus both an environment and a matrix oriented programming language, which enables the user to build own reusable tools. The users can create their own customized functions and programs (.m files) in MATLAB code. The toolbox is a specialized collection of M-files for working on particular classes of problems. MATLAB documentation set has been written, expanded and put online for ease of use. The set includes online help as well as hypertext based and printed manuals. The commands in MATLAB are expressed in a notation close to that used in mathematics and engineering. There is a very large set of these commands and functions known as MATLAB M-files. Solving problems using MATLAB is faster than other traditional programming. It is easy to modify the functions since most of the M-files can be opened and modified. For ensuring high performance, the MATLAB software has been written in optimized C and coded in assembly language. Various feature of MATLAB can be summarized as:

- Built-in toolboxes for several areas like signal processing, image processing, neural network, statistics, fuzzy logic, communication etc.
- Ability to interface with C and FORTRAN programs
- A complete online help system
- A powerful matrix oriented high level programming language with ability of GUI interface
- Large collection of build-in functions
- 2-D and 3-D graphics for visualization of data
- Facility of dynamic simulation of linear and non-linear systems.

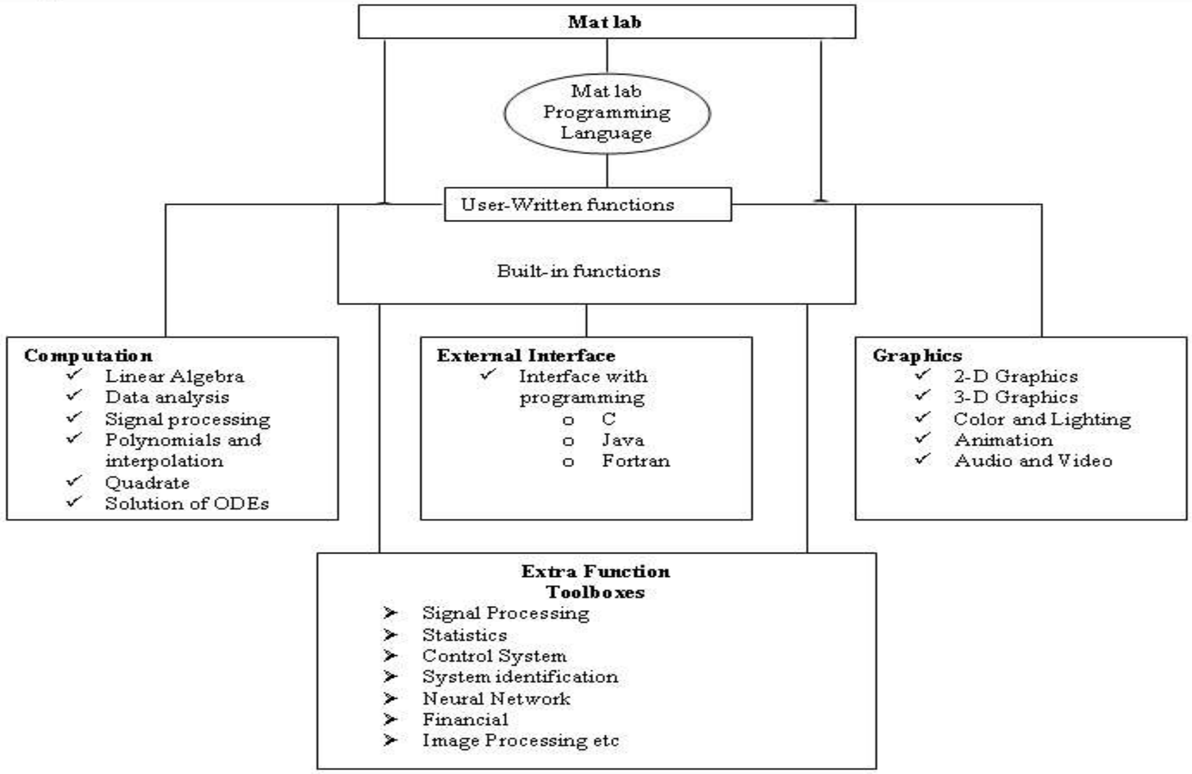

Figure 1 MATLAB: A high performance software

Description of the system:

The face detection using the proposed system is carried out using the following steps:

- It first loads the images data set for the neural network (or Fuzzy neural network).
- Then it applies a set of neural network-based filters to train the network for the above dataset.
- In the last step, we recognize an arbitrary image and if image found in the training set, the face is marked with the square.

Here I give the snap shots of various steps and results of my face recognition system.

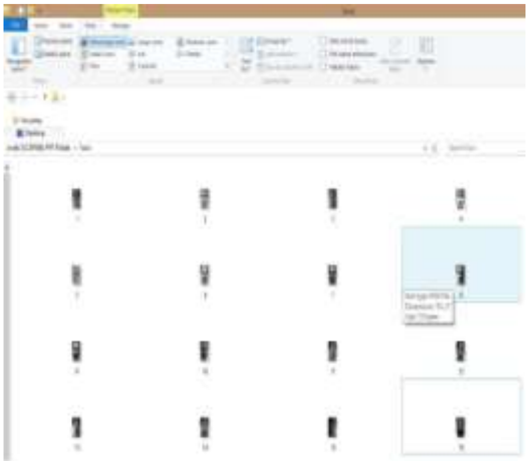

Figure 2 Training Data Set

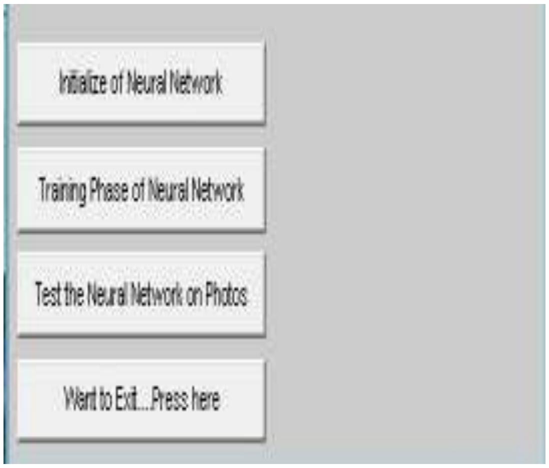
Initialize of Neural Network
Training Phase of Neural Network
Test the Neural Network on Photos
Want to Exit....Press here

Figure3 Graphical User Interface of the System

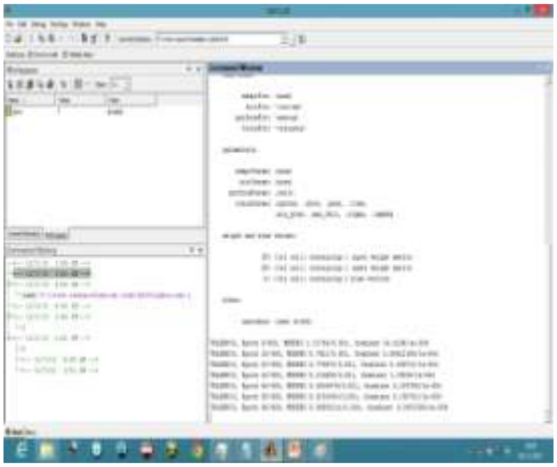

Figure 4 Training Phase of the Project

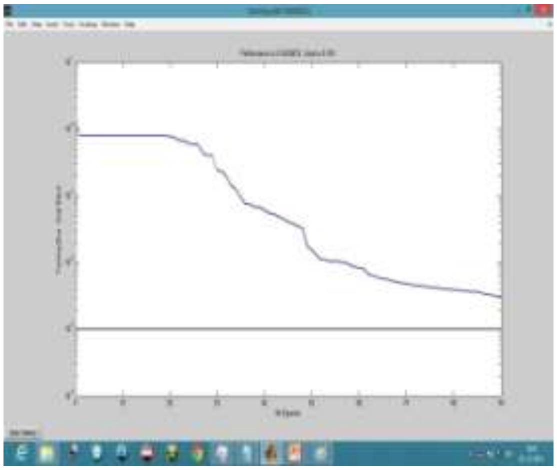

Figure 5 Performance window of the system

Result Analysis:

The training sets are given of with training faces. Image in the training data set is first enlarged by 50% and then cropped and scaled to 20 by 20 pixels. After that training is performed using a feed-forward network/ fuzzy neural network. Once the performance goal is met, the performance of the proposed system is tested by supplying a number of test images. It was noticed that most of the time system is able to detect the face (if present in the training dataset). A few failure of the system were observed.

The face detector system was trained on frontal, upright faces available in the training set. The faces were only very roughly aligned so there is some variation in rotation both in plane and out of plane. The detection becomes unreliable when rotation is more than mentioned above. Also in case of backlighting in which the faces are very dark while the background is relatively light sometimes system fails to recognise.. It is interesting to note that using a nonlinear variance normalization based on robust statistics and fuzzy logic to remove outliers improves the detection rate in these type of situation. Finally, this face detector fails on significantly occluded faces.

Conclusion:

Face recognition is a very valuable technology as it enables to achieve non-intrusive and convenient security system. It is challenging as the projected image depends on the person's pose, expression, lighting conditions, perspective angle and distance with respect to the camera. We intend to address the problem using Artificial Neural Network, a technology inspired by human brain mechanism, which is capable of solving complex problems such as face recognition by feed-back network and fuzzy logic techniques.

We choose to use the gray-level analysis of image using the ANN techniques, as it is observed by repetition of experiments several time that accuracy is about to be 96% for face detection classification compared to 97.9-98.3% accuracy of ANN using Fuzzy logic. We considered feed-forward types of neural network architectures. Back Propagation network ise used which is considerably easy to implement. Using multilayer perceptron along with back propagation algorithm would help achieve a reliable system with ability to learn and classify with high accuracy.

In next possible approach , we used the concept of fuzzy logic with feed forward mechanism to produce better output for image detection. Above methods of ANNs are implemented with the help of MATLAB and a GUI is created which make this system simplest and easy to use without any knowledge of ANN. However the system performed poorly when a lot of noise is added to the input images. However, pre-processing of input dataset helps drastically overcome noise problem.

Future Scope:

Although face detection is a key area of interest in the field of artificial machine intelligence, the usability of face recognition techniques lends the technology to a wider range of applications. Face detection techniques lie at the root of many face detection systems, identifying the location of faces, prior to attempting to recognise that face from a database of faces. Therefore a natural extension of this project, would be to extend this project with a option to use various techniques together at same time.

However concept of fuzzy logic, rough set theory with ANN will deliver better algorithms in the field of Face recognition. Above concepts can also be used with other classification techniques to improve the accuracy in the face detection system.

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