Sudan University of Science and Technology

College of Graduate Studies

Comparison of Iris Recognition Algorithms Using Artificial Neural Network

مقارنة خوارزميات التعرف على قزحية العين لتقليل خطأ التقسيم باستخدام الشبكات العصبية الاصطناعية

A comparison of iris recognition algorithms for segmentation error reduction using artificial neural networks

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الاستهلال

بسم الله الرحمن الرحيم

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ٱلْمَغْضُوبِ عَلَيْهِمْ وَلَا ٱلضَّآلِّينَ (٧)))

سورة الفاتحة الآية (1-7)

صدق الله العظيم

DEDICATION

With love and respect

Dedicated to my mother

Dedicated to my father

Dedicated to my siblings

Dedicated to my beloved husband

Dedicated to my aunts

Dedicated to my special people

Dedicated to my teachers

In whom I believe so much

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I would like to acknowledge and express my gratitude to after Allah the Almighty, my beloved ones for the incorporeal and financial support they have been giving me. And for all those whomever helped me on this research, especially my supervisor Dr-Fath Elrhman Ismael , who was the foundation stone for this research.

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Abstract

Iris recognition is regarded as the most reliable and accurate biometric identification system available. Iris recognition systems take an image of an individual's eye and the iris in the image is segmented and normalized for feature extraction process. The performance of iris recognition systems depend on segmentation and normalization, and segmentation succeeded depend on quality of image be captured, occurs error named segmentation error. In this research has reviewed iris recognition system and discussed two algorithms BP and BR to decrease error and determined what better than other about performance, error occur in non-iris region therefore, to process it can cut non-iris region from iris image during processing. Using artificial Neural network algorithms to process an iris image and using two algorithms and compare between its. Take a sample (captured images) , Design system model , segmented and extracted features of that images, using features as input to ANN technique, implemented some algorithms and compare between its using Matlab. The BPNN with different algorithms topology used in recognition because of its Recognition percentages for the irises tested images, but it needs more execution time for learning. the recognition rate of BPNN is more than the BR for the iris tested images, the size of the images are same in the both networks. find performance error in back propagation is bigger than in bayesian regularization. And time can be needed to designed model in bayesian regularization is more than in back propagation. in BP time to generate design is 1sec but in BR time equal 15sec, and error in BP 0.025872 but in BR equal 0.021009.

المستخلص

يعتبر نظام التحقق من الاشخاص بواسطة قزحية العين أكثر وثوقية ودقة من انواع طرق الاحصاء البيولوجية الاخرى، في هذا النظام تؤخذ الصورة لعين واحدة وتقسيم هذه الصورة وتسويتها لاستخلاص خصائص الصورة ، اداءه يعتمد على جودة التقسيم والتسوية بشكل كبير والتقسيم ايضا يعتمد على جودة الصورة التي تم التقاطها خلال هذه العملية يحدث خطأ يقلل من جودة عملية التوثيق يسمى خطأ التقسيم ، في هذا العمل استخدمت تقنية الشبكات العصبية الاصطناعية في عمل نموزج لهذا النظام لمعالجة هذا الخطأ بتقليله او التخلص منه عن طريق خوارزميتين تسمى خوارزميات الانتشار العكسي مع المقارنة بينهما في الاداء، اولا تؤخذ عينات (تلتقط صور للاشخاص الذين يراد التعرف عليهم)، ثانيا يصمم نموزج للنظام ، ثالثا تقسيم وتسوية كل صورة للحصول على خصائصها التي تعتبر دخل للشبكة العصبية الاصطناعية. تتم المقارنة بين الخوارزميتين باستخدام برنامج المحاكاة (ماتلاب) في نسبة الخطأ في كل خوارزمية والزمن الذي تستغرقه كل خوارزمية لتصميم نموزج للنظام (شبكة عصبية تمثل النظام).

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List of Abbreviations

ANN	Artificial Neural Network
BPNN	Bach Propagation Neural Network
BRNN	Bayesian Regularization Neural Network
CVP	Cross-Validation Pruning
GUI	Graphical User Interface
GLCM	Gray Level Co-occurrence Matrix
ICP	Information Criterion Pruning
JPEG	Joint Photographic Experts Group
MLP	Multi Layer Perceptron
STD	Standard Deviation

List of Symbols

Xc	**Center Coordinates for Pupil**
Yc	**Center Coordinates for Iris Recognition**
R	**Radius to defined any circle**
Vi	**Position of Vertex**
Fi	**Internal Force**

Chapter one

Introduction

Chapter One

Introduction

This chapter is an introductory chapter to the thesis. It presents background of iris recognition algorithms, states the problem and explores the objective of research. Finally it explains the scope and organization of this research.

1.1 Preface

At present many systems in different fields needed security by high level., biometric techniques is suitable to use instead of traditional techniques like passwords and etc. Iris recognition is the best technique for authentication and identification from others because it is more reliable and accuracy. Iris recognition completed by stages (steps), any one includes process and every steps is very important for complete iris recognition, but important stage is the segmentation iris which means segmented iris image to localize iris, if iris segmented is in accuracy then these next steps are not succeed. Any mistake in segmentation process is created error called by segmentation error, this image segmented consist of iris region and non-iris region, the segmentation error occur in non-iris region.

1.2 Problem Statement

During segmentation image can occur some errors named segmentation errors. It is occurs in non-iris regions in iris image decreases the accuracy of iris recognition.

1.3 Proposed Solution

This research is an attempt to study segmentation error and find method to avoid this error. error occur in non-iris region therefore, to process it can cut non-iris region from iris image during processing. using artificial

neural network algorithms to process an iris image and using two algorithms and compare between its.

1.4Objectives of thesis

To obtain high accuracy for authentication by iris starting from captured iris image by high quality . To decrease the segmentation error for minimal until not decreases the accuracy of iris recognition and To decreases error rate.

1.5 Methodology

Take a sample (captured images) , Design system model , segmented and extracted features of that images, using features as input to ANN technique, implemented some algorithms and compare between its using Matlab.

1.6 Organization of thesis

The thesis is organized as follow:

Chapter Two is a theoretical, it discusses the concept of iris recognition algorithms and reviews the comparison between them.

Chapter Three contains extracted features of iris segmentation process (system model and design) .

Chapter Four presents the results discussion of this research

Chapter Five discusses conclusion and recommendations of this research.

Chapter two

Literature review

Chapter Two

Literature review

2.1Backgruond

Life in today's depends upon information , these information require security by high level. Biometric authentication system is suitable because it has high accuracy [1]. Biometric measured human characteristics for authentication, these characteristics such as: face, finger, voice and iris. biometric involves: facial features, finger print, voice, gait, palm print, iris, retina, handwritten signatures and hand geometry [5]. Iris recognition is special kind of biometric system because it is used to identify person by test the patterns in the iris, iris recognition is most accurate and reliable in authentication due to it is high recognition rate [7]. In figure 2.1 explain the parts of human eye that used in iris recognition system.

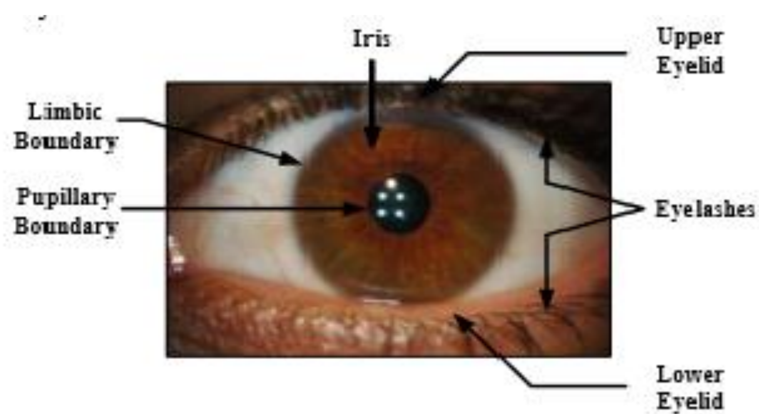


Figure 2.1: eye image used in recognition system.

Iris pattern is increasing the amount of accuracy, reliability and it has high degree of randomness and uniqueness [2]. Iris of human eye is survives same throughout the human lifetime moreover iris of left and right eye for same person is different, two individual have not same iris even twins [3].many applications like immigration control, aviation security , financial security are needed reliable and accurate identification of people, so all these systems recur to biometric identification methods is the best type recognition of iris because they are different for different, person even for same person therefore it is suitable[14]. Identification process of human iris is divided into important steps all these steps effect overall performance but segmentation is critical one because the recognition performance of system can be improved at segmentation of iris is accurate[14]. These steps Localization, segmentation, normalization, feature extraction and matching[5].

-localization: in this step boundaries of inner and outer iris are calculated [5], the image must be localized carefully at segmentation step[17].

-Normalization: transform segmented iris to fixed dimension by normalized iris regions to make comparison[17].The size of iris for the same person may mutate due to variation in illumination or other factors[5].

-Feature extraction: extracted information from normalized iris image, these extracted features are encoded to form template and using band pass of iris image to form biometric template[17].

-Matching:

At this stage measures the similarity and dissimilarity between two iris templates are formed at feature extraction to make decision of acceptance or rejecting[17].These steps is implemented to eye image respectively as shown in figure 2.2:

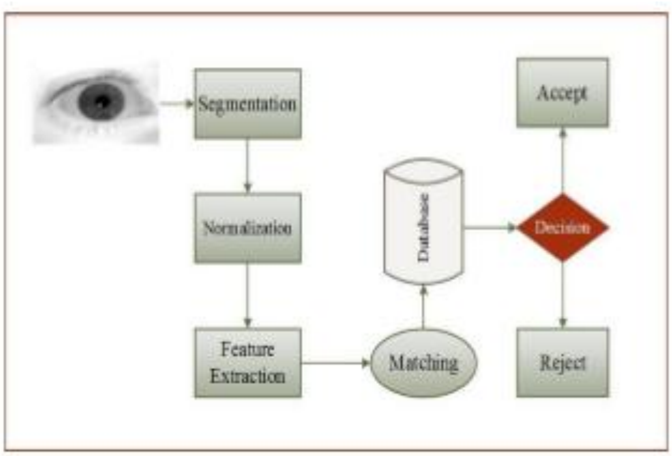


Figure 2.2: iris recognition stages.

2.1.1Traditional Techniques

Traditional techniques like password , keys and …, become not suitable for security because its easy to penetrate therefore gone to advance methods ,from these methods biometrics.

2.1.2 Biometric

Biometric indicate to technologies that measure human characteristics for authentication aim. these human characteristics consists: fingerprint, voice, facial, hand measurements, gait and irises [12]. these characteristics are used to secure any system and more powerful therefore used instead of traditional techniques [1].the attractive goal in computer vision is person authentication and identification, any biometric type get input(image) and apply some algorithms to extract features [5]. In authentication system iris recognition technique is the most reliable than others [1].biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual, Reliable personal recognition is critical to many processes.

Nowadays, modern societies give higher relevance to systems that contribute to the increase of security and reliability, essentially due to terrorism and other extremism or illegal acts. In this context, the use of biometric systems has been increasingly encouraged by public and private entities in order to replace or improve traditional security systems, Biometrics can be regarded as the automated measurement and enumeration of biological characteristics[21].

2.1.2.1 Iris Recognition

Iris is colored portion of eye and it has unique features, normally situation for iris between white portion "sclera" and black portion "pupil" [1]. iris recognition has several advantages factors such as: higher speed, high accuracy and simplicity when compared to other biometric feature. Iris is different for every person [5]. Iris includes several layers, the epithelium layer is the lowest, which contains dense pigmentation or color cells. Iris recognition is used to determine a person by analysis patterns in the iris and recognize human accordance, iris is controls in the amount of light enter to the retina and diameter and size of the pupil, iris recognition accurate and reliable because it has high recognition rate [7]. Iris color is obtained by melanin pigment and become interesting to reliable recognition of persons when image can be captured at distance less than meter and need search big databases without affording any false matches that a large number of possibilities [8].Iris pattern is increasing the amount of accuracy, reliability and noninvasive characteristics, it has high degree of randomness and uniqueness [2].Identification in iris recognition system is becoming more increasingly embedded in security applications. These security applications are used for access control, banking, border control, and forensics. Nowadays a special consideration is given to iris recognition system due to its high performance and reliability for identification, the recognition starts with image acquisition and ends with the decision to accept or reject [17]. Iris identification process is divided into four steps: localization, Normalization, Feature extraction and Matching [5].The iris is overt body that is available for remote assessment with the aid of machine vision system to do automated iris recognition, iris recognition technology combines computer vision, pattern recognition, statistical inference and optics [9].Iris recognition is one of the most accurate and widely employed approaches for the automated personal identification. The performance of iris recognition algorithms is highly dependent on the effectiveness of segmenting iris region [13].Iris recognition has been emerge as one of the most preferred biometric modalities for automated personal identification,

Traditional iris recognitions stems have been designed to work in strictly constrained environments in order to mitigate the influence of the noises from various sources like illumination changes, occlusions from eyeglasses, eyelashes, hair and reflections [16]. Current iris recognition systems claim to perform with very high accuracy. However, these iris images are captured in a controlled environment to ensure high quality[18].With the increasing demands of security in our daily life, the systems for person recognition based on biometric features have broad applications in both commercial and security areas, the iris recognition systems are very reliable and could be used in most secure places[20].Iris recognition systems capture an image of an individual's eye from frontal as shown in figure 2.3, the iris in the image is then segmented and normalized for feature extraction process. The performance of iris recognition systems highly depends on segmentation and normalization [21].

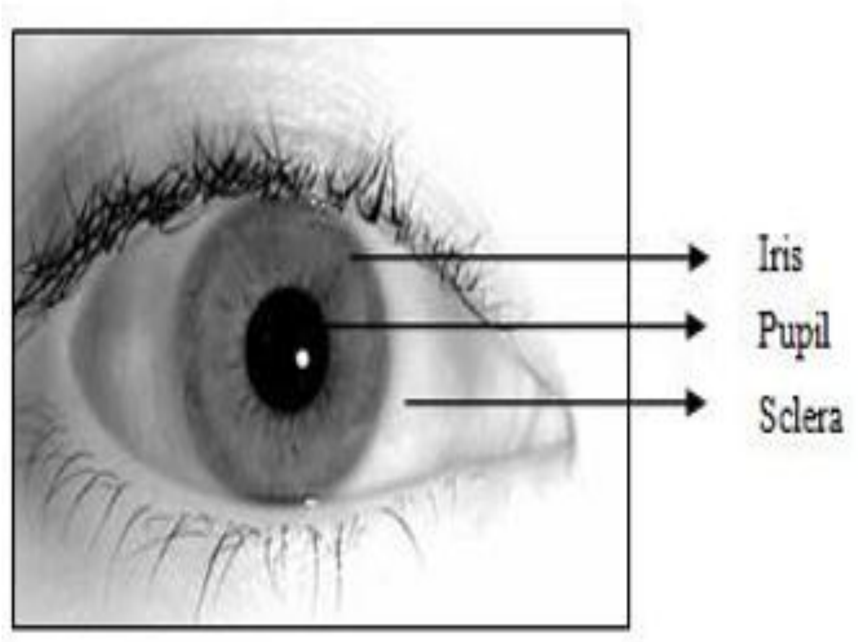


Figure 2.3: human frontal eye.

I. Iris Localization

The iris localization is achieved by finding the iris boundaries as well as eyelids with location of iris inner and outer boundaries. The process of locating and isolating an iris from an image is known as iris localisation or segmentation. The primary task of segmentation is to determine pixels in the image that correspond to the iris region[7]. We calculate the approximate center of iris based of iris detection method. Using this technique, the initial point for active contour is performed around the approximate center. a rough iris center is extracted in iris images, which provides important cues for contour initialized. [20].

II. Methods Used for Iris Localization

II.I Hough Transform

Hough transform is a standard image analysis tool for finding curves that can be defined in a parametrical form such as lines, polynomials and circles. The recognition of a global pattern is achieved using the local patterns. For instance, recognition of a circle can be achieved by considering the strong edges in an image as the local patterns and searching for the maximum value of a circular Hough transform.. [21].The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions[9].The circular Hough transform is used to find the radius; centre coordinates of the pupil and iris regions. Here, parameters x c and y c are the centre coordinates and r the radius which is used to define any circle by the equation:

$$X^2c + Y^2c = R^2 \quad (2.1) \qquad [7]$$

II.I Active Contour Models

An active contour works with internal and external forces by deforming moving across an image till equilibrium is established. The contour consisting of various vertices and their positions may be changed by internal and external forces. The internal force depends on the characteristics and an external force is image dependent. The vertex is moved between time t and t + 1 by the Eq: .

$$\mathrm{Vi(t)} + 1 = \mathrm{Vi(t)} + \mathrm{Fi(t)} \quad (2.2) \qquad [7]$$

Here, F(i) is the internal force; is the external force and vi is the position of vertex I[7].

III Eyelash and Noise Detection

If a resultant point is smaller than a threshold, then this point belongs to an eyelash. Many eyelashes are detected using the variable intensity[7].

2.1.2.2 Iris Compare with Other Biometrics

Biometrics in general considered is the best method and more powerful for security than traditional methods like passwords, PIN number and etc. and it can used to secure any system [1].Recognition systems which use iris biometric are believed to be very accurate [14]. Iris of human eye is survives same throughout the human lifetime moreover iris of left and right eye for same person is different, two individual have not same iris even twins [3].In face recognition difficulties seem from the fact that the face is variable social organ displaying a variety of expressions, image varies with viewing angle, pose, illumination, accoutrement and age. Facial image taken at least one year apart even the best current algorithms have error rates from 43% to 50% [8].In fingerprint many fingers wrinkle or shrivel at immersed in water when used in biometric identification, recognition rate degrades because fingers are wrinkled .Iris recognition is one of the most accurate and widely employed approaches for the automated personal identification than another biometric features[13].Iris recognition algorithms have succeeded in achieving a low false acceptance rate; however, reducing the rejection rate remains a major challenge. To make iris recognition algorithms more practical and adaptable to diverse applications, the FRR needs to be significantly reduced [18].Iris recognition is regarded as the most reliable and accurate biometric identification system available as shown in figure 2.4 [21]

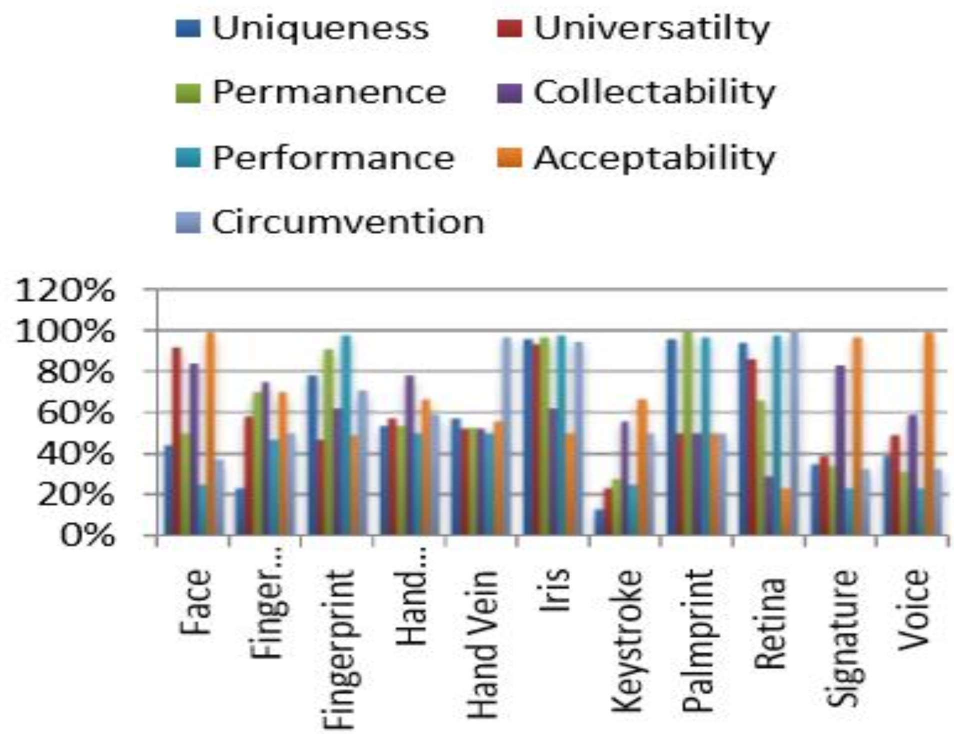


Figure 2.4: compare between common biometric trails.

2.1.2.3 Segmentation Iris

Iris image segmentation is important step to acquire high accuracy in iris recognition technique but noisy image decrease these accuracy and most of errors occur in non-iris region, this error is segmentation error, to avoid segmentation error can excluded non-iris region from iris image before the iris localization step. Most of the errors in segmentation step occurred by the high local contrast on non-iris regions [1]. Traditional iris segmentation methods give good results just when the iris images are taken under ideal imaging conditions however the segmentation accuracy of iris recognition system significantly influences it is performance especially in non-ideal iris image [2].Iris segmentation is to locate the valid part of the iris for iris biometrics, including finding the pupillary and limbic boundaries of the iris, localizing its upper and lower eyelids if they occlude and detecting and excluding any superimposed occlusions of eyelashes, shadows or reflections. Each algorithm of iris recognition system begins with iris segmentation [20].

Segmentation is the first stage of iris recognition is to isolate iris region in digital eye image, the success of segmentation depends on the imaging quality of eye image, The success of segmentation depends on the imaging quality of eye images. The center of pupil can be used to detect the outer radius of iris patterns [9].There are many definitions for image segmentation such as segmentation subdivides an image into its constituent regions or objects, Segmentation is a process of grouping together pixels that have similar attributes. Image segmentation is the process of partitioning an image into non-intersecting regions [15]. Segmentation techniques can be classified as either contextual or non-contextual. 1-contextual segmentation techniques: exploit the relationships between image features .2-non-contextual segmentation techniques: ignore the relationships that exist between features in an image [15]. Many iris segmentation algorithms are divided into three classifications 1)iris segmentation with the classical circular approaches and their improvements, 2)iris segmentation with noncircular approaches and 3)iris segmentation with active contour models[2].

Iris images captured in an uncontrolled environment produce non ideal iris images with varying image quality. If the eyes are not properly opened, certain regions of the iris cannot be captured due to occlusion, which further affects the process of segmentation and, consequently, the recognition performance. Images may also suffer from motion blur, camera diffusion, presence of eyelids and eyelashes, head rotation, gaze direction, camera angle, reflections, contrast, luminosity, and problems due to contraction and dilation[18].Iris segmentation is one of the most important steps in iris recognition system and determines the accuracy of matching. Most segmentation methods in the literature assumed that the inner and outer boundaries of the iris were circular explained that in figure 2.5 . Hence, they focus on determining model parameters that best fit these hypotheses[20]

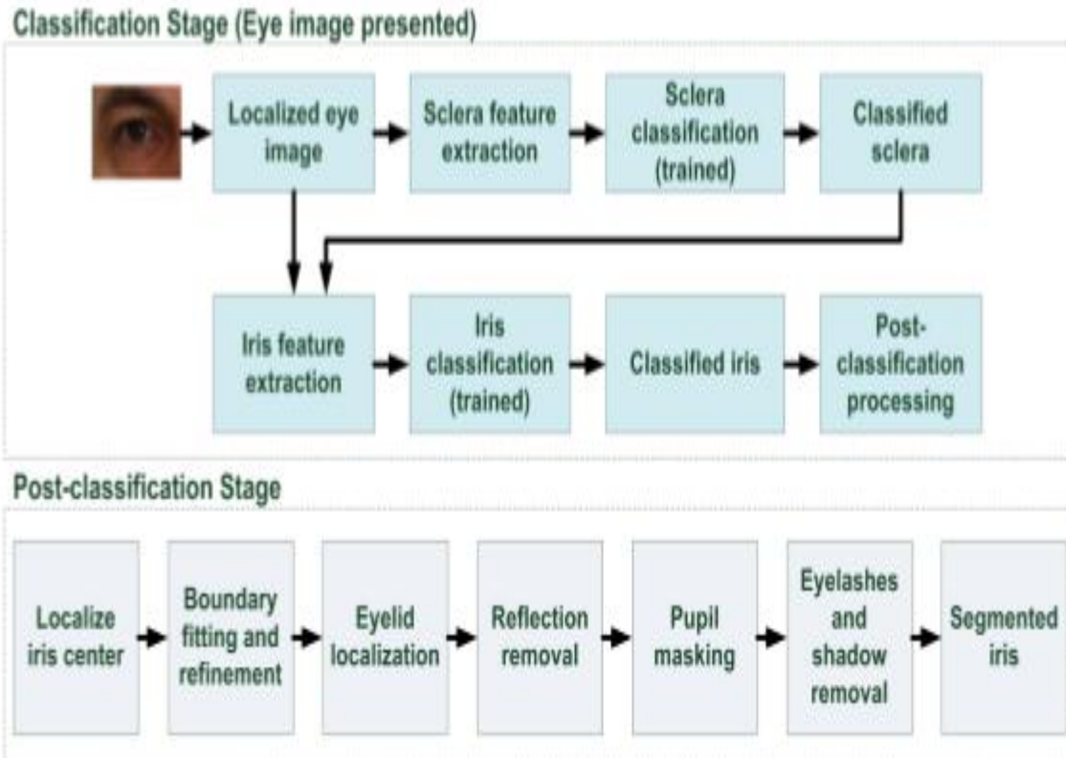


Figure 2.5 : block diagram for proposed iris segmentation method.

I. Segmentation Error

For nonideal and irregular iris images are causes segmentation errors,In nonideal cases, eyelids and eyelashes may be present as noise and decrease the recognition performance, researchers have recently proposed segmentation algorithms that combine conventional intensity techniques with active contours for pupil and iris boundary detection[18].

II. Iris Segmentation Algorithms

Processing non ideal iris images is a challenging task because the iris and the pupil are noncircular, and the shape varies depending on how the image is captured. The first step in iris segmentation is the detection of pupil and iris boundaries from the input eye image and unwrapping the extracted iris into a rectangular form [18].

Modern iris recognition algorithms operate on normalized representations of the iris texture obtained by mapping the area between inner and outer iris boundaries[19].It is reported that most failures to match in iris recognition system result from inaccurate iris segmentation, specular reflections are a major cause of errors in iris recognition systems because of the fact that the affected iris pixels cannot be used for recognition. In this case, these bright spots are a cause of segmentation error as high texture values are assigned to the pixels surrounding these points which are in turn segmented as eyelashes[20].

III Iris Segmentation Under Less-Constrained Imaging

This approach assumes that each of the eye images may be acquired under a relaxed imaging environment, i.e., at-a-distance and under variable spectrum bands, the next framework explained this approach Pre-processing Under less-constrained imaging, several factors such as varying illumination intensity and the angle of the illumination source can have adverse impact on the accuracy and quality of iris segmentation [13].

2.1.3 Artificial Neural Network

Work on artificial neural networks, commonly referred to as "neural networks "has been motivated right from its inception by the recognition that human brain computes in an entirely different way from the conventional digital computer. An artificial neural network, which is the formal name for the term neural networks used here, is one of many attempts to build an intelligent machine or to create artificial intelligence. It is based on biological neural networks. The basic idea to model this is to make a very simplified model of biological neurons and their synapses[22]. The novelty of Artificial Neural Network (ANN) theory could undoubtedly be attributed to the experiment performed by "McCulloh" and "Pitts" in modeling bio-systems using nets of simple logical operations back in 1943.The idea was to find a simple parametric nonlinear model for a real neuron. Ever since this innovation, there has been a great interest from various researchers and scientists, thus several ANN-based models in different fields were discovered. The technology though had lost its momentum in the late 1969 till 1986 when the back-propagation of error was discovered. To date, ANN-based models have been successfully implemented in a number of industries ranging from: Aerospace, automotive, defense, electronics, entertainment, financial and so on. Artificial neural Networks have been also successfully applied in medical fields[23].ANN is a part and parcel of intelligent based systems, designed distinctively to improve the performance of conventional computing techniques. The biggest drawback associated with the so called conventional methods is the inability to learn and identify patterns in dynamic systems. Thus the need to eliminate this shortcoming through learning is proven essential. Artificial Neural Network is an information processing paradigm inspired by the way biological nervous systems, such as the brain, process information. The human brain has 100 billion biological neurons with about 100 000 connections per neuron. A simplified biological neuron is illustrated in Figure 2.6:

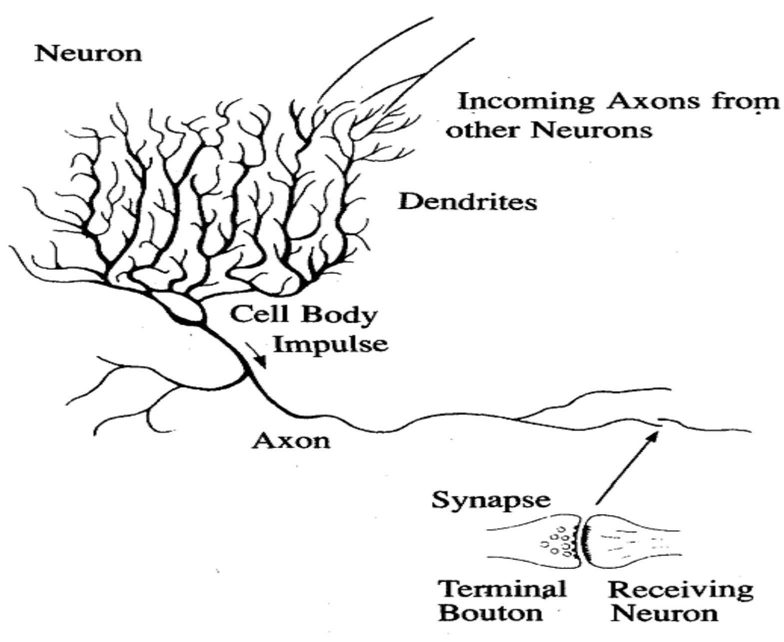


Figure 2.6: A biological neuron.

Biological neurons receive spikes through synapses located on the dendrites of the neuron. When the spikes received are strong enough and exceed a definite threshold, the neuron is activated and fires a signal though the axon. This signal travels from the body, down the axon, to the next neuron(s). Learning arises by adjusting the effectiveness of the input

(synapses) so that it influences one neuron on other changes. Humans and highly trained animals use the same configuration and summing up to extremely complex networks [22].Similarly, an artificial network is made up of simple interconnected processing elements called neurons. The neurons are arranged in a layered structure to complete a network competent of executing parallel and distributed computations. Architecture of a simple ANN is shown in Figure6. The attraction of ANN-based models comes with the network's ability to learn, recognize data patterns, and adapt to a changing environment like the human brain. This adaptive characteristic is often called "the human-like reasoning".

The architecture illustrated in Figure6, presents a three layered feed-forward network. ANN has a remarkable capability to develop sense from convoluted or imprecise data, extract patterns and detect trends that are too complex often only noticeable by either humans or other computer techniques. In broad terms, ANN-based models offer a variety of benefits namely: adaptive learning, self organization, real time operation, fault tolerance via redundant information coding. Thus neural network processes information in the similar way the human brain does[22].The neurons are organized in a way that defines the network structure. The most concerned structure is the multilayer perceptron (MLP) type, in which the neurons are organized in layers. The neurons in each layer may share the same inputs, but are not connected to each other. If the architecture is feed-forward, the outputs of one layer are used as the inputs to the following layer. The layers between the input neurons and the output layer are called the hidden layer as shown in figure 2.7:

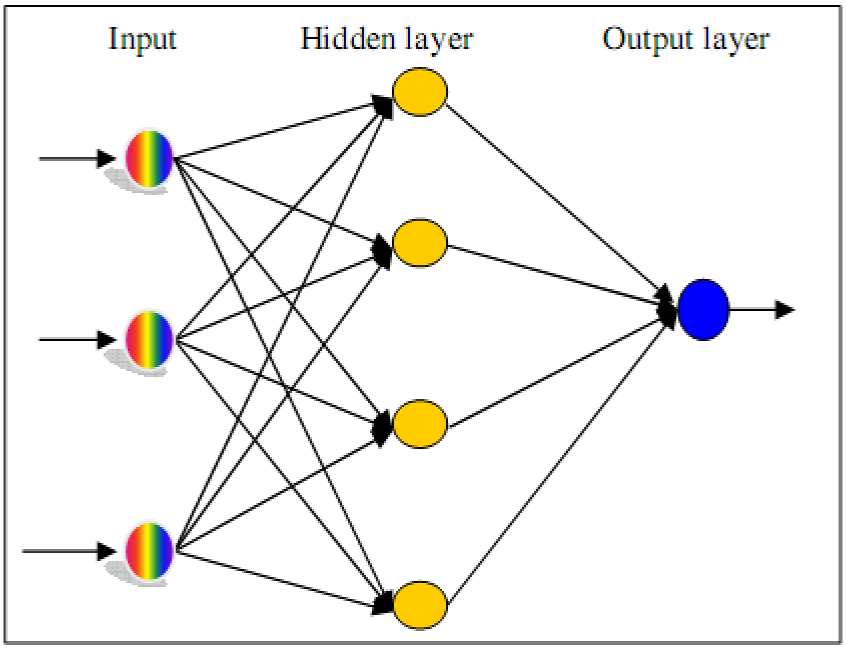


Figure 2.7: Architecture structure of a feed forward neural network

2.1.3.1 Basic Architecture of a Feed-forward Network

The feed-forward network topology illustrated in Figure6 permits signals to travel one way only, from the input through the hidden layer to the output layer. These types of networks are somehow straight forward and associate inputs with outputs. They are extensively used in pattern recognition. This kind of organization is also referred to as bottom-up or top-down and commonly used in pattern recognition. Figure 4.2 also shows the commonest type of artificial neural network which consists of two layers. The hidden layer neurons are connected to the output layer neurons. The functions of each layer in the network are defined below:

a)The input layer neurons represent the pre-processed data fed into the network. b) The input of each hidden layer neuron is defined by the sum of the input vector set and the connection weights between the input layer and hidden layer. c) The input of the output neuron is determined by the weighted sum of outputs of the hidden layer neurons. d) The output of a neuron is defined by the type of the transfer function used in that specific layer. This type of network is attractive because the hidden neurons are free to develop their individual representations from the input set.

2.1.3.2 The Perceptron – A Network for Decision Making

The perceptron, a basic neuron, invented by Rosenblatt in 1957 at the Cornell Aeronautical Laboratory in an attempt to understand human memory, learning, and cognitive processes prior to his demonstration on the first machine that could "learn" to recognize and identify optical patterns in the early 1960. The mathematical model of the perceptron or artificial neuron is modeled in the similar manner of the biological architectural set-up. Again, the three major components are considered:

Axons and synapses of the neuron are modeled as inputs and weights respectively. The strength of the connection between an input and a neuron is denoted by the value of the weight. The mathematical model of this topology is illustrated in Figure 2.8. The weighted inputs are added together and passed through a nonlinear activation transfer function. Finally, the activation function controls the amplitude of the output of the neuron. The suitable scale of output is usually between 0 and 1, or -1 and 1.

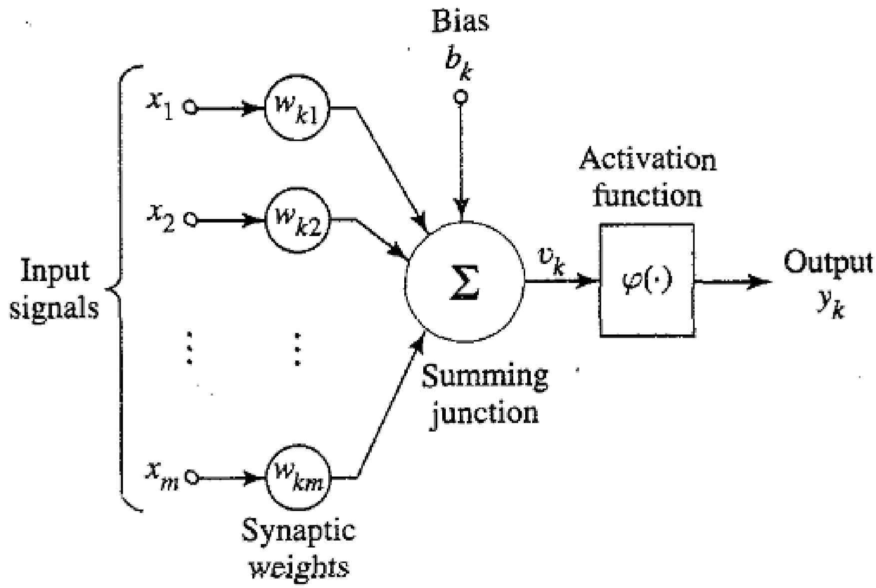


Figure 2.8: A perceptron model

2.1.3.3 Feed Forward Network

In a MLP feed-forward network, connections are unidirectional and no loops are introduced in the network, thus each neuron is linked only to neurons in the next layer, a feed-forward network is referred to as a directed cyclic graph[23] . This implies no backward links either.The importance of loopless networks is that computation can proceed uniformly from input neurons to output neurons. And since there are no backward links, activation functions from the preceding time step play no role in the computation. Figure 2.8 shows a simple multi-layered feed-forward network topology. In Figure 2.8 , only one output layer neuron is considered and. In some approximation problems, the number of output neurons equals to the number of outputs. Each layer has a specified number of nodes; the interconnections are only between neurons of adjacent layers, and each neuron belonging to a layer is connected to all the neurons of adjacent layers. Note that ANN may contain more than one hidden layer; the number of neuron in each layer should be carefully selected depending on the application requirements. Isolated in figure2.9:

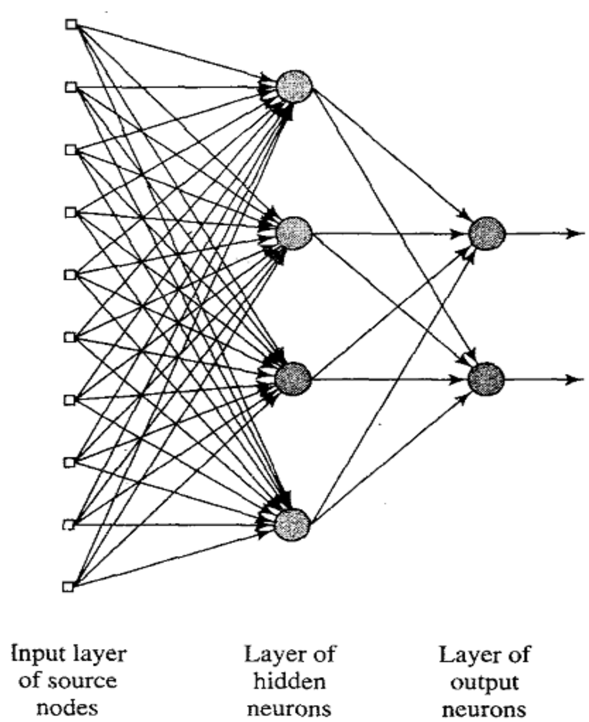


Figure 2.9: A fully connected feed-forward network with one hidden layer and one output layer.

2.1.3.4 ANN Training and Generalization

There are various processes involved in developing a supervised ANN-based model. Amongst others, training process and validation process are some of the vital steps. The input-output patterns are repeatedly presented to the network during the training process. Through this process, the network learns the subjected environment or patterns, and eventually yields the desired output. The desired output is attained as a result of adjusting weights of all interconnections between neurons to establish the correct set of input-output response. However, during the training process, optimal training time is required to avoid overtraining. Overtraining of the network can be prevented by employing complex stopping criterion. Early stopping (the most common), regularization, pruning, Information Criterion Pruning (ICP), Cross-Validation Pruning (CVP) are some of the stopping methods[23].

Training the network at infinitum normally results in a reduced error function for a given set of inputs. Though, this does not guarantee better accuracy and robustness of the network because the error could be extremely big if the network is presented with the data it has not seen before. This characteristic is explored during the validation process. Moreover, the validation process also improves the network reliability and generalization.

2.1.3.5 Network Coupled Errors

Broadly speaking, there exist two types of errors during the training process: training error and generalization error. The general error presentation can be seen in Figure 2.10. At the beginning of the training, the training error is at maximum, and gradually decreases as time elapses. Optimum training time should be within the circled area in order to maintain network generalization tendency. In essence, the desired goal should not be an error-free output, as the network will tend to memorize the input-output patterns if trained at infinitum.

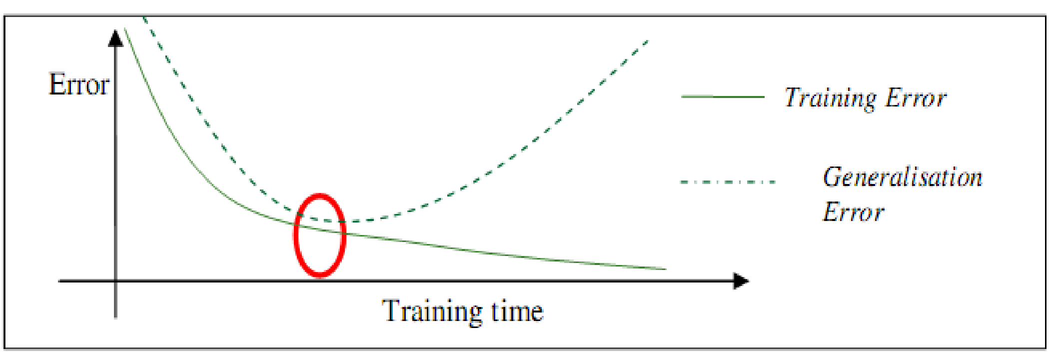


Figure 2.10: : Errors vs. Optimal network training time

2.1.3.6 ANN Learning Paradigms

Like in any other intelligent based systems, a desired output of the network does not come by chance. The network rather adapts itself to a stimulus, and ultimately yields the desired output. The main difference here perhaps could be featured to the type of learning a particular network is subjected to. Broadly speaking, there are different learning paradigms that can be used to train neural networks. Supervised and unsupervised learning are the most common, with reinforced and competitive learning techniques also gaining considerable popularities. The learning process is essential to adjust network weights in order to reduce the error. During the process of adapting and adjusting the synaptic weights, the network acquires knowledge similar to human-like reasoning. However, the learning process requires sets of mathematical algorithms describing how synoptic network weights and biases are attuned.

2.1.3.7 Supervised Learning:

This is a type of training approach where the input and the desired output are clearly specified. Suppose, the input vector is represented by [$x_1 , \dots, x_m$] and the corresponding output vector is denoted by [$y_1 , \dots, y_m$], an optimal rule is to be determined .

The idea is that the network adjusts its weights as an attempt to minimize the approximation error preferably to the smallest value possible, and thereafter the network returns a trial result. This result is then compared to the desired output. Figure 2.11 illustrates a basic network structure for a supervised ANN model. Here the error function is feed back into the system as an attempt to find a correct set of input vectors. If the desired threshold is not attained, another update of the network weight vectors could be initiated. In dynamic systems especially, the need for a network to map the nonlinear relationship between inputs and outputs is enormous, thus this approach is commonly employed in ANN based models. Some of the key measures to evaluate a supervised learning session are: time required per iteration, number of iterations per unit pattern, convergence points i.e. local or global minima(s) …etc.

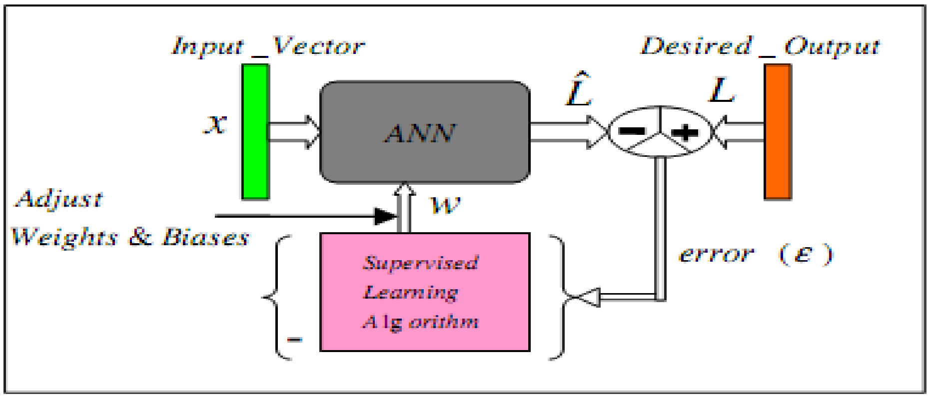


Figure 2.11: basic layout for a supervised learning paradigm using error correction technique

The NNs were trained using different training algorithms belonging to two back-propagation classes described as follows:

I. Back propagation

The back propagation algorithm looks for the minimum value of error function in weight spae using a technique called the delta rule or gradient descent. The weights that minimize the error function is then considered to be a solution to the learning problem, back propagation is a supervised learning algorithm for training multi-layer perceptrons (artificial neural networks)[24]. BP methods is training multilayer neural network . a back propagation algorithm trains a feed forward network. In the training process, the back propagation algorithm learns associations between a specified set of input-output pairs. The back propagation training algorithm acts as follows: first , it propagates the input values forward to a hidden layer, and then, it propagates the sensitivities back in order to make the error smaller; at the end of the process, it updates the weights. The mathematical frame of the back propagation algorithm can be seen in several studies suchas“TrainingFeedforwardNetworkswiththeMarquardtAlgorithm”[27].

feed-forward back-propagation network is created using new function. User needs to provide input argument such as input and output data, hidden layer and node size, node activation function, networks training algorithm and etc[25].

II. Baysian Regularization

Can apply this process to neural networks and come up with the probability distribution over the network weights ,w, given the training data, p(w| D). BR and LM have better performance than the conventional methods in terms of both speed and the over fitting problem, BR has an objective function that includes a residual sum of squares and the sum of squared weights to minimize estimation errors and to achieve a good generalized model [27].

2.2 Related Work

In [26] Devesh Batra compare between levenberg and scaled conjugate gradient and find the Levenberg Marquardt algorithm has shown slightly better performance in terms of accuracy squared error), whereas the Scaled Conjugate Gradient algorithm faired better in terms of speed (as found in the average training iteration) on a simple MLP structure (2 hidden layers).

In [28] Dr. Md. Ali Hossain , Abdul Matin ,Md. Tanvir Ahmed and Md. Sabbir Ejaz are compared between three algorithms (k-mean, PAM and CLARA) they found CLARA algorithm is the best because it can be used to deal with larger data sets.

In [30] Mayank Vatsa ,Richa Singh and P.Gupta are compared between four algorithms (Avira, Li Ma, Tisse and Daugman) they found daugman algorithm is best because gave maximum accuracy among the for .

In [29] Jennifer Webb , Delores M.Etter, Fellow, IEEE, Vianka Barboza and Elena Sharp used images with high quality provided segmentation and template algorithms to examine how images taken with different illumination compare with each other and found difference in illumination causes decrease match score.

In [31] Sheela Tiwari, Ram Naresh and Rameshwar Jha compare between LM and BR ,they found average time and standard deviation in LM is lower than in BR.

Chapter Three
System Model and Design

Chapter Three

System Model and Design

3.1 Overview

In this chapter the design of Iris recognition system will be performed. The chapter will also explain the image processing and neural network. Image processing will show you how to extract the images and which technique is used for the extraction of the images. And Neural Network is used for the identification of the iris images. For iris recognition k-means and Back Propagation Neural Network techniques are used.

3.2 System Design Requirements

System requirements are extracted from the previous theoretical principles. They will be detailed in the next chapter for the practical work software as leading to the best results in analysis. A digital image captured by camera having an eye in Three-Dimensional (3D) matrix RGB image must be divided into an intensity image for dealing with 2D matrix image and the binary image will be used for pupil darkness density extraction. A convolution is important for each image filter type performed, where an un sharp filter will be used for producing heavy sharpness image and an average filter performed on iris image for noises extinction. Morphological dilation performed by using square structuring element shape into reaching a reference point for iris image extraction and disk structuring element shape for iris image contrast enhancement. Histogram equalization is very effective in image detail enhancement.

In identification, a neural network and BPNN are used each one alone. A linear activation function used in the network and a tan-sigmoid activation functions with momentum technique are used in BPNN. The comparisons between the two methods will be illustrated in chapter 5. Figure 3.1 shows an iris recognition system design model.

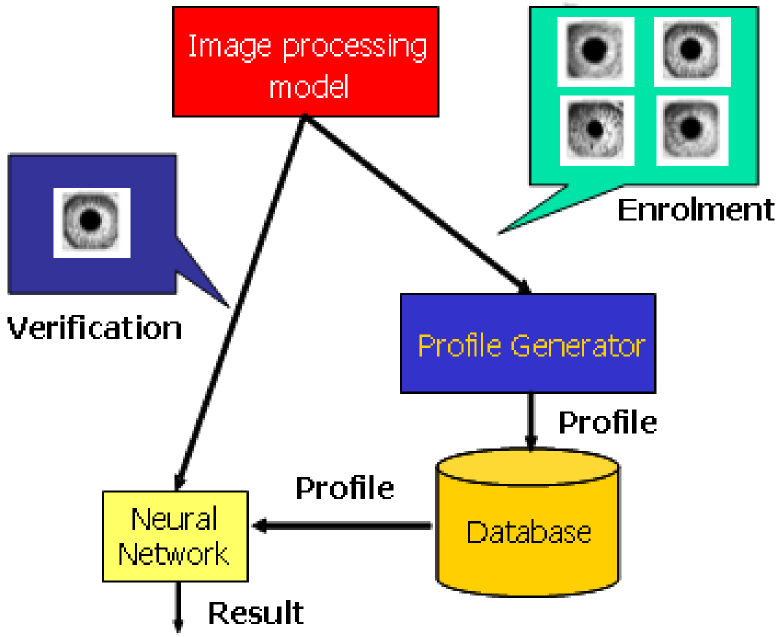


Figure 3.1: on-line iris recognition system model

3.3 Image processing

The acquired image always contains not only the ‘useful’ parts (iris), but also some ‘irrelevant’ parts (e.g. eyelid, pupil etc.). Besides, under some conditions, the brightness is not uniformly distributed. For the purpose of analysis, the captured image needs to be preprocessed [2]. To capture the rich details of iris patterns, an imaging system should resolve a minimum of 50 pixels in iris radius [11]. This chapter explains the steps of image preprocessing starting from data acquisition which consists of sharpened image and converting to an intensity image, after that image localization which consists of histogram equalization image, low pass filtered image, converting to a binary image, morphological dilation process and extracting the iris image, then image enhancement which consists of average filtered image, enhancement contrast filtered image and histogram equalization image. Finally image segmentation for data pattern extraction. Figure 3.2 shows the block diagram of these steps which is adopted in processing the eye image.

3.4 Overall Proposed Architecture

Proposed architecture described with a block diagram Figure 3.2and the details of each block are elaborated below.

- Pre-Processing
- Initial Segmentation
- Feature Extraction
- Region Refinement through Neural Network
- Identification
- Classification

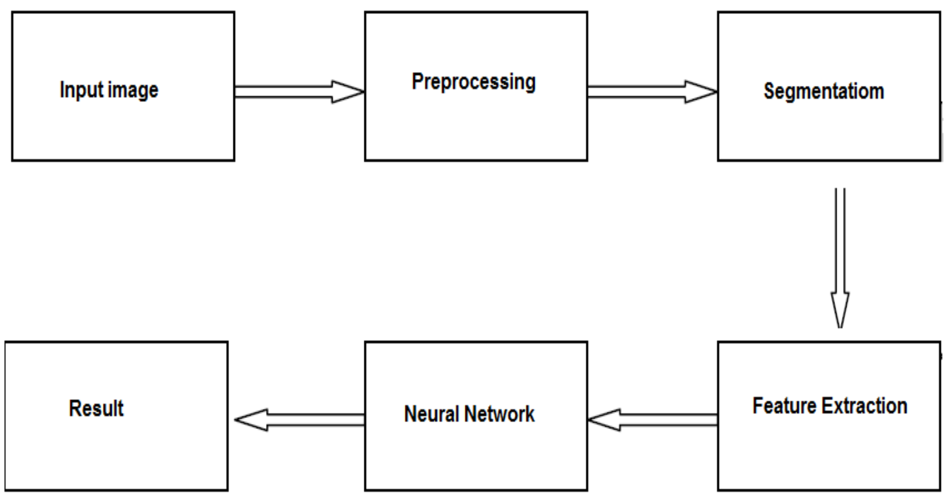


Figure 3.2 Block diagram of the architecture

3.5.1Pre – Processing

The first block pre-processes the input images by artifact reduction and enhancement. The main purpose of this step is to remove the undesirable parts, enhances the image, corrects the image skew and removes noise from the image.

3.5.2 Segmentation

Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. There are many different ways to perform image segmentation. We have used transform method of segmentation.

3.5.3 Feature Extraction

In the classical pattern recognition and image processing, feature extraction is a special form of dimensionality reduction for any kind of identification or classification task. To classify an object adequately and distinctively texture features must be extracted out of any images. Determining the eminent and important features of image data is very crucial. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called feature extraction.

There are several techniques available to extract features from images. Some of the commonly used methods are as below.

1. Spatial features
2. Transform features
3. Edges & boundaries
4. Shape features
5. Moments
6. Textures

Here texture extraction method is used. Texture is a combination of repeated patterns with a regular frequency. In visual interpretation texture has several types, for example, smooth, fine, coarse etc. Texture analysis is defined as the classification or segmentation of textural features with respect to the shape of a small element, density and direction of regularity. Texture analysis approaches are categorized into four types i.e. Structural, Statistical, Model based and Transform. From these approaches statistical method has been used here. This approach i.e. machine learning is the most widely used and more generally applied method because of its high accuracy and less computation time. Texture statistics is frequently classified into first-order, second-order and high order statistics. We have used GLCM and Wavelet methods for texture analysis.

3.5.4 Classification through Neural Network

Artificial Neural Network has been used as the classifiers as most of the existing studies mentioned it as a best performing one.

3.6 System Flow Chart

The flow chart of the system is shown in figure 3.3. The process starts by entering image from data base to start training phase, after this phase the captured image is preprocessed, and then segmented to extract its features. A 13 features are extracted and fed into the neural network to make the classification.

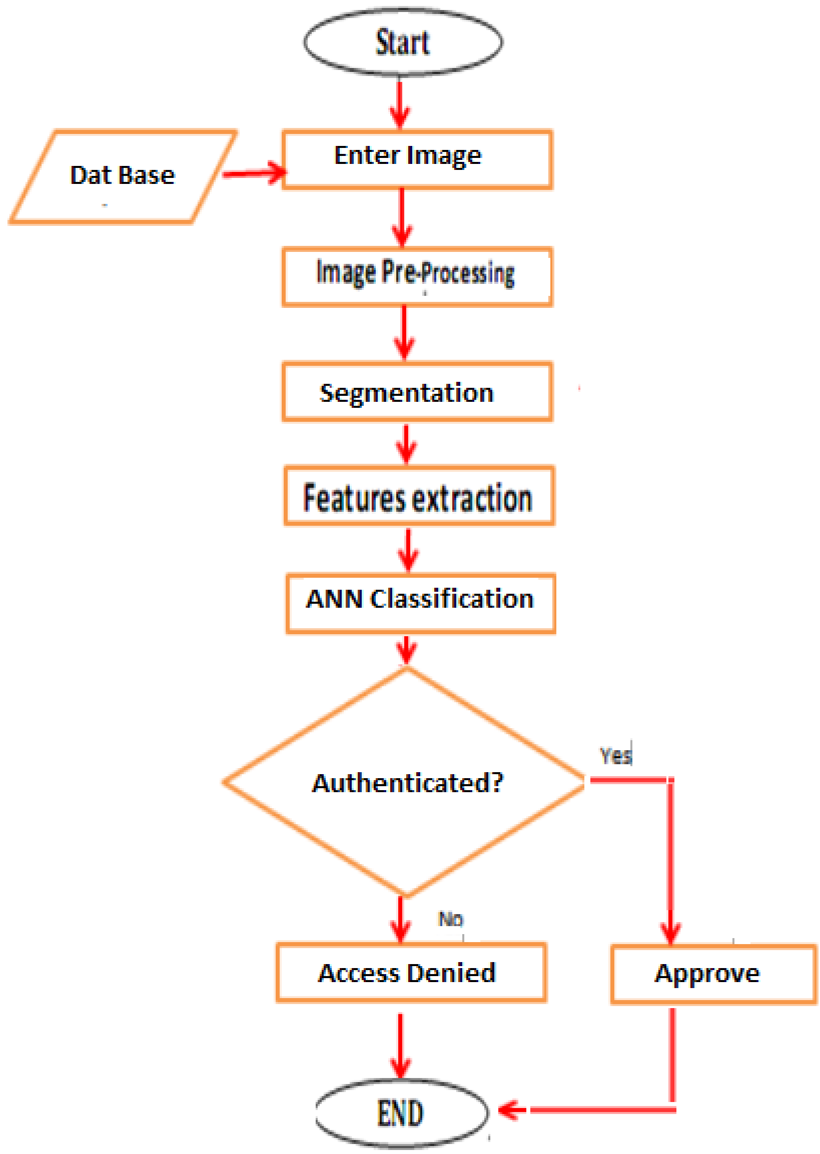


Figure 3.3 Flow chart of the architecture

3.7 BPNN Suggested Topology

The BPNN which is suggested in figure .3.4 has thirteen nodes in the input layer, ten nodes in the hidden layer and one node in the output layer. This topology requires hidden units ranging from 1 to 20, the more hidden units the better results but complex computation. The activation functions used are tan-sigmoid activation functions for the whole neurons on the hidden and linear function for output layer. And momentum technology is used to speed up convergence. As mentioned previously, image segmented into matrixes and the standard deviation (STD) and pther features are calculated for each segment.

These values flow parallel to the input layer for training. The calculated weights (including biases) are stored in the database file and become the comparison base to detect any other iris image. Every iris image to be tested enters the network in the same way, the output values will be compared with the outputs of the original image. Then the error will be compared with tolerance value, and this is the least value of any tested image. Because as much as the error value is less, more accurately the image is recognized properly.

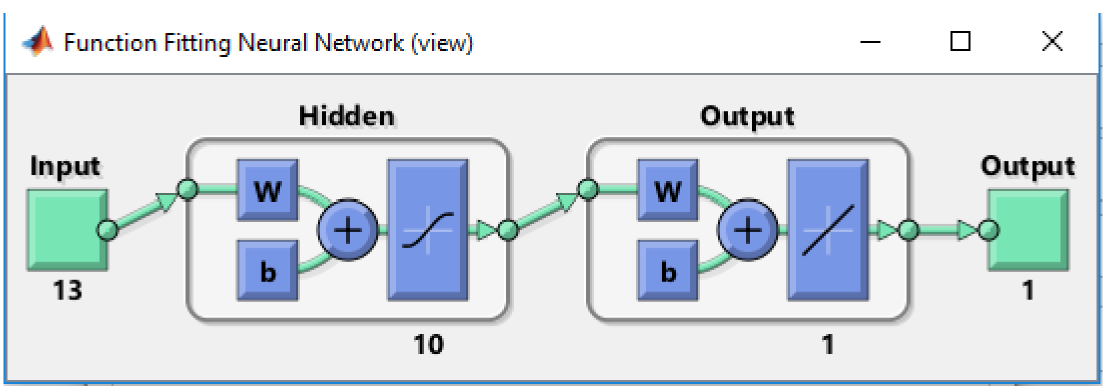
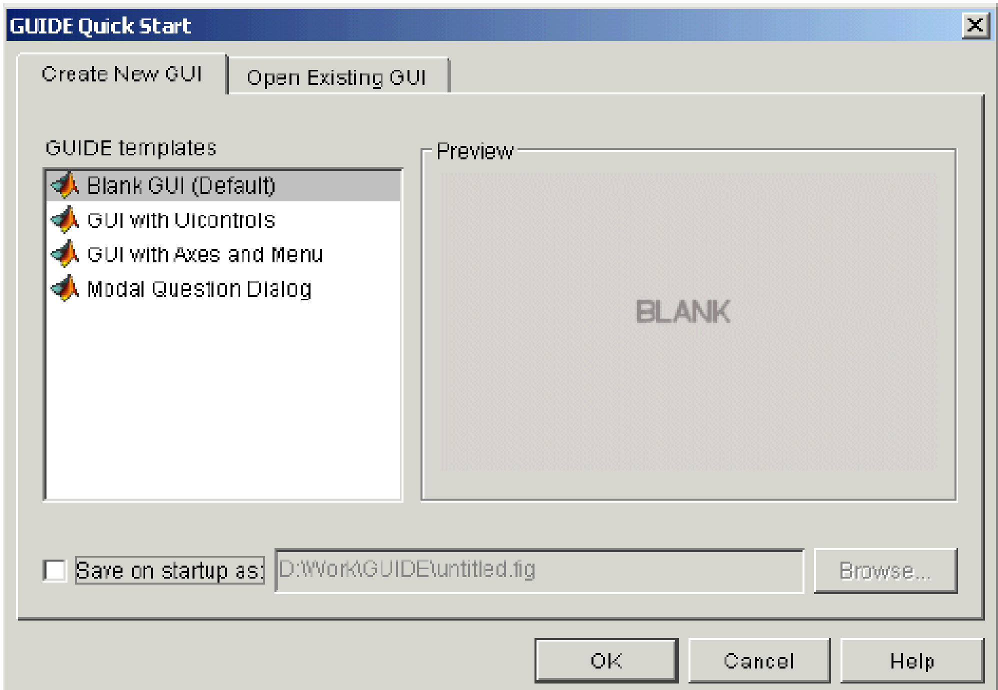


Figure 3.4: BPN suggested design

3.8 Graphical User Interface Design

To start GUIDE, enter guide at the MATLAB prompt. This displays the GUIDE Quick Start dialog, as shown in the following figure.



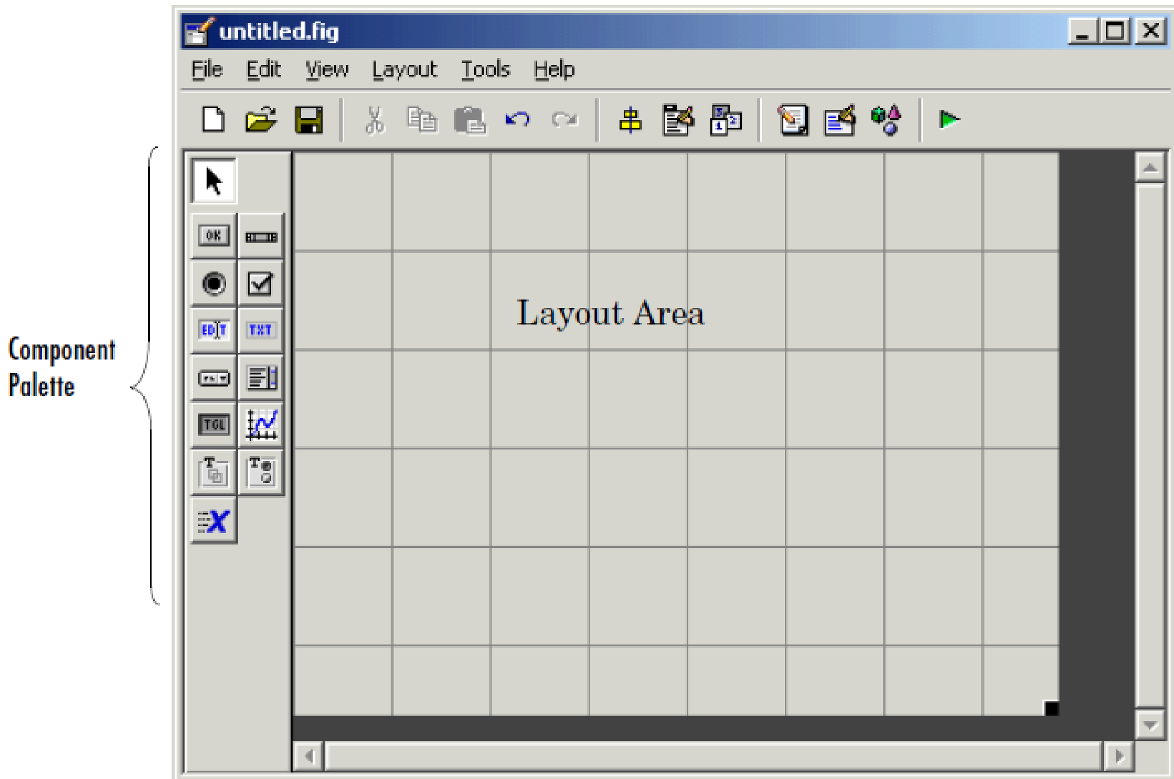
From the Quick Start dialog, we can

•Create a new GUI from one of the GUIDE templates — prebuilt GUIs that you can modify for your own purposes.

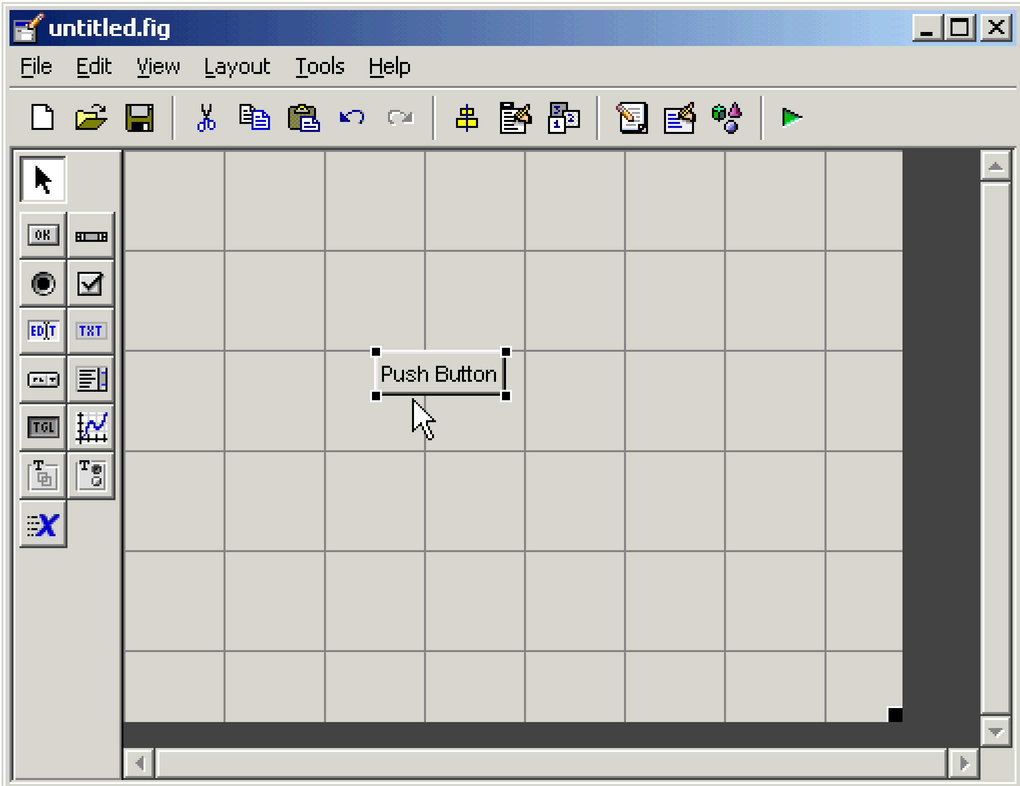
•Open an existing GUI.

Once you have selected one of these options, clicking **OK** opens the GUI in the Layout Editor.

When we open a GUI in GUIDE, it is displayed in the Layout Editor, which is the control panel for all of the GUIDE tools. The following figure shows the Layout Editor with a blank GUI template.

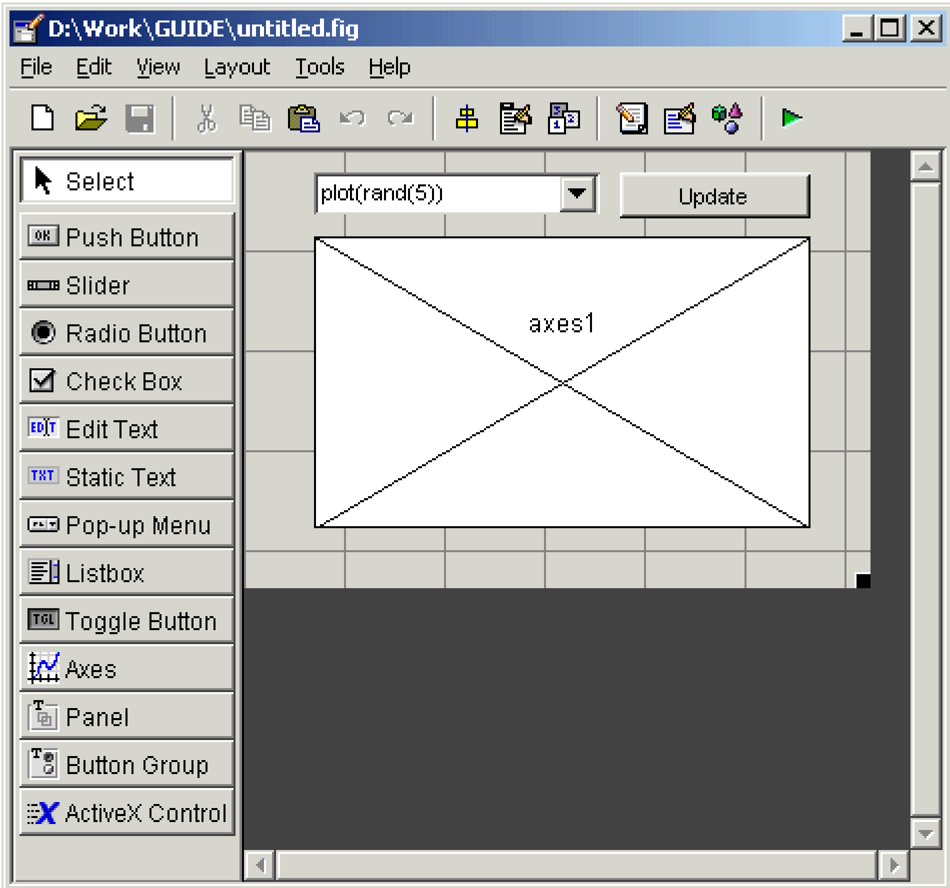


We can lay out GUI by dragging components, such as push buttons, pop-up menus, or axes, from the component palette, at the left side of the Layout Editor, into the layout area. For example, if we drag a push button into the layout area, it appears as in the following figure.



we can also use the Layout Editor to set basic properties of the GUI components.

To display the names of the GUI components in the component palette, select **Preferences** from the **File** menu, check the box next to **Show names in component palette**, and click **OK**.



GUIDE stores a GUI in two files, which are generated the first time we save or run the GUI:

•A FIG-file, with extension .fig, which contains a complete description of the GUI layout and the components of the GUI: push buttons, menus, axes, and so on.

•An M-file, with extension .m, which contains the code that controls the GUI, including the callbacks for its components.

These two files correspond to the tasks of laying out and programming the GUI. When you lay out of the GUI in the Layout Editor, your work is stored in the FIG-file. When you program the GUI, your work is stored in the M-file. After laying out your GUI, you can program the GUI M-file using the M-file editor. GUIDE automatically generates this file from your layout the first time

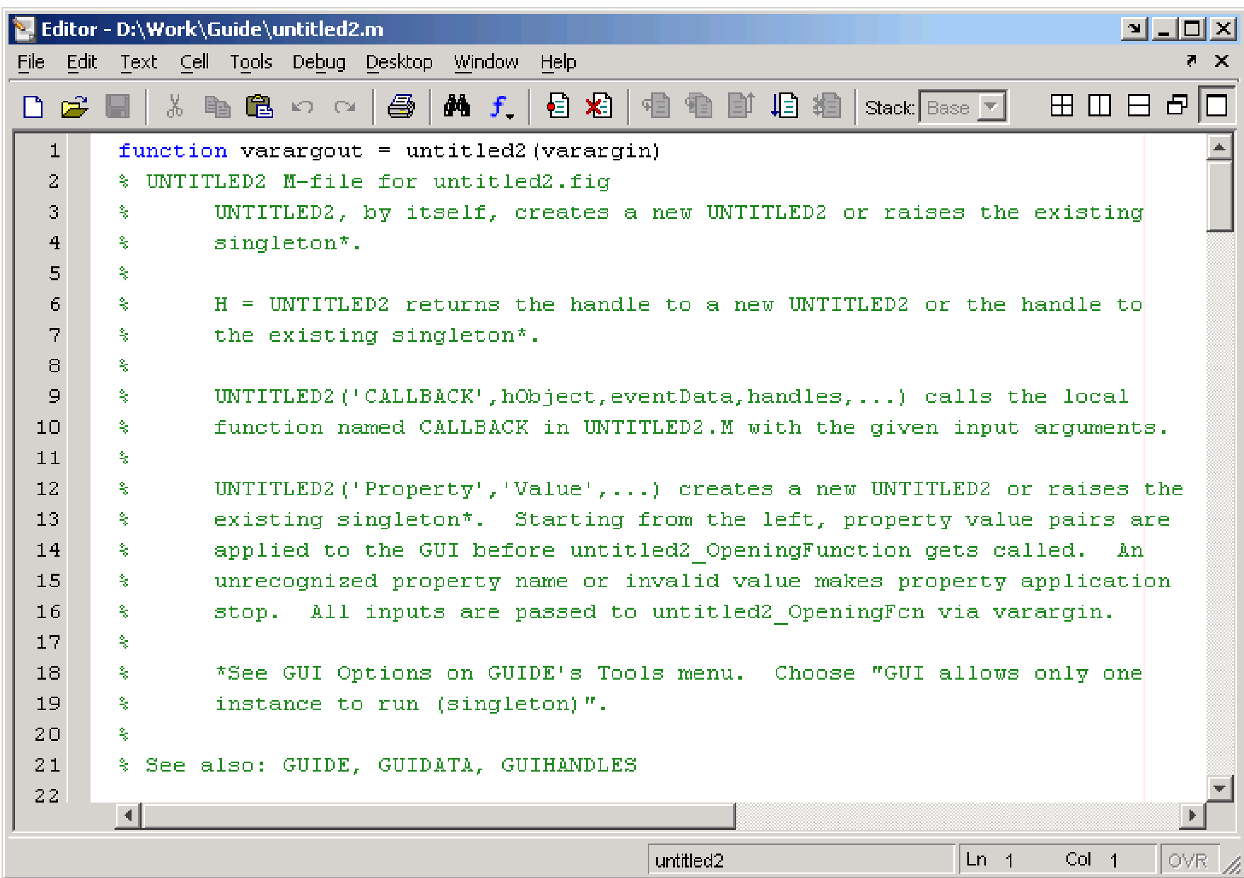
you save or run the GUI. The GUI M-file

•Initializes the GUI

•Contains code to perform tasks before the GUI appears on the screen, such as creating data or graphics

•Contains the callback functions that are executed each time a user clicks a GUI component

Initially, each callback contains just a function definition line. You then use the M-file editor to add code that makes the component function the way you want it to. To open the M-file, click the M-file Editor icon on the Layout Editor toolbar. The following figure shows the M-file for the GUI with Axes and Menu template.



Chapter Four

Results and discussion

Chapter Four
Results and Discussion

4.1 Overview

This chapter describes the system software with reviews to its performance in Simplicity, fast and easy to use. Also, it displays the obtained results of image processing and neural networks with explaining the best way that can be used to have a good compression and less executive error. To make sure that the system efficiency is high, two algorithms are accredited in measurement.

4.2 System Features

The system designed for iris recognition is simple but expensive. It consists of Software program of iris recognition with MATLAB program .Figure 4.1 which exposes the system features. The system consists of three parts, part 1 for data preparation for the training, part 2 for the neural network topology selection, the parameters are: ANN type, number of neurons, number of layers, type of algorithm...etc. The third part is for the main system which simulates the image capturing, image resizing. The whole system is designed using MATLAB environment by typing “guide” in the command window and complete the design interface by using design tools. The code is generated automatically by saving the file.

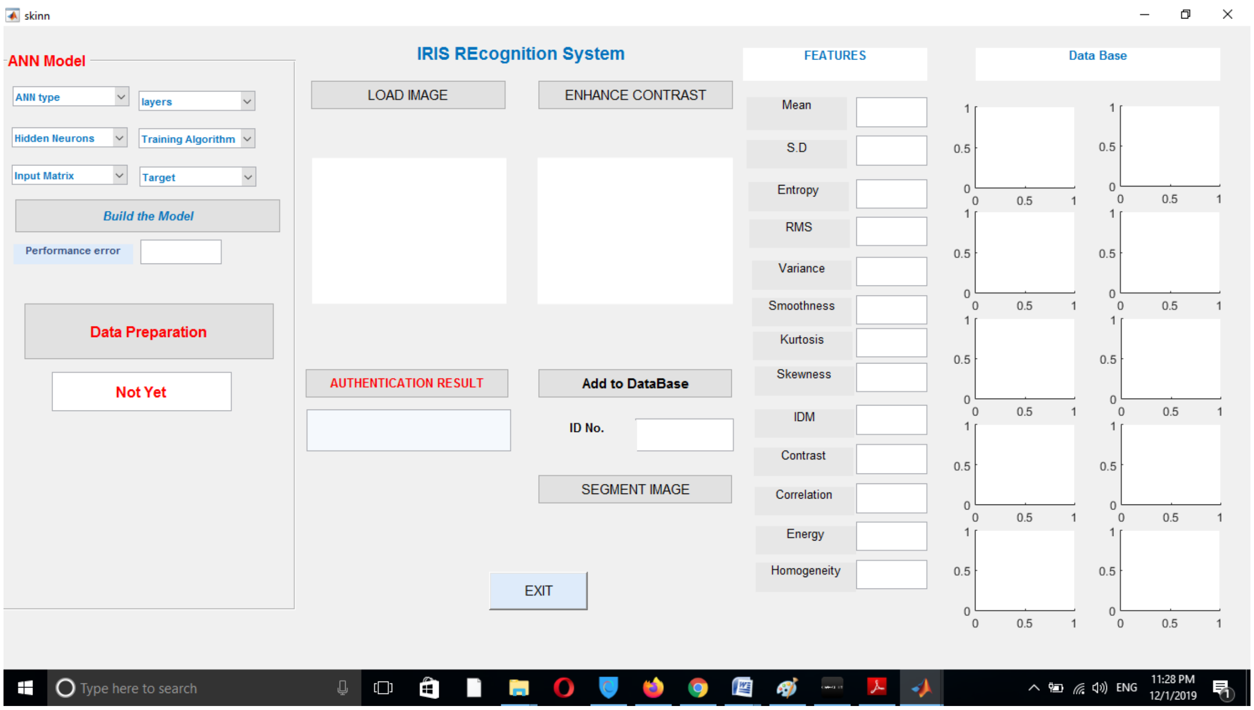


Figure 4.1: System features

As mentioned earlier, the image is offline captured, when pressing a photo captured image icon the software program need to input a name for the image with type JPEG.This system provides authentication and small time recognition of an individual's identity by mathematical analysis for the iris random patterns of an eye. The program execution steps are found in appendix A.

4.3 Image Processing Results

Image processing is a leading part of this work to get an enhancement iris pattern image for data extraction. The results obtained from the applications of image processing techniques on the captured eye image are.

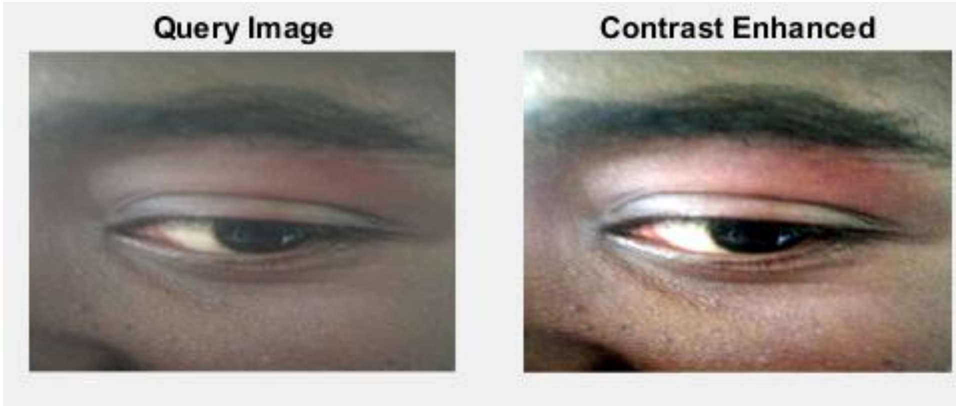


Figure 4.2: Image enhancement

Figure 4.2 Shows the preprocessing step by enhancing the image contras , this is the first step in image preprocessing followed by filtration.

Figure 4.3 shows sample of data base stored in MATLAB environment, the capacity is 10 and this number can be increased depending on the design of the interface. Every user is given an ID number and this ID is appeared when the user is authorized. The images can be replaced in the folder by changing their names, every data base image is defined by “i" and every test image is defined by “t”.

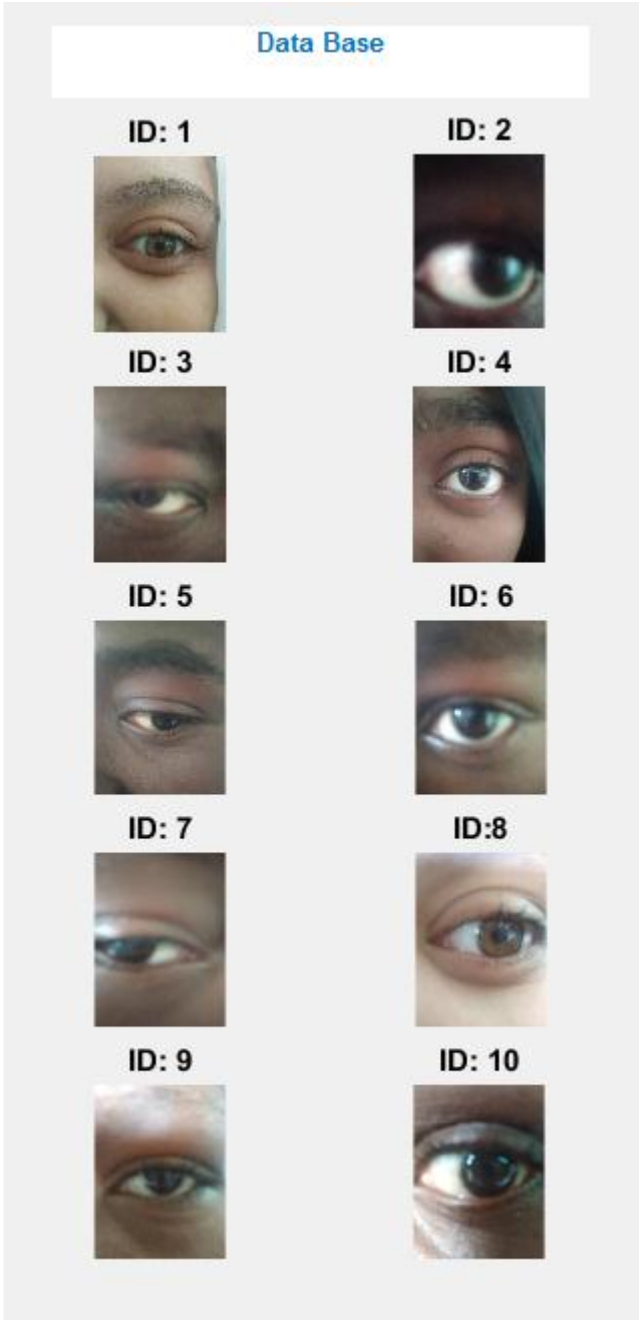


Figure 4.3: System Data Base

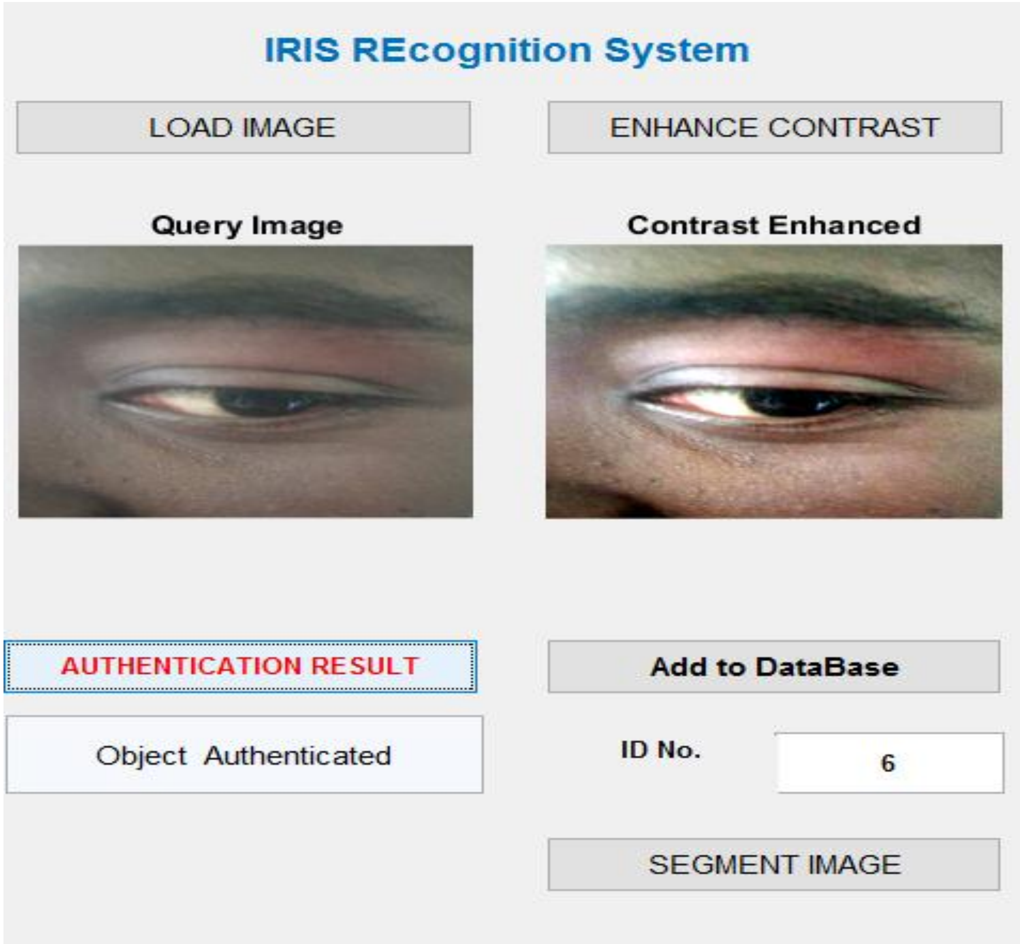


Figure 4.4: Result with successful image

Figure 4.4 shows the results of recognition system for authenticated object where the image is taken from data base and the system is required to know if the object is authenticated or not, the result is "object authenticated" and its correct recognition. The contrast is done by increasing the value of the pixel to enhance energy.

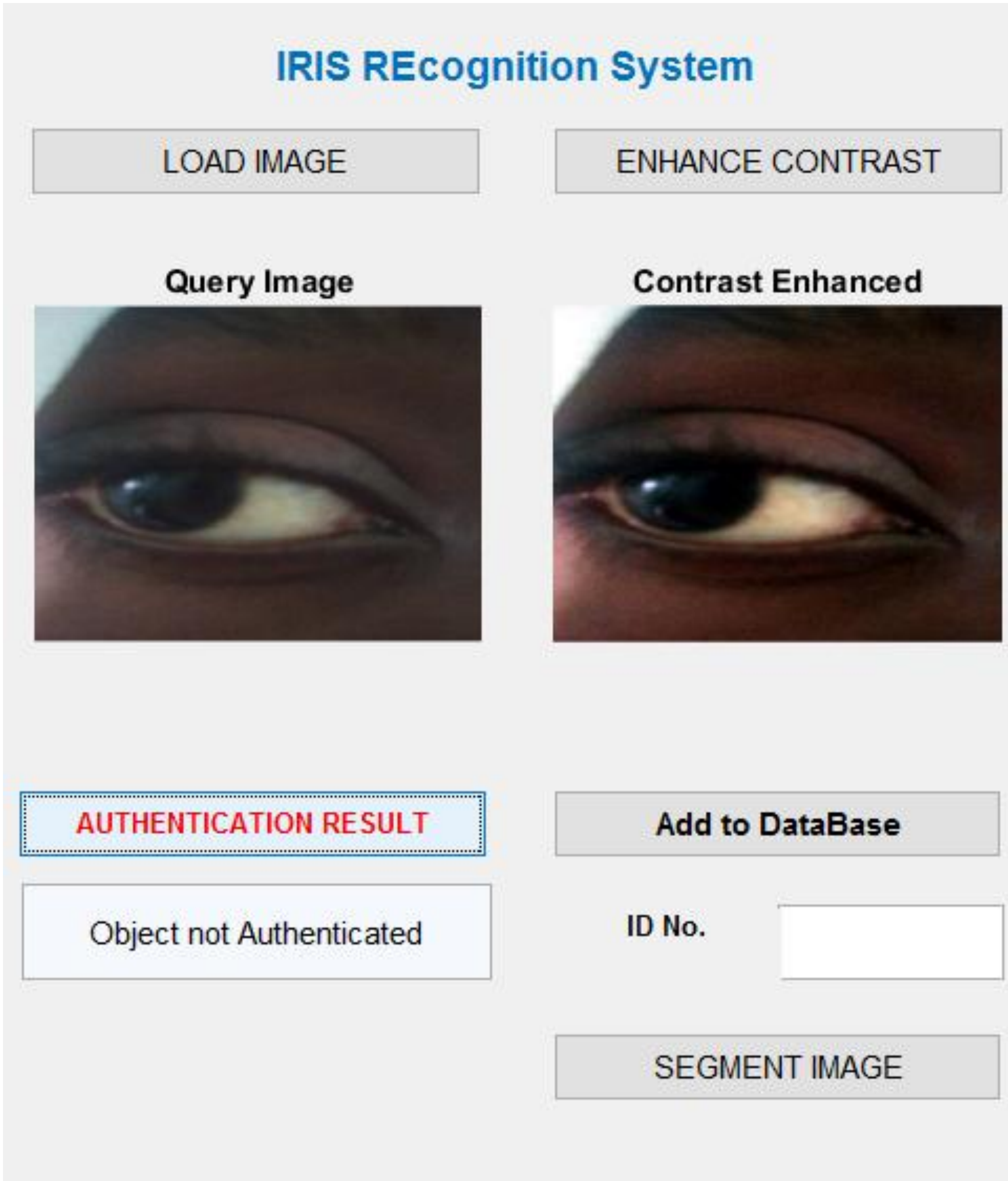


Figure 4.5: Result with unsuccessful image

The second test is done for an object not found in the data base .Figure 4.5 shows the results for unauthenticated object where the image is taken from out data base and the system is required to know if the object is authenticated or not, the result is "object not authenticated" and its also correct recognition.

4.4 Neural Networks Results

Two algorithms for neural network were used for the recognition as explained in Chapter Three.

The number of Iris images used in training for the two types are 117 samples. The input data used for training for each iris segment:

The BPNN topology, as shown in Figure 4.6, is a multiple-layer consisting of 13 nodes for input, 10 nodes for hidden and 1 node for output. It has 130 weights in the hidden layer and 10 weights in the output layer to be stored in the database file. The data input stream is parallel for each iris image. By using this network in the system, an execution time is about 6 seconds or less for iris image training due to the feedback word in BPNN learning algorithm.

4.5 Comparisons

The BPNN with different algorithms topology used in recognition because of its Recognition percentages for the irises tested images, but it needs more execution time for learning. Table 6.1 shows the differences between these two used methods.

Table 4.1: Difference between the two neural networks methods

Comparison subject	Back propagation	Baysian regularization
Network type	Feed forward	Feed forward
Feed forward flow	100 input / 3 hidden / 1 output	100 input / 3 hidden / 1 output
Database stored	130 weights	130 weights
Program generalization time	1sec	15sec
Size of input images	400*400	400*400
Error	0.025872	0.021009

In Back propagation Neural Network we use multi layer network, we have 13 inputs and one output , the recognition rate of BPNN is more than the BRNN for the iris tested images, the size of the images are same in the both networks. BPNN topology used is more accurate than the BRNN network topology used in recognition because of its recognition percentages for the iris tested images, but it need more execution time for learning.

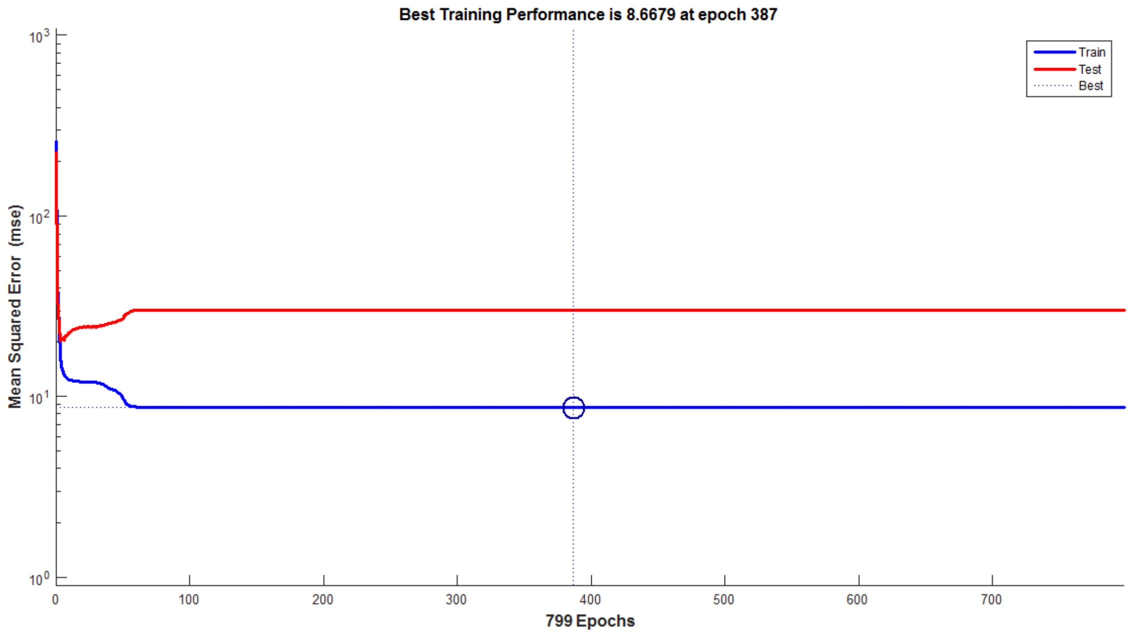


Figure 4.6: Performance of baysian regularization algorithm

The performance of baysian regularization algorithm is show in figure 4.6 the figure shows the convergence of the error with the training time. The error starts from high value and decreases gradually.

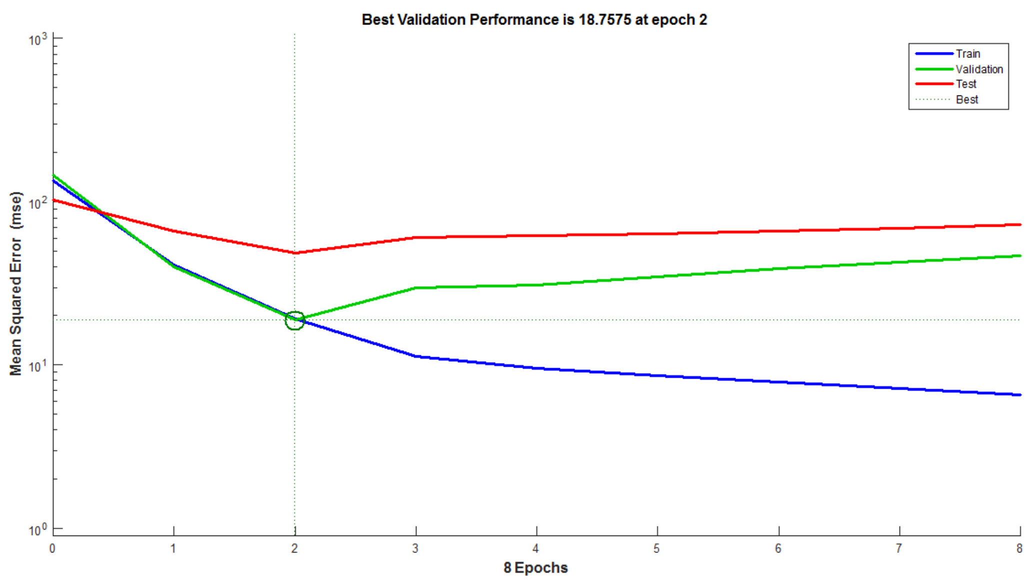


Figure 4.7: Performance of back propagation algorithm

The performance of back propagation algorithm is show in figure 4.7 the figure shows the convergence of the error with the training time. The error starts from high value and decreases gradually.

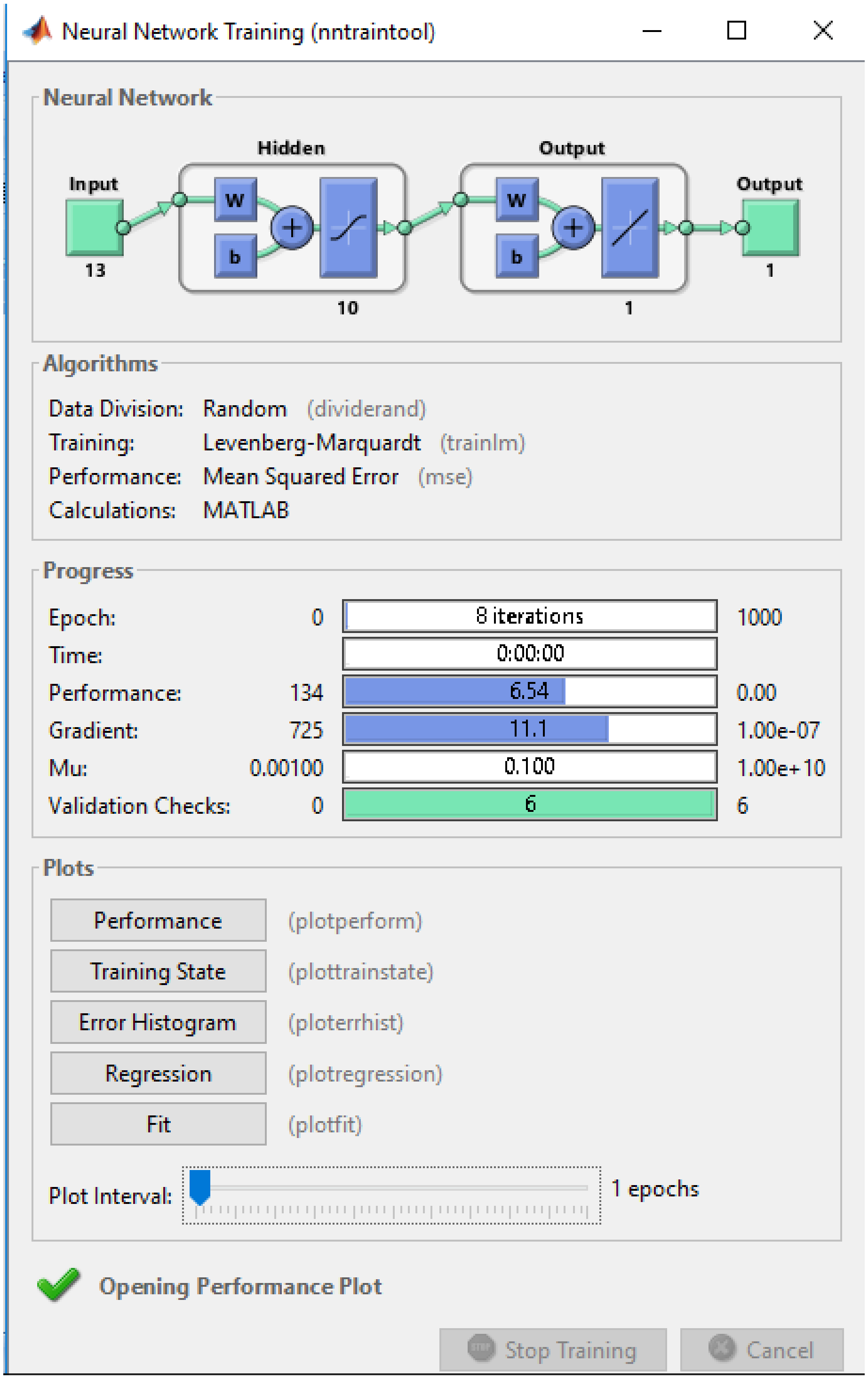


Figure 4.8: ANN training with back propagation

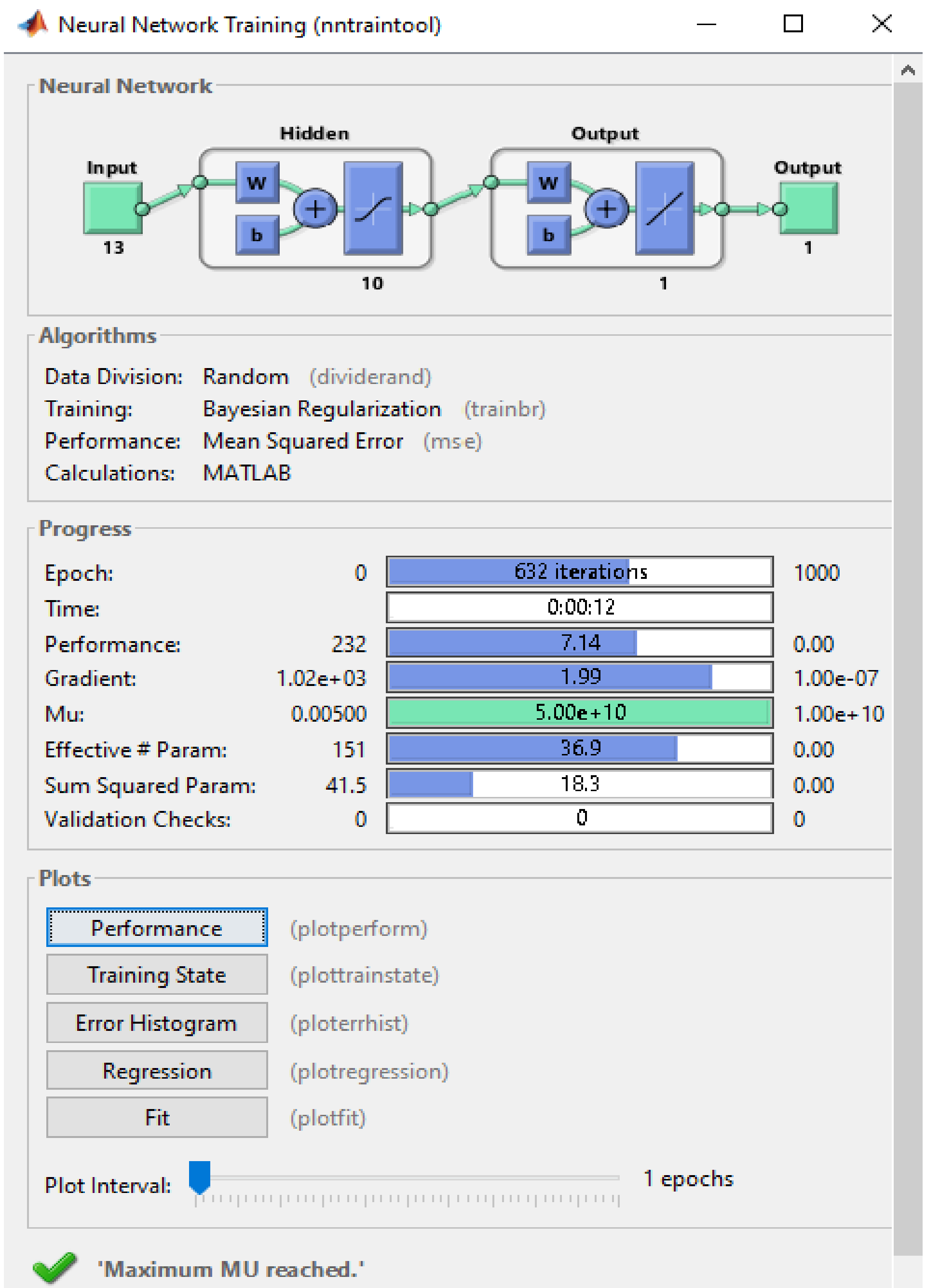


Figure 4.9: ANN training with bysian regularization

Figures 4.8 and 4.9 show the training interface for both algorithms, the figures show different parameters such as training time , number of iterations, performance error and so on . These parameters are used to compare both algorithms to decide which one is better in iris recognition. The comparison is relative , that’s mean every algorithm has its own characteristics and advantages, these advantages are relative to other algorithm.

Chapter five

Conclusion and recommendation

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

In this work, an iris recognition system has been designed and implemented. The system consists of complete GUI system, and of images are taken offline.The software built program consists of two stages, image processing stage for getting an enhancement iris pattern image and neural network stage for recognition by utilizing the data of the iris pattern. The neural network stage consists of two phases: training phase for human iris identifying and testing phase for deciding whether the human iris exists on the database or not.Two methods of neural network have been used in this thesis BRNN method and BPNN method. The latter yielded the best results compared with the other method. Dealing with JPEG type of pictures proved to be successful. Getting the iris location is performed by following the darkness density of pupil. Iris image can be converted to the matrix for GLCM values. Features values attained good results. ANN has fast mathematical methods for identification. Back propagation Neural Network can be used for iris pattern classification. Multiple activation function in Back Propagation has advantages in speed and accuracy. BPNN network is a fast way for identification but it has high rate of percentage error compared with the other employed methods. The iris recognition system designed is general, easy to use, fast and compatible with different computers. The proposed system compared with many other recent researches and this system achieved higher recognition and speed.

5.2 Recommendations

There are some ideas for future work and recommendations to improve this research, the following points display these ideas The system may be interfaced with control system on the organization entrance door. Identification report can be created for each tested person by the system. This report may have: name, job, address, … etc. Multi-online persons recognitions system can be designed. and the iris picture can be captured at suitable distance by using high performance camera .

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