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Biometric Techniques Using Neural Networks

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Abstract: Biometrics is the science and technology of measuring and analysing biological data. The standard method used for personal authentication is password, which is known to a user only. There is no security in the use of password if it is known to an imposter. Hence to overcome these problem passwords replaced with biometric authentication. Biometrics is the most secure and convenient authentication tool till today. Commonly used biometric is fingerprints, iris, retina, face, hand geometry, palm, etc. Identity verification in computer systems has been classically based on something what you are or what you already have. The guideline to be considered for user authentication system is recognition of the authorized user and rejection of the imposter. The aim of the biometrics is to decide whether the characteristics belong to the same person or not. So a better classifier is necessary to classify the patterns correctly. The survey presents various biometric techniques based on neural network**.**

Keywords: Neural network, authentication system, biometric & key authentication.

I. INTRODUCTION

Biometric is expected to perform better than classic method of identification because they depend on what you actually have. Formally biometrics refers to automatic identity authentication of individual on a basis of once unique characteristics. Some of the popular biometrics that are used include fingerprints, retina, iris, hand geometry, face, signature, palm prints etc.

Authentication and security become very popular because of the introduction of new latest technologies like e-banking, e-commerce and smartcard. Privacy and security becomes the most important part which comes into focus and an increased demand on the privacy and security of data stored in various databases, automatic personal identification is very vital in a broad range of application.

It may involve the use of passport, ATM and driver licenses [1]. Hence the easiest solution is to use biometric authentication.

II. BIOMETRIC TECHNOLOGY

The technology is mainly used for authentication and access control or for identifying individuals. Biometric authentication is that everyone is having some unique pattern and an individual can be identified by his or her physical or behavioural characteristics.

There are mainly two process of biometric recognition system, first one is enrollment where the system performs one to one comparison of a captured biometrics and in second process i.e. recognition individuals data is compared with the given template i.e. nothing but a matching and system performs one- to- many comparison to detect an unknown individual if any present.

The block diagram illustrates the steps involved in biometric system [2].

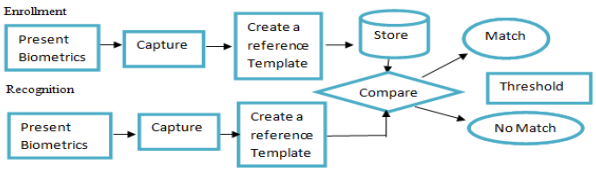

Fig.1. Process Involved in Biometric Recognition [2].

A. Advantages of Biometric System

1) No more forgotten or stolen password
2) Positive and accurate
3) Highest level of security
4) Offers modality
5) Impossible to forge
6) Serves as a key that cannot be transferred

B. Biometric Features [3]

1) Uniqueness: an identical trait and which won't appear in two people.
2) Universality: The existence of the pattern is consistent throughout the universe.
3) Performance: It doesn't change over time that is it remains same for Life time.
4) Measurability: Measurability means it is measurable with simple technical instruments.

III. BIOMETRIC TECHNIQUES

There are different biometric techniques available nowadays. A few of them are in the stages of research only, but a specific number of technologies are already available and used in real time application. Different types of biometrics are commercially available nowadays: fingerprint, finger geometry, and hand geometry, palm print, iris pattern, retina pattern, facial recognition and voice comparison and signature dynamics. In Biometrics, we have to allow for some variability of the data in order to, not to reject too many authorized users. The variability is usually called a security (threshold) or a security level.

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If the variability allowed is small then the security or the security level is called high and if allowed for greater variability then security level is called low.
Biometric authentication for a particular pattern can be followed by a conventional flow graph as shown in fig [2]

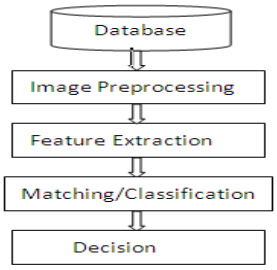

Fig.2. Flow Graph of conceptual overview

Steps involved in conceptual overview are as follows:
1) Image Acquisition (Database)
This is the basic first stage of obtaining images of a person and further stored in database. Once the image has been obtained many steps of processing can be applied further.

2) Image Pre-processing
It basically involves preparation of an image required for the further processing. It includes conversion to grey scale, applying threshold, localization, quality assessment, isolation, edge detection, noise removal.

3) Feature Extraction
The main goal of feature extraction is nothing but to obtain the most relevant data from the original one, and represent that information in a more compact or a low dimensionality space. Feature extraction is the process required for the reduction purpose by keeping the good quality of the original one.

4) Matching / Classification
It is the most important and very last step used for recognition purpose. Classification means to put the things into group according to their characteristics therefore the authorization can be made easy.

A. Types of Biometric
Basic two types of biometrics:
a) Physiological
   i. Face
   ii. Fingerprint
   iii. Hand Geometry
   iv. Palm Print
   v. Iris
b) Behavioural
   i. Signature
   ii. Voice
   iii. keystroke
   iv. Gesture

Further study of this paper will be more focused on neural Networks; hence for the classification purpose we are studying neural networks. Our survey is based on overall idea of a neural networks applied on different biometric techniques.

IV. IMPORTANCE OF NEURAL NETWORKS

An artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous system works such as the brain, process information. It is having highly interconnected processing elements [4]. Thus the term 'Neural Network' specifies two distinct concepts i.e. a biological neural network is a plexus of connected or functionally related neurons in the peripheral nervous system or the central nervous system. In the field of neuroscience, it most often refers to a group of neurons from a nervous system that is suited for laboratory analysis.

A. Why use neural Networks?
- Ability to derive meaning from complicated data.
- Adaptive learning - An ability to learn how to do tasks based on the data given for training
- Self Organization - An ANN can create its own organization or representation of the information it receives during learning time.
- Real Time Operation - ANN computation may be carried out in parallel and special hardware devices are being designed and manufactured which take advantages of this capability.
- Fault Tolerance via Redundant Information Coding - Partial destruction of a network leads to the corresponding degradation of performance. However, some network capabilities may be retained even with major network damage.
- A significant number of technologies is already mature and commercially available
- Hence neural network is the most suitable for the classification and a matching purpose.

V. RELATED WORK

This survey of physiological and behavioural biometrics shows the main and important biometric techniques using a neural network as a classifier.

A. Face Recognition
It is a type of biometric to recognize or identify human faces for identifying an individual through a computer scan. Mostly the facial recognition system demands the user to stand at some specific distance away from digital camera. This ensures a specific size tolerance and keeps the feature in a similar position each time as possible [7]

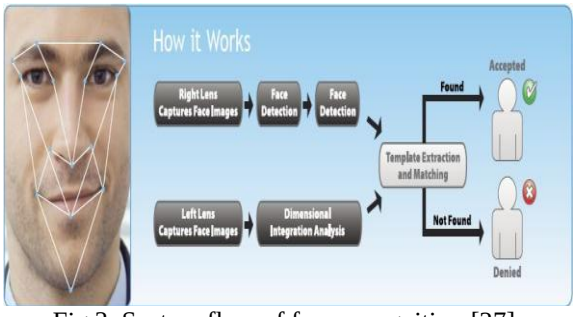

Fig.3. System flow of face recognition [27]

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Shye-chorng kuo, Cheng-Jian Lin, Jan-Ray Liao [5] constructed a human faces using IKICA model for solving photometric stereo problem, which allows easier convergence and makes system stable. Author have proposed three types of fetching methods for extracting a facial feature i.e. Contour based , circle based and feature based fetching method.

As a classifier authors has used three layers feed forward neural network trained by back propagation algorithm which gives non linear transfer function i.e. two value, Sigmoid and Hyperbolic tangent function, from that Back propagation algorithm was the most frequently used non linear function which provide a procedure for changing weights.

The performance evaluation of the methodology was performed on set of 10 person's facial features. The approach is more focused on minimizing the error between target output and network output in the training by using the supervised learning algorithm.

Jing Lu, Jianwei Zhao, Feilong Cao [8] gives the brief idea about the comparison between NNRW (NN with random weights) and 2D-NNRW (2 Dimensional NN with random weights). The paper adopts the idea of neural network with random weights to learn all the parameters.

But among that 2DNNRW uses the matrix data as direct input and can preserve the image matrix structure. Author performed the experiments on different databases, i.e. ORL and FERET, with the combination of 2D extraction method and bi directional two dimensional principal component analysis hence considering the performance 2D-NNRW improves the better performance as compared to NNRW.

Sung-Hoon Yoo, Sung-Kwun Oh, Witold Pedrycz [9] proposed a hybrid method of face recognition by using the information from different regions of the face that is further extracted from detected face region. Pre-processing part based on Active shape model (ASM) and principal component analysis algorithm. Author implemented RBF-NN classifier which consists of three functional modules with the help of fuzzy rules.

B. Fingerprint Recognition

Fingerprint biometrics is the oldest of all the biometrics. It provides automated method of identification between two individuals. It is also necessary to find the pattern and structure of a human skin. There are three basic pattern of fingerprint:

- Arch - The ridges enter from one side of the finger, rise in the centre forming an arc, and then exit the other side of the finger.
- Loop- The ridges enter from one side of a finger, form a curve, and then exit on that same side.
- Whorl- Ridges form circularly around a central point on the finger.

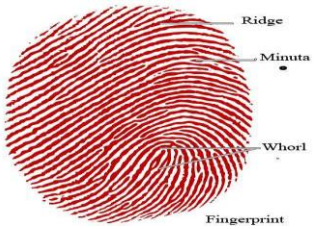

Fig.4. Finger Print Recognition [28]

Yuan Yao, Gian Luca Marcialis, Massimiliano Pontil, Paolo Frasconi, Fabio Roli [10] proposed an algorithm based on two machine learning approach i.e. support vector machine (SVM) and recursive neural networks (RNN). This approach gained two advantages one is it can tolerate the presence of undecided fingerprint image in the training set and efficiently identify the most difficult fingerprint image in the test set. This approach rejects ambiguous images which improves system significantly. Results obtained by training SVM on both finger code and RNN extracted feature.

Gowthami A .T, Dr. Mamatha H. R [11] proposed a linear binary pattern for fingerprint representation and matching/classification purpose. This approach equally divides whole fingerprint image into nine equal sized zones. Each zone particularly studied, identified and used for recognition. Eight different sets of database were used of total 3500 samples. So for classification purpose neural network back propagation algorithm and nearest neighbour classifier were used, it is observed that the implementation gained good accuracy.

Hamsa A. Abdullah [12] introduced an algorithm which not only match the fingerprint parameter and relate to a unique member provided for each sample but also returns the best match for given sample parameter. The features extracted by the method of moments feature extraction, gives 12 features from each fingerprint (50×12). Implantation divided into 2 phases i.e. pre-processing and neural processing phase. Pre-processing phase deals with time effective pre-processing to make image data best fit to NN input. The back propagation algorithm used as a classifier for this implementation for 12 input parameter and 6 output parameter using only 1 hidden layer of 25 neurons. Hundred percent recognition rates obtained for this proposed methodology.

Mr. Lokhande S.K., Prof. Mrs. Dhongde V.S [13] divided the whole implementation into three main stages, pre-processing, post processing and final minute Matching stage. Enhancement of an image done by using histogram equalization, binarization and morphological operation which transformed into binarized thinned image. The author proposed back propagation neural network as a classifier, once the matching process is invoked, network automatically find out to which class of thumb image is correspond to. Original matching done by taking the pixel position of that sample input and these positions are matched with all the images of that particular class, so when it is matched with the original one it indicates the success

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C. Hand Geometry

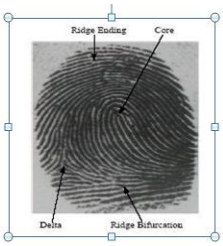

Fig.5. Hand Geometry [29]

A various measurement of the human hand can be used for biometric authentication. It may include hand shape, length of the finger, width of the finger, size of the hand. Sometimes environmental factors such as dry or wet weather may also consider. The shape of the human eye does not change after certain age. Various methods are used to measure a hand. These methods are most commonly based either on mechanical or optical principle. The main advantage of using this authentication system is, though it requires a special hardware to use; it can be easily integrated with other device. The noise factors such as dirt and grease do not pose a serious problem, as only the well captured image of the hand shape is important.

Amit Taneja and Sonika [13] presented an approach where it can be able to freely acquire the image without ant restriction by putting users hand virtually in any position. The process extracted the left and right tip of each finger with thumb hence overall 10 features extracted for the classification purpose. The back propagation algorithm used as a classifier. It takes the training samples, multilayer feed forward network as an input and gives the trained classified samples as an output.

Juan-Manuel RAMIREZ-CORTES, Pilar GOMEZ-GIL, Vicente ALARCON-AQUINO, David BAEZ-LOPEZ, Rogerio ENRIQUEZ-CALDERA [14] considered hand shape and extracted feature using morphological pattern spectrum or pecstrum method. Identification of a given sample done by using obtained feature vector as an input by the combination of neural network and SVM (Support vector machine). Levenberg –Marquardt back propagation algorithm is used as a classifier, which obtained good result and also helps to train the samples fast. ERR of proposed approach was considered. It worked for the properties of invariance to rotation and position of the pattern spectrum allows user to pose naturally.

Dr. Firas M. M.Al-Fiky, Zainab Salih Ageed [15] studied various types of physiological and behavioural characteristics of biometric techniques. Among that proposed approach more focused on hand geometry measurement. The hand image taken by a scanner covered with black box. Feature extraction contains 20 distances for fingers, palm and determine the centre point on it using bwboundaries. BPNN (Back propagation neural network) used with trainlm algorithm which divides the algorithm into 3 stages 1) initialization of weights 2) activation and 3) Weight training. Recognition rate founded and performance met on epoch 12 during 07:38 time for approximately 10 sample classes.

Dr. Haithem A. Alani [16] proposed an approach of tracing the hand edge to find the location of the finger tip points, base points and start of palm points. Feed forward back propagation neural network having a pattern presented at the input were transformed from layer to layer until it reaches the output layer hence classification occurs. Classification mainly divided into 3 stages i.e. training, validation and test sets. The overall performance obtained as, when network was trained with noisy data, it gives perfect result though the test data is at 0.2 of noise level and gives correct result when noise level at 0.3.

D. Palm print

Palm print recognition refers to the acquired palm region of the hand. Images can be taken from the database or form the scanner as per the availability of the user. Palm prints can be used for criminal, forensic and any other commercial applications. A palm recognition system is designed to detect the flow of the overall ridges to use it for classification and then extract the minutiae detail. Minutiae are restricted to the location, direction, and orientation of the ridge endings and splits along a ridge path.

Fig.6. Sample of Palm Print recognition [30]

Mayanda Mega Santonia, Dana Indra Sensusea, Aniati Murni Arymurthya, Mohamad Ivan Fananya [17] proposed grey level co occurrence matrix convolution neural network (GLCM-NN). The author used 5 different types of cattle data for research as compared with the earlier work. GLCM is a matrix that represents different combination distribution of pixel brightness values that occur in an image. GLCM provides feature related to texture of an image. The implementation has done on 5 different classes with best accuracy for 100 iterations so cattle identification done automatically.

Goh Kah Ong Michael, Tee Connie, Andrew Beng Jin Teoh [18] proposed online and offline palm print recognition system. Aim of this research is 1) to find distance between the hand and input sensor 2) Hand position and its orientation 3) lightning changes. Skin colour thresholding method used for segmentation of the hand image and hand valley detection algorithm for detecting valley of finger. The methodology tested on 320 individuals, PNN (Probabilistic neural network) used as a classifier for matching which require only one single pass through the training data. Advantage is new data can be

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added any time without the need of retrain the entire network and verification performed in less than 1sec.

E. Iris Recognition

Among all the biometrics iris recognition has attracted a lot of attention because it has various advantages factors such as speed, simplicity and accuracy as compared to all other biometric techniques. In addition the left and right iris pattern is different for any individual. It is also not possible to alter or tamper the iris images, because it could lead to blindness. In this perspective, iris is indeed most safe and reliable biometric pattern that is used in biometric identification system.

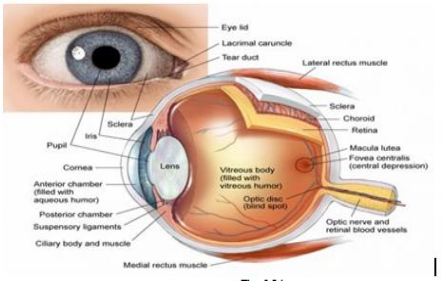

Fig.7. Iris Structure [31]

The human iris has a random texture and it is stable throughout the life, it can serve as a living passport or a living password. This password, one need not remember but is always present [19]. Basic iris recognition system model is as shown in fig 8.

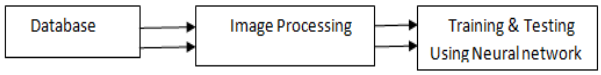

Fig.8. Basic system model

Gajendra Singh Chandel, Ankesh Bhargava [20] proposed an image tool for calculating the length of the iris from left to right and top to bottom. CASIA is used as a database for this approach. Feed forward back propagation algorithm is used a as a classifier for this approach. A vector of predictor variable Values(x1, x2) are presented at the input layer with number of two neurons. The weighted sum is fed into a transfer function which outputs a value. Bayesian Regulation Training (trainBR) algorithm is used to learn neural network. This function updates the weight and sometime adjusts a weight and bias the value according to Levenberg-Marquardt optimization.

Omaima N. Ahmad AL-Allaf, Abdelfatah Aref Tamimi, Shahlla A. AbdAlKader [21] in this proposed approach classification is based on five different ANN (Artificial neural network) models. The training part consists of first determining the architecture of given ANN model then initializing ANN model weights and bias unit further initializing the output target vector for each input vector, so author implemented the experiments on 150 samples. Then the input vector applied to compute output of each layer to find original output vector. Implementation and evaluation done by considering MSE for 4 layers ANN with 5 Hidden Nodes, MSE for 7 layers ANN with 5 Hidden Nodes, effect of Number of Hidden Layers, Effect of Number of Hidden layer Unit, Testing ANN models with Testing Samples. Comparison result shows trainlm is the most suitable algorithms for this proposed work. Trainlm can train any network as long as its weight, net input and transfer function have derivative function. It updates its weight and bias values according to Levenberg-Marguardt optimaization.

Usham Dias, Vinita Frietas, Sandeep P.S. and Amanda Fernandes [19] presents personal identification of an iris consist of iris localization, normalization, image enhancement and pattern recognition using neural network. In the addition with this, author successfully shown persons left and right eye is unique. Using Canny Edge detection method edge of an iris is detected. Given network classify sample images of an iris pattern and were trained using error back propagation algorithm with adaptive learning rate (traingda).The experimental results show that the training is sensitive to initial weights and overtraining gives the bad results. Gradient descent with adaptive learning rate backpropogation (traingda) updates weight and bias values according to gradient descent with adaptive learning rate. It sets the network trainFcn property.

Leila Fallah Araghi, Hamed Shahhosseini, Farbod Setoudeh [22] proposed the covariance matrix of discrete wavelet transform for edge detection and Probabilistic neural networks and LVQ, or Learning Vector Quantization as a classifier. This approach used to classify noisy image. LVQ is the supervised counterpart of vector quantization system. It is related to self organizing map (SOM). The network has a first competitive layer and a second linear layer.

R. P. Ramkumar, Dr. S. Arumugam [24] identifies human characteristics by extracting textural feature of a human eye. Pupil localization is done by using negative function and neighbors method. Histogram equalization technique is used for enhancing the normalized iris image. Hamming distance and cumulative sum based change analysis employed by the author to extract the feature.

Mrunal M Khedkar and S.A Ladakhe [25] proposed an approach where it takes, iris images of 10 different people as an input. After localizing region of interest for extracting the feature the experiment is more focused on image statistics, texture and 2D SVD transform domain. Hence extracted features given as an input to neural network based Pattern Recognition (PR) system. Hence MLP, RBF and SVM are investigated by an author for suitability with PR systems. The experimental results clearly show the performance of MLP (Multi Layer perception) based PR system gives the most consistent results though it retrain with multiple random initialization.

F. Voice Recognition

It is also referred as speech recognition. It is widely used to operate a device, perform commands, or write without using keyboard, mouse or press any button. It is a

biometric technique comes under behavioral types by which sound, words or sentences spoken by human are converted into electrical signals and further transformed into coding patterns. The most common approach to this is basically divided into two parts, i.e. feature detection and template classification.

Fig 9 Voice recognition system

Voice recognition technique is the unique one since every human is having a unique feature in his voice [26]. Human voice has two types of information i.e. high level (an accent, talking style) and low level (rhythm, tone, bandwidth and frequency of the voice).

Aryaf Abdullah Aladwan, Rufaida Muhammad Shamroukh, Ana'am Abdullah Aladwan [26] proposed a method to improve matching process speed. Overall work divided into three phases i.e. pre processing, Feature extraction and recognition phase. MLP (multi Layer perception) neural network implemented for training and testing phase using cross validation technique. Neural network trained with different sets of features extracted from DWT from different levels. Considering the performance author recognizes each level of decomposition and decides the best level that is enough to give comparable best result.

Hence the overall survey and related study of biometric techniques gives the better security options for the real time environment. All the papers included here tries to fulfil the requirement and obtained satisfactory results. Depending upon the biometric technique, it may have some drawbacks like requirement of hardware; the surrounding environment and the cost may also increases. But the authentication and security defiantly takes into consideration. Hence by analysing these factors and the accuracy, one can choose any biometric technique for his/her research.

VI. CONCLUSION

Biometric systems are used increasingly to recognize individuals and regulate access to physical spaces, information, services, and to other benefits, including the ability to cross international borders. There are several types of biometrics, and each has its own advantages as explained in this survey above. Depending on what level of security and what do you want to provide, you have to make the decision and good choice. Biometrics implies that you have to face some ethics and law considerations. But if you can go through this problem, it can provide you a very good, secure and easy way of authenticate people. By analysing the existing biometrics based security system, it can be clearly said that the usage of neural network along with biometrics features will provide better security than other techniques. The further study of this work will be more focused on one of the biometric technique which attracts the attention and proves the better accuracy and performance with the combination of neural networks.

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