AUTOMATIC BIOMETRIC RECOGNITION USING ARTIFICIAL NEURAL NETWORKS

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Abstract - Personal identification, recognition is a vital problem in any biometric application scenario. Biometrics finds a lot of application in the modern day security aspects whether it may be in industrial sector, defense sector or in domestic sectors. Entry of a person into an organization in the work environment plays a very important role as unauthorized persons if entered into a premises may create a flutter & inviable to some terrorist attacks. Hence, biometrics of an authorized person into the work environment plays a very important role. There are a large number of biometric methods for identification, viz., physiological & behavioural. Some of them are face, fingerprint, iris, voice, hand, thumb, ear, vein, gait, code, password, signature, pattern, palm print, etc... As there are a number of biometric methods for the automatic detection of human beings, retina scan is being considered as the biometric identity in the research work undertaken by us because of a large number of advantages over the other biometric identities. For biometric recognition of a person using retina scans, a number of methods exists in the literature. In this context, ***Artificial Neural Nets & Convolution Neural Nets***method aresome of the methods that could be used for biometric recognition of humans. Hence, the retinal recognition is performed in our proposed work for identifying the person by developing new approaches using ANN (current) & CNN (future work) methodologies. Hybrid algorithms were developed & simulations were performed in the Matlab environment, the simulation results were observed and compared with the work done by the other authors till date to establish the supremacy of the proposed works.

IndexTerms – Biometrics, Retina scan, Physiological, ANN, CNN, Behavioural, Matlab, Simulation, Security, Eyes, Recognition, Authentication.

I. Introduction

Biometrics is the art of identifying a human being by different methods. Identifying or verifying one identify using biometrics is attracting considerable attention in this modern day automated world, one the main reason being the security issues in various highly sensitive places. It is the beautiful science of automatic identification of individuals that uses the unique physical or behavioral traits / characteristics of individuals to recognize them. Since biometrics is extremely difficult to forge and cannot be forgotten or stolen, biometric authentication offers a convenient, accurate, irreplaceable and high secure alternative for an individual, which has a tremendous advantages over the traditional cryptography-based authentication schemes.

Fig. 1: Types of biometrics (physiological & behavioural)

Fig. 2: Biometric device - Retina scan machine

The paper is organized as follows. A brief introduction to the related work was given in section I as the introduction. The retinal recognition system conceptual development is presented in section II followed by the methods for retinal recognition in section III. The section IV gives the motivation obtained for taking up the work which is followed by the problem statement & its definition. The scope of the research work is given in section V followed by the objective of the research work in section VI. The section VII discusses about the possible outcome of the research work, whereas a brief literature survey / review / background work done in this field is portrayed in the section VIII. The proposed research methodology is depicted in section IX followed by the implementation in section X. Next, the simulation results are graphically displayed in section XI followed by the advantages & future scope of the work in section XII. The tools used in the simulation is given in section XIII. The paper concludes with a brief conclusion in section XIV followed by the references.

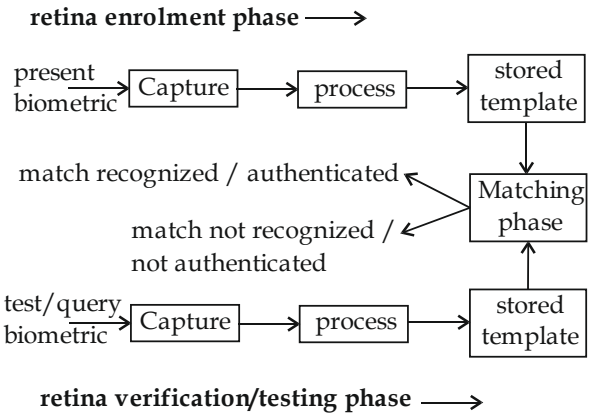


Fig. 3 : Block diagram of a typical biometric scheme for the recognition purpose

II. Retinal Recognition System

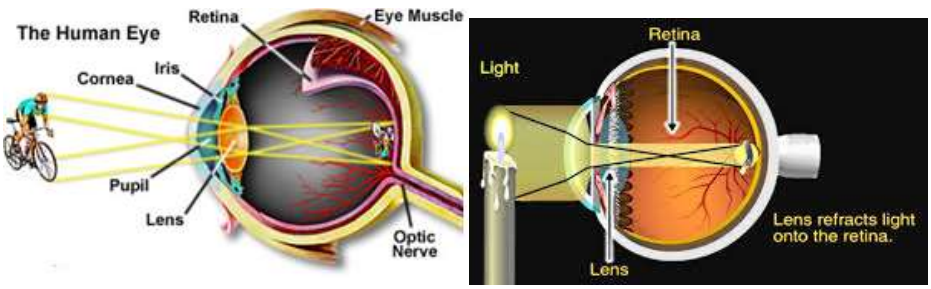


Fig. 4 : A front view of the human retina along with its different parts

In the section, the structure of the retinal recognition system is being presented in a nutshell. The structure of human eye is shown in the Fig. 4 along with the retinal parts, which is our ROI. The protective outer layer of the eye is called as the sclera. The other components of the eye are cornea, lens, iris and retina. Retina is the light sensitive tissue which forms the inner side of eye (back end). The optical elements of the eye focus the image onto the retina, thus initiating a series of chemical & electrical events within the retina. Nerve Fibres (NF) within the retina send electrical signals to the brain, which then interprets these signals as visual images. Retina is approximately 0.5 mm thick and covers the inner side at the back of the eye. A number of blood vessels (BV) are present all over the eyes to provide nutrition to various parts of the eye. The mean diameter of the blood vessels is about 250 μm& the retina connects all the optic nerves to the brain [1]-[10].

III. Method used for retinal recognition

Retinal biometrics is one of the accurate biometric techniques used for personal identification in the modern days in this digital technological world. A number of methods are considered for retinal identification process. Some of them are the [1]-[10]

- ANN
- CNN

& in the present work, ANN is being used in our research work for the biometric identification of human beings, whereas CNNs is considered for the future work (later stage).

Artificial Neural Networks – is one of the important machine learning techniques which is used to train a network & used the trained information for recognizing the retina. Neural network approach is one of the powerful method which is used for the analysis & recognition using retina scans. The block-diagram of the proposed methodology for this contribution was presented in Figs. 3, 6 & 7 respectively. The developed algo is enunciated as follows [1]-[10].

An artificial neural network is a system based on the operation of biological neural networks or it is an emulation of biological neural system. The ANN can be defined to be parallel, distributed processor that has a natural capacity for retaining experimental knowledge and extending it for use in subsequent stages. ANNs have seen an explosion of interest over the last few decades and are being successfully applied across an extraordinary range of problem domains. The basic idea behind the use of ANN in Retina Recognition System are[10]:

In this research work, the focus is to study the system performance of the identification system that provides reliability, accuracy and reduced overall match speed using ANN-BPA concepts. The steps of the algorithms of the system model are shown in Figs. 3&6 respectively.

IV. Motivation & Problem Statement

Even though, there are quite a number of biometric techniques as mentioned previously, the retina is considered as the efficient method as it the retinal part is at the back end of the eye, it is non-contact and unique for a particular person.

Finally, in this context after studying the implications of each of the biometric methodologies, we arrived at the selection of the retina as one of the best method of biometric identification of human beings due to its large number of advantages mentioned above. Also, due to the current initiative taken up by the central government in the field of biometrics in all sectors, this had further *motivated* us to take up the research work on the retina method of biometric recognition [1]-[10].

The main motivation being some of the digital initiatives taken up by the central & state governments in the wake of security issues in the country. This has made us to identify the problem. Hence in continuation, with zeal of this research work after making a through survey, we are going to propose some novel methodologies for the automatic recognition of biometrics using retina scans by developing some software algorithms in Matlab, the problem finally, being defined as the research problem statement, “Novel human biometric recognition system development using ANNs with the help of back propagation algorithm”.

V. Scope of the research work

The major scope of the proposed research work is mainly of 3 fold, viz., to develop some new approaches to overcome the security and authentication problems faced in many fields using retina scans, to improve the performance of the commonly used existing algorithms, to compare various techniques available for retinal identification based on their accuracy and error rate with the work done by us and to develop some hybrid algorithms for retinal biometric recognition.

VI. Objective of the Research work

The main objective of the research work that is undertaken by me under the guidance of my research guide is aimed to develop some sophisticated bio-medical image processing algorithms for the effective biometric identification of human beings through the retinal part of the human eye & to conquer the difficulties located in the works done by the earlier authors, at the same time developing some new approaches for retina recognition.

VII. Possible outcome of the Research work

The possible outcome of the research work is to show that when the designed algorithm/s that are going to be developed in the Matlab environment is run, the automatic recognition of the retina is done with minimum computational time leading to whether the person is being recognized / authenticated or not in comparison with the work done by the fellow authors till date taking into consideration some of their drawbacks, thus enhancing and improving the performance of the existing algorithms and showing that the research work done by us is superior over the others.

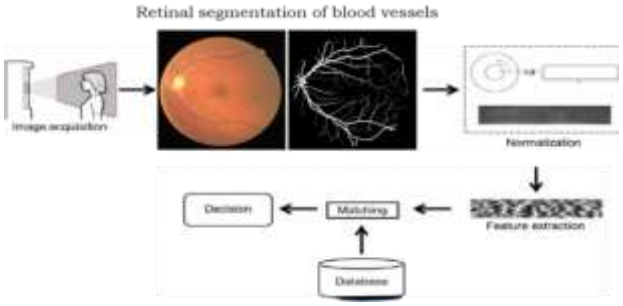


Fig. 6 : General process of a retinal biometric detection

VIII. Literature survey / Review

Many works have been proposed on retina biometric human recognition system for secure authentication till date. This section provides the knowledge about the existing technologies, its advantages and disadvantages, work done by other authors till date. Subsequent paragraphs explain how the researchers have contributed to the field of biometric recognition using retina scans. To start with, 100's of research papers were collected from various sources, studied @ length & breadth and its outcomes were studied, analyzed to start with and the problem statement was finalized and defined. A large number of papers were referred to in [1]-[10].

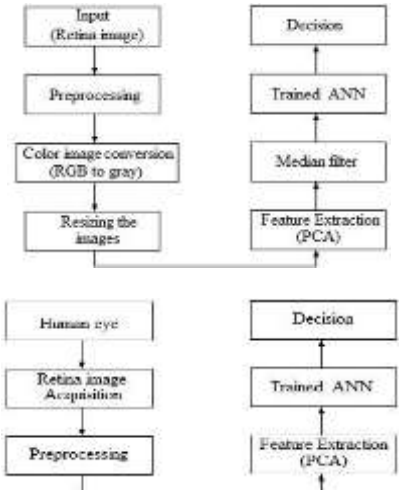
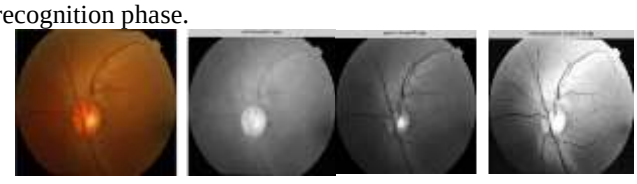


Fig. 7 : Block diagram of the proposed retina scan identification technique using the ANN concepts

IX. Proposed research methodology

In this section, the methodology for the proposed research work is being presented. The proposed block diagram shown in the Figs. 3, 6&7 for biometric recognition using retina scans explains the methodology that we are going to adopt in our work to develop an efficient retinal recognition system for humans. In this work, first, the retina recognition system has got 2 levels (arms), viz.,

- The registration arm : the retina enrolment section and
- The verification arm: the retina recognition phase.



(a) (b) (c) (d)

(e) (f)(g) (h)

Fig. 8 : Matlab simulation results

(a) Original image (b) Red channel (c) Green channel (d)

Enhanced green channel (e) Retinal binary image (f) Retinal Capillaries removed (g) Inverse retinal image (h) Retinal artery and vein segmented image

X. Implementation

The software implementation results of the automatic biometric retinal identification is carried out using the Matlab tool due to its add-on features and support provided with good tool boxes. Codes are developed in the Matlab environment as **.**m files w.r.t. the new approaches that we are going to develop. The developed **.**m files are run & the simulation results are observed, finally, the conclusions were drawn on the observation of the simulation results & compared with the work done by others. For the simulation purposes, standard retinal databases were used & some images were taken from the eye hospitals across the country.

XI. Simulation results

Codes were developed in the Matlab environment & are run for different input retinal images & the results are observed for recognition & non-recognition of humans. To start with, the pre-processing of the retinal input image is done first. Gray scale conversion is done next. Then, the dilation & erosion processes are used for cropping the images to get the retinal nerve fibres, which is being used for further processing in order to get the retina nerve fibre layer. Intensity equalization, thresholding is done to obtain the region of interest, i.e., enhanced retinal nerve fibre layer.

A 2 layer back propagation network is employed for the biometric recognition process of humans. The transfer function used was log sigmoid transfer function. The network was trained using parameters of 100 human beings. The training data was used to teach the network to classify the scanned image as recognized (authenticated) or non-recognized (not authenticated) case.

Again to be noted that ANNs were used as the classifiers. Template matching concept is used to match the given test/query retinal image with the retinal image which is stored in the database. If the test image & the one which is stored in the database are the same, then the end result says that the test query image is matched, else, it says the result is not matched, person is not authenticated as shown in the Figs. 2, 8, 14, 16 & 17 respectively.

Work Carried out	Compilation time	performance	μ
Proposed	0.00:03	19.9	0.001
[20]	0.00:05	21.2	0.002

Table 1: Performance criteria statistics

The neural network trained values are shown in the Fig. 9 along with the training of the network states in the Fig. 12. The regression plot & the performance analysis plot showing the no. of epochs is shown in the Figs. 10 & 12 respectively. The no. of epochs used for the simulation was 4 iterations. For the same input image for which the recognition had taken place, the time taken was 3 secs whereas the compilation time taken in [20] was 5 secs, which shows the effectivity of the methodology developed by us.

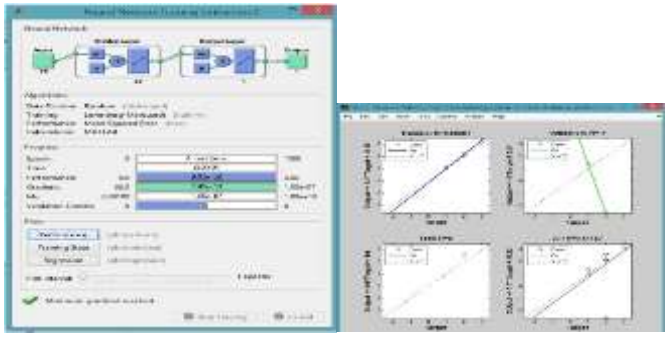


Fig. 9: Neural network trained values window

Fig. 10: Regression Plot

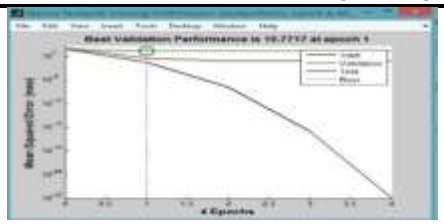


Fig. 11 : Performance plot showing the no. of epochs

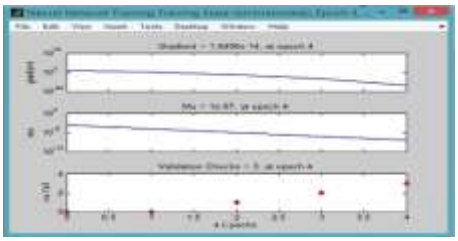


Fig. 12: Training Plot showing network training states

The results of the Matlab simulation are shown in the Figs. 13 & 14, where the command prompt itself shows 2 separate cases for retinal recognition, whereas for an non-authentication, case it is shown in the Fig. 18.

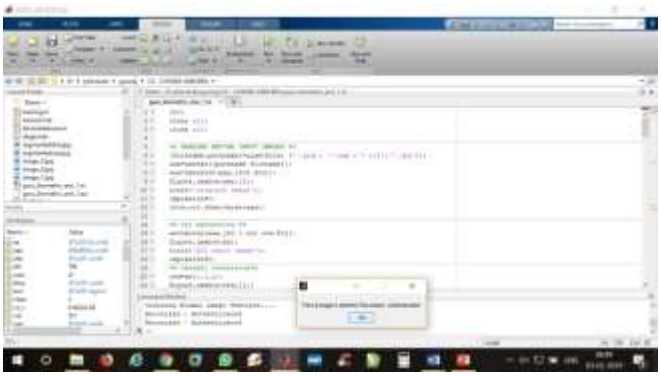


Fig. 13 : Result shown in the Matlab command window

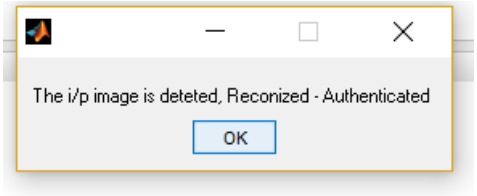


Fig. 14 : Dialog box showing the input image is detected or recognized or authenticated.

XII. Advantages & future scope

Retinal scanning finds a lot of advantages in the current digital scenario & has been used in prisons, for ATM identity verification and the prevention of welfare fraud. Retinal scanning also has medical applications. Communicable illnesses such as AIDS, syphilis, malaria, chicken pox and Lyme disease as well as hereditary diseases like leukemia, lymphoma, and sickle cell anemia, which affect the eyes & other parts of the body can also be cured. One main advantage being it is non-contact in nature & hence a protected biometric parameter as the retina is at back of the human eyes. Pregnancy also affects the health of the eyes. Likewise, indications of chronic health conditions such as congestive heart failure, atherosclerosis, and cholesterol issues first appear in the eyes. The future scope is to implement the same work using the concept of CNN & with the hybrid combination of ANN-CNN as 2 separate case studies, further in LabVIEW also.

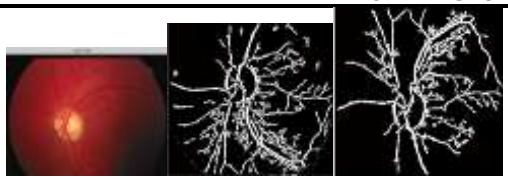


Fig. 15 : Inputted original retinal image or the test/query sample-2 (input)

Fig. 16 : Matlab retinal simulation result for another input test, query image (not-recognized case) – (output)

Fig. 17 : Retinal image of the person not in the database (not-recognized case)

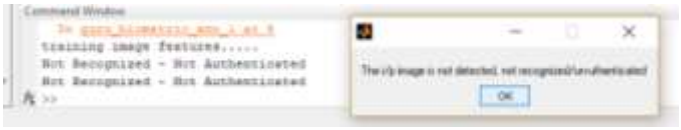


Fig. 18 : Matlab results showing the input image not recognized or authenticated (not in the database), dialog box showing the not recognized case as the input image-2 is not there in the database.

XIII. Tools used

Matlab is the tool that is used in our research work. Codes are developed as **.**m files, run & the simulation results are observed both for the recognized case as well as the not recognized case.

XIV. Conclusions

Research was conducted for the development of novel approaches for secure biometric authentication using retina scans using ANN techniques. Broad writing-literature overview was done in this emerging-developing field. An extensive number of research papers and the work done by different scientists / authors in this field was gathered from different sources.

Different issues w.r.t. the drawbacks of the works done by the various authors was deeply examined, analyzed, studied in greater depth in more prominent profundity. The research problem was formulated & defined after an exhaustive survey done on this field. Coding was done in the Matlab environment & the simulation results were observed.

From the test results, it could be found that the recognition process is well accepted, also if the image is not there in the database, then it shows the result 'not recognized'. One special feature of our algorithm developed is that this works for any type of image. Also, the compilation takes very less time compared to the others. Finally, the conclusions are going to be drawn w.r.t. the retinal bio-metric recognition of human beings.

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