Iris Recognition for Secure Biometric Authentication using Artificial Neural Networks & Pupil Dilation

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Abstract – *Secure authentication has always been the foremost requirement in the advancing age of technology. From e-mail accounts to vaults and government to military database, authentication has been a major concern. The primitive methods were passwords and PIN numbers, but the advent of electronics, Biometric Authentication has taken the central stage. Biometric methods are based on the personal traits of a person. Unlike passwords, these traits cannot be changed or imitated, therefore making them secure. Among these methods, the spotlight is on Iris Recognition. A method that analyses the unique attributes of a person's eye using image recognition, and stores it with his identity profile on the system. The proposed system uses an AI that analyzes the input iris image against the data that is available to scrutinize various emotional scenarios, and judge whether the person should be granted access.*

***Keywords*: Iris Recognition, Biometric Authentication, Image Recognition, AI.**

1.INTRODUCTION

In a world where anything and everything is stored on a cloud database, and data security is becoming more and more integral, secure identity verification and authentication is the peak demand in every industry. Identity verification has travelled a long distance from passwords to biometrics. Among the vast options, iris recognition has been proved to be the most accurate and secure way of authentication. Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on video images of one or both of the irises of an individual's eyes, whose complex patterns are unique, stable, and can be seen from some distance.

Daugman [1] proposed an iris recognition system representing an iris as a mathematical function.
Mayank Vatsa proposed a support-vector-machine-based learning algorithm which selects locally enhanced regions from each globally enhanced image and combines these good-quality regions to create a single high-quality iris image.[2] Mayank proposes algorithms for iris segmentation, quality enhancement, match score fusion, and indexing to improve both the accuracy and the speed of iris recognition. M. Gopikrishnan used hamming distance coupled with Neural Network based iris recognition techniques are discussed. Perfect recognition on a set of 150 eye images has been achieved through this approach; Further, Tests on another set of 801 images resulted in false accept and false reject rates of 0.0005% and 0.187% respectively, providing the reliability and accuracy of the biometric technology [3].
Leila Fallah Araghi used Iris Recognition based on covariance of discrete wavelet using Competitive Neural Network (LVQ). A set of Edge of Iris profiles are used to build a covariance matrix by discrete wavelet transform using Neural Network.[4]

Today with the development of Artificial Intelligence algorithm, Iris recognition system may race ahead in terms of speed, hardware simplicity, accuracy and learning ability. The increasing accuracy of Iris Recognition systems combined with the advancements in Artificial Intelligence show a very promising future for the proposed system.

2. IRIS RECOGNITION SYSTEM

2.1 Existing System

All publicly deployed iris recognition systems acquire images of an iris while being illuminated by light in the near infrared wavelength band (NIR: 700–900 nm) of the electromagnetic spectrum. The majority of the world population has "Dark Brown eyes". The dominant trait of the majority, under the visible wavelength, seems to be very unstructured, but under the Near Infrared Region wavelengths, appears richly structured. Using the NIR spectrum also enables the blocking of corneal specular reflections from a bright ambient environment, by allowing only those NIR wavelengths from the narrow-band illuminator back into the iris camera.

Iris melanin, also known as chromophore, mainly consists of two distinct heterogeneous macromolecules, called eumelanin (brown–black) and pheomelanin (yellow–reddish), whose absorbance at longer wavelengths in the NIR spectrum is negligible. At shorter wavelengths within the VW spectrum, however, these chromophores are excited and can yield rich patterns. Hosseini, [5] provide a comparison between these two imaging modalities. An alternative feature extraction method to encode VW iris images was also introduced, which may offer an alternative approach for multi-modal biometric systems.

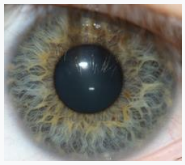
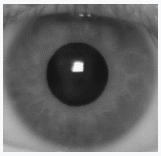
Visible wavelength iris image	Near infrared (NIR) version	NIR imaging extracts structure
		

Figure 1. *The human eye under visible, and near infrared light.*

2.2 Proposed System

In existing system, the iris recognition doesn't consider mental scenario of a person trying to gain access. Here we are proposing a system, where mental/emotional scenario is also considered for authentication, i.e., a person under stress or depression won't be granted access to the information. This is important in scenarios, when intruders can pressurize the right person to gain access. For considering emotional scenarios, we train the Neural Network based on pupil dilation.

Iris images are taken by CASIA iris image database. The feature extraction is done by using wavelet transform. Data sets will be prepared using features obtained by the feature extraction technique. These obtained features are fed to the AI for the classification.

The images from CASIA iris image database are taken. It contains 7 images of 108 persons of one eye at two sessions. They are of 320 x 280 bitmap images.

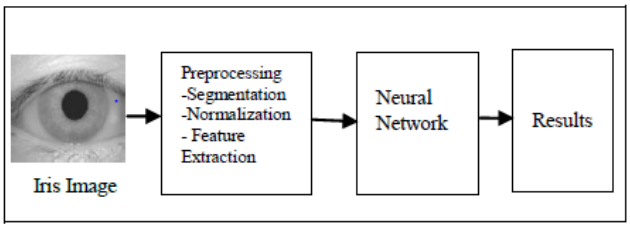


Figure 2. *Block diagram of proposed system*

3. IRIS PREPROCESSING

The iris recognition system consists of image acquisition, iris segmentation, normalization, feature extraction and matching. A high-quality image must be selected for iris recognition. In iris pre-processing, the iris is detected and extracted from an eye image and normalized. At first stage, the training of recognition system is carried out using Gray scale values of iris images [6]. Neural network is trained with all iris images. After training neural network performance validation is done.

The aim of this system to not only analyze the structure of the iris for authentication, but also analyze other variables like pupil dilation, eye movement to predict the emotional state of the person requesting access.

5. SEGMENTATION

The segmentation module detects the pupillary and limbus boundaries and identifies the regions where the eyelids and eyelashes interrupt the limbus boundary's contour. A good segmentation algorithm should involve two procedures, iris localization and noise reduction. The noise reduction process refers to localizing the iris from the noise (non-iris parts) in the image. These noises include the pupil, sclera, eyelids, eyelashes, and artifacts depict the iris segmentation step [4].

The main objective here is to remove non useful information, namely the pupil segment and the part outside the iris [7]. The technique used is canny edge detection method for detecting the iris and pupil boundary as shown in the figure.

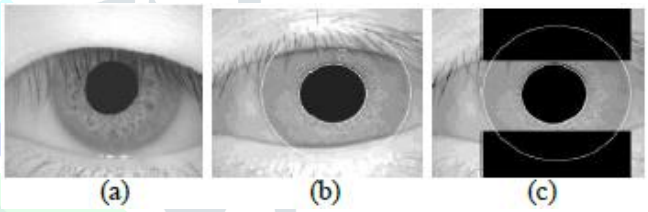


Figure 3. *(a) Sample Image (b) Localized Image (c) Noise reduced image*

6.NORMALIZATION

After the segmentation step has estimated the iris's boundary, the normalization process is used to transform the iris texture from Cartesian to polar coordinates. The process, often called *iris unwrapping* yields a rectangular entity that is used for further processing [2].

The variations in eye image due to optical size, position of pupil and the iris orientation change from person to person.

7. FEATURE EXTRACTION

After the completion of the normalization process for iris part, iris pattern is ready for feature extraction stage. Extracting features from the iris image is the most important stage in iris recognition system; especially this system depends on the features that are extracted from iris pattern.

Here, three approaches are used to extract the features from the iris; these approaches differ from each other in

terms of method of extracting features. These approaches are Histograms of Oriented Gradients (HOG) approach, Gray Level Co-occurrence Matrix (GLCM) approach and Local Binary Pattern (LBP) approach, [8]

8. NEURAL NETWORK CLASSIFICATION

The word "Neural Network" has been motivated from its inception by the recognition that the human brain computes in an entirely different way from the conventional digital computer. The brain is a highly complex, non-linear and parallel computer (information processing system) [3]. An **artificial neural network (ANN)**, often just called a "neural network" (NN), is a mathematical model or computational model based on biological neural network [5]. It consists of an interconnected group of artificial network and processes information using a connectionist approach to computation.

9.PUPILLARY RESPONSE

Pupillary response is a physiological response that varies the size of the pupil, via the optic and oculomotor cranial nerve.

A constriction response (miosis), is the narrowing of the pupil, which may be caused by scleral buckles or drugs such as opiates/opioids or anti hypertension medications. Constriction of the pupil occurs when the circular muscle, controlled by the parasympathetic nervous system (PSNS), contracts.

A dilation response (mydriasis), is the widening of the pupil and may be caused by adrenaline, anticholinergic agents or drugs such as MDMA, cocaine, amphetamines and some hallucinogenics. Dilation of the pupil occurs when the smooth cells of the radial muscle, controlled by the sympathetic nervous system (SNS), contract.

The responses can have a variety of causes, from an involuntary reflex reaction to exposure or inexposure to light—in low light conditions a dilated pupil lets more light into the eye—or it may indicate interest in the subject of attention, or sexual stimulation. The pupils contract immediately before REM sleep begins. A pupillary response can be intentionally conditioned as a Pavlovian response to some stimuli.

The latency of pupillary response (the time in which it takes to occur) increases with age. Use of central nervous system stimulant drugs and some hallucinogenic drugs can cause dilation of the pupil.

10. CONCLUSION

The aim of this Neural Network is to analyze the pupil dilation and movements of the eye to corelate them to emotional states of a person. The neural network can be trained by providing biological data that is available regarding the relations between different levels of pupil dilation and the emotional states connected with it.

Since we are proposing a neural network, instead of a hard-wired system, the iris recognition system can learn and adapt to become more and more advanced. For example, A hard wired system compares the input with the data that is available, an ANN can learn the specific eye movements of every individual in the database, and alter the parameters as per that individual.

This system can be highly beneficial for many organizations. Military bases can be secured to prevent forced authentication under duress. Factories with dangerous machinery can employ this method to ensure that intoxicated personnel do not operate the machine.

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