CHAPTER 1

INTRODUCTION

In the area of financial services biometric technology has been introduced, making life easy for consumers and enhancing their protection at the same time. Use of biometric in financial and banking services have shown to be much safer than conventional ways of authentication. Health is the biggest aspect of our everyday existence. Security has a crucial part to play. Whenever citizens cross airports, use payment cards, access machines or cross high security zones, they must check their identification. In some instances, a username and a password are required, but personal identification cards are used in some circumstances. However, you can forget about user names and passwords, and you can lose or stolen identification cards. This suggests that the methods of human identity must be strengthened and new techniques established, which are more accurate and specific than conventional ones [1]. Current scientific and technical advancements have allowed individuals to be recognized by their biometrics. Currently, biometric authentication is used in many applications. Next, entry to restricted areas should be regulated. Secondly, it may be used in airport passenger screening and in border inspection. Thirdly, links to records and financial resources was applied. Latest new biometric identification carts and passports focused on irises or facial recognition systems have been released by the UK and Australian border authorities. The combination of iris technologies speeds up the protection search at some airports [2].

Interclass Correlations, ICV, Noisy Data, Spoofing, Non-universality Problems involve issues surrounding biometric systems, such as unimodal systems that offer us a higher FCR and a FRR. It would send us a bad individual in the end. Quality of the method. Other constraints enforced by unimodal biometrics may be strengthened by including several sources of knowledge to define an individual [3]. Multimodal biometrics functions differently by integrating an authentication method or an authentication device, utilizing two or more biometric modes to shape one or both. The problem of non-universality is tackled using different characteristics, ensuring adequate population coverage [4].

The issue of spoofing faced by unimodal system is overcome by the multimodal biometric methods as multiple modality are combined together. An impostor will find it hard to connect many attributes to a real identity in tandem. The promise of multimodal biometrics for a very large variety of applications is growing. Examples of bank security include ATM surveillance, cash transactions, card transactions, IT security programmes, computer login, etc.

Every multimodal biometric device allows a binary choice, which leads to the "genuine individual" or "imposter "decision. In theory, different output metrics are used to assess multimodal system accuracy such as Genuine Acceptance [GAR], Positive Predictive Value [PPV], False Rejection Rate [FRR], False Discovery Rate [FDR], Falsified Acceptance Rate [FAR] etc.

Multimodal biometric systems operate in two phases which are described as follows:

Enrolment phase: - During this phase, user's biometrics are collected and then saved in the database of the device. These are used for authentication process as enrolled use.

Authentication phase: - In this phase, user parameters are captured once again and used by the system to identify a person. Identification involves comparing the user data to that of the captured data with user references of all users in the database. Whereas verification is the process of only one-one matching of user data with user reference in the system [3] references.

The earliest biometric cataloguing was started in 1891 by Juan Vucetich from Argentina, who collected fingerprints for identification of criminals. An example of automatic biometric system presented in literature is e given below in Figure 1.1.

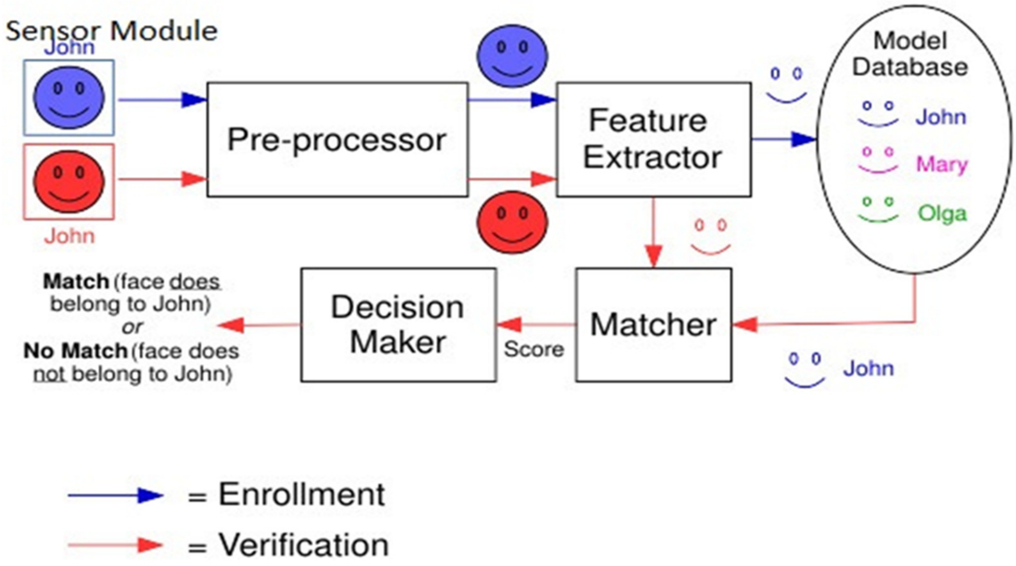

Figure 1.1: Example of classic biometric system [3]

The standard biometric system comprises of following different modules:

•**Sensor module:** -This module captures the biometric modalities and then the same are given as inputs to extract features from the next module.

•**Feature extraction module**: -This module extracts features from different modalities after completion of the pre-processing stage. This offers a compact representation of the extracted features or extracted modalities, which are supported for matching or comparing in addition to the next module.

•**Matching module:** - The extracted features are correlated with reference data or template(s) previously contained in the database in this module.

•**Decision making module:** - The consumer choice is either approved or refused in the Decision-Module. The product of the previously working agreements is used.

Either serial or parallel modes can be used to operate the multimodal bio-metric systems. When running in serial mode, a single module output is used before the next module joins the picture [5] to filter potential identities. The average machine detection period is shortened by this. The data of various modules is used simultaneously in parallel mode. The decision to approve or refuse could be taken at any degree of fusion in the case of any multimodal biometric device. Fusion can be performed at different level such as feature level, matching level or at a decision level.

1.1 OVERVIEW

Eye-based biometric systems are one of the most common and trusted biometric systems [6]. The remote detection of an individual using iris scans has very broad and diverse civil applications as well as surveillance applications. Good segmentation algorithms to exclude iris from region of the human eye will rely on the production of success. The texture of the area of human irises remains the same and persistent during human life span. Iris pattern and shape are not readily influenced and affected by external environmental conditions [7]. Iris recognition method is the most accurate, precise and reliable method mentioned in literature. The reliability and accuracy of the iris detection and recognition mechanism is result of extremely rich texture available in iris modal where shape and pattern is remain stable over person's lifespan.

The human iris can have different coloured layers in the eye (black, brown, blue, green, grey, hazel). The pupil diameter or scale is often regulated with two muscles known as sphincter and dilator. This monitors the light hitting the eye's retina (Figure 1.2). The smaller the pupil, the stronger the illumination in the eye.

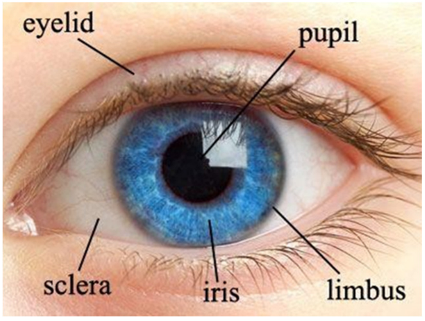

Figure 1.2: Anatomy of the human eye [8]

The human iris is made up of different colour pigments, colour passages and color furrows. We can randomly determine the details of iris texture of any human eye at the time of fetal development, and they always differ from person to person. For each individual they are also different for right and left eye also. More importantly the effect of environment cannot alter the characteristics of an iris of human eye [9].

Alphonse Bertillon initiated the iris-identification tradition in the middle of the 19th century, utilizing the symbolic eye colour [10]. There are 4 steps of the normal protocol for the detection of an iris. The first stage is the capturing of the image explaining the unit that takes the frame, the distance to be taken from the light source. The second stage is the recovery of the captured image. This stage can be separated into two more stages, the segmentation of the picture and image normalization. In the segmented picture the field of concern (in this instance, iris) from the whole picture is filtered and the filtered iris picture (shaped like a doughnut) is then converted into a rectangular picture coordinate from a cartesian coordinate in the image normalization process. The third stage is the extraction of the function, in which the individuality of the Iris is stripped and put in a vector attribute from the normalized image. It is then included in the fourth stage of corresponding models for experiments [11].

In this study, the first module implements a capable segment of irises, sclerosis and pupils from visual images with a clustering dependent on CNN entropy. The quality of iris, sclera and segmentation relies strongly on the segmentation. On the basis of entropy measurements CNN divides the iris, sclera regions here effectively. Further improve its performance second module uses an effective multimodal biometric system using support value based matching process. At first the iris, sclera regions are adequately segmented utilizing entropy-based CNN clustering. After that, the effective features are extricated for all the iris, sclera, pupil segments and dependent on the extracted features support value is estimated. Matching score at last determined to decide the user is recognized or Non-recognized.

1.2 MOTIVATION

Digital revolution in 21^{st} century indicates us that existence of small electronic gadgets, such as smartphone, digital watches, cameras can be used for biometric person identification in present era. As these electronic devices are portable and having low cost they can be used as biometric sensors for authentication. Commercial products used in biometric research have received huge attention due to the technological advances and revolution in digital sensors to secure the world. This promised to gain high security and trust in biometric universally. The biometric research conducted now a day identifies that the unimodal biometric systems cannot be Universal framework owing to problems of real-time systems intra-class disparities, disparities, universality, noisy results, spoof assaults, etc. To address these issues, we proposed multimodal biometric system by combining the information from multiple traits like iris, sclera, and pupil.

In comparison with all available human traits for biometric identification, iris recognition provides better results. Eye is intensely protected and stable from changes in environmental conditions and exterior activities [6]. Unique biometric features for left and right eye for an individual as well as for identical twins also differ in their features. In literature, we can find multiple biometric modalities like retina, iris, sclera, cornea, etc. Ocular and peri-ocular are two more emerging biometric systems established now a days [12]. A texture generated due to vein patterns available in iris (as labeled in Figure 1.2) is unique and stable which is used for each individual in biometric identification. Blood vessels of retina makes specific patters which help to identify user in biometric authentication. White part of eye known as sclera has red blood vessels forming complex mesh like structure which is utilized for biometric identification. Lately peri-ocular region surrounding the eye like skin color can also be used as biometric modality.

Eye traits provide discriminative features and detailed personal information distinguishing characteristics with higher stability of each user. Nevertheless, as every coin has two sides there are few disadvantages of existing biometric system as well such as user comfort and acceptances, participation level, robustness to change in various surrounding conditions. The procurement of eye traits is not a problem but vein pattern in sclera including the shape of cornea, retina, eyelid, eyelashes, and periocular region causes difficulties in attaining precise shape and patterns. Iris is most trustworthy trait in biometric measures [6]. Because of these few drawbacks more detailed persistent and prolonged research is requisite in this field.

When the position of the eye varies, the difficulty is eccentric which is common in people suffering from cock eye or squint. Person Identification becomes more difficult in such non ideal situation where the need of user involvement is gradually increases in acquisition of biometric traits. Furthermore, research in iris recognition is also vital in mobile environment. The key is to capture iris in visible spectrum in uncontrolled environment at different conditions. However, the iris recognition performance for dark irises in visible spectrum reduces drastically. To overcome this challenge, iris can be combined with another eye biometric modality. Therefore, multimodal eye biometric systems came into existence [6].

To use this concept however we have to first assess the given information of a sclera and iris of the human eye and determine if the combined information can be used for identification. It is also important to investigate this given information with regards to various parameters like population coverage, change in environmental conditions, time span and data mining techniques. To date, this biometrics method is not as vastly studied and casts a doubt regarding its usefulness.

In order that we can test our future multimodal biometrical system output through the combination of iris, pupil and sclera to enhance precision and adaptability, we are initiating research and development of an imaging processor and pattern recognition module. This will also lead to a deeper interest of discovering more in sclera biometrics. It is also essential to take in to accounts various feature extraction, classification and matching techniques which will help us to determine constructive methods to portray effective multimodal biometric system. But it tends to become more fascinating to understand the paradigm of multimodal biometric system using ocular biometry, sclera and iris due to properties mentioned above.

1.3 PROBLEM DESCRIPTION AND SCOPE OF RESEARCH

There are several issues that will be considered in this thesis for providing security and identification using a multimodal eye recognition system. Though several other works have focused on some of these issues, they have failed to consider parameters with images such as

- Unconstrained noisy environment
- Eye gaze and posture direction
- Capturing on-the-move and Blur image
- Wavelength of visible images
- Illumination, reflection, at-a-distance, etc.
- Reliability of distance iris images
- Efficient localization
- Accuracy of eyelash, eyelid's location estimation etc.

The issues which are not addressed in the existing research works contribute to main points of our research.

- Noise factors occurring in the image.
- Evaluation of various image qualities in terms of recognition rates.
- The quality measures of extracted image features.
- Image noise that affects the image pixel threshold.
- Boundary effects on the image shape.

Problem Statement

Design and develop efficient multimodal eye biometric system based on iris, sclera and pupil features for unconstrained eye images in visible wavelength to improve the accuracy of biometric recognition.

Objectives

The aim of the proposed research work is to design and develop an adaptive and effective multimodal biometric system culminating in the automated, secure and accurate biometric eye system for uncooperative users. We also identified some drawbacks from traditionally suggested methods and have taken them into account by integrating CBIR features for iris, pupil and sclera, we have tackled the multimodal eye biometry scheme. Finally, more study difficulties are listed below.

i. To develop an efficient multimodal biometric system, which uses the pupil, sclera and iris properties to enhance eye biometric performance in unconstrained environments.

ii. To design and develop fast and efficient segmentation algorithm to separate iris, sclera and pupil region for unconstrained colored eye images by reducing time required for segmentation.

iii. To design and develop an efficient quality feature selection and extraction method to improve accuracy of multimodal biometric system for relaxed viable wavelength eye images.

iv. To develop a better method for fusion of pupil, sclera and iris template to improve biometric system recognition performance.

1.4 CONTRIBUTIONS

Study of some recent development in biometric system for person authentication is carried out and based on literature following methodologies are proposed and presented in this thesis. To meet the objectives following contributions are made.

- A noisy eye image is segmented into iris, pupil and sclera regions to introduce a fully automated segmentation algorithm, by using active contour method with entropy based CNN (Convolutional Neural Network) where only quality features are considered to improve result of segmentation by time-consuming elimination.
- To reduce the number of features by preserving important information in image during feature extraction process of multimodal eye biometric system, we proposed multi algorithmic texture, color and Y-shaped feature extraction from segmented iris, pupil and sclera region.
- To perform the fusion for optimal number of features extracted from iris, pupil and sclera, we calculate quality score support value that are utilized in fusion process. Thus, the authenticated person is recognized by comparing support value with the biometric database.
- To analyses performance of proposed system, we evaluate performance of our methods on publicly available eye image research dataset MMU, UBIRIS.v2 and MICHE.

1.5 ORGANIZATION OF THE THESIS

This thesis structure is defined as below,

- Chapter 2 includes the analysis and identification for unconstrained visual representations of different methodologies and latest advances in the fields of iris, sclera and pupil segmentation. The survey of the multimodal eye biometric system is also carried out.
- Chapter 3 suggested proposed research methodology and progress on pupil, iris and sclera segmentation on the color eye images.
- Chapter 4 involves proposed methodology for the effective, entropy-based CNN clustering and support value-based fusion matching multimodal biometric framework.
- Chapter 5 incorporates the findings and discussions of successful segmentation of eye and multimodal biometric structures of the pupil, iris and sclera areas focused on entropy-based CNN clusters and support value-based fusion-associated study methodologies.
- Chapter 6 outlines the conclusion and suggests future scope for this research work.