M.Tech. Thesis

IRIS Biometric Identification System Based on Modified Canny Edge Detection Algorithm

Submitted in partial fulfillment of the requirements for the degree of
Master of Technology in Electronics & Communication Engineering

by

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October 2014

CERTIFICATE

I, **Arun Kaushik (96436882794)**, hereby declare that the work being presented in this thesis on IRIS Biometric Identification System Based on Modified Canny Edge Detection Algorithm is an authentic record of my own work carried out by me during my course under the supervision of Dr. Satvir Singh. This is submitted to the Department of ECE at Shaheed Bhagat Singh State Technical Campus, Ferozepur (affiliated to Punjab Technical University, Jalandhar) as partial fulfillment of requirements for award of the degree of Master of Technology in Electronics & Communication Engineering.

Arun Kaushik (96436882794)

To the best of my knowledge, this thesis has not been submitted to Punjab Technical University, Jalandhar or to any other university or institute for award of any other degree or diploma. It is further understood that by this certificate, the undersigned do/does not endorse or approve any statement made, opinion expressed or conclusion drawn therein, however, approve the thesis only for the purpose for which it is submitted.

Dr. Satvir Singh [Supervisor]

The M.Tech Viva-Voce Examination of Arun Kaushik (96436882794) is held at Department of ECE, SBS State Technical Campus, Ferozepur on **October 14, 2014**.

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for... Sanjeev Dewra
M.Tech. Coordinator, ECE

There are only two ways to live your life. One is as though nothing is a miracle. The other is as though everything is a miracle.

- Albert Einstein

Dedicated to

My Family & Guide

ACKNOWLEDGEMENTS

It gives me great pleasure in expressing my gratitude to all those people who have supported me and had their contribution in making this thesis possible. First and foremost, I must acknowledge and thanks The Almighty God for blessing, protecting and guiding me throughout this period. I could never have accomplished this without the blessings of my supervisor and promoter **Dr. Satvir Singh** , Associate Professor Department, of Electronics Communication Engineering, Shaheed Bhagat Singh State Technical Campus, Ferozepur, Punjab, India, for his constant guidance, support, motivation and untiring help during the course of my thesis. I can never forget the cheerful moment of my life he accepted me as research scholar. He has always been nice to me. I will always remember his calm and relaxed nature. Without his constant chase and help, this work could not have taken this shape. I am thankful to God for giving me a mentor like him.

My sincere thanks are to **Dr. T.S Sidhu**, Director SBS State Technical Campus, Ferozepur and to **Mr. Sanjeev Dewra**, Head ECE Department, SBS Sate Technical Campus, Ferozepur for facilities he providing me to accomplish this project.

I thankfully appreciate the help and support I received from my friends and Colleagues, **Mr.Puneet Sharma** CDMS in RCF, Kapurthla, **Miss Rashmi**FCET, Ferozeshah, **Mr.Atul Goel**, TCS Banglore.

I cannot imagine my current position without the love and support from my family. I thank my parents **Sh. Naresh Kaushik** and **Smt. Kanta Kaushik** for striving hard to provide a good education for me and my brother. I always fall short of words and feel impossible to describe their support in words. I would proudly mention that my parents are very simple and the taught me how to lead a simple life. It is their sacrifice and constant blessing that kept me motivated and committed, until I reached this end. More-over I would like to thank my elder brother **Mr. Ananddeep Kaushik** who made me awake early in the morning in my tough days of thesis and my bhabhi my Sister **Mrs. Bhawana Kaushik**, **Mrs.**

Mamta Kaushik who accomplished the tasks coming under domestic responsibilites and reduced my work. Her Coperation helped me alot in completing my thesis work.

Finally, I must thank GOD for giving me the environment to study, people to help, opportunities to encash and potential to succeed.

Place: SBS STC Ferozepur
Date: October 14, 2014 Arun Kaushik

LIST OF THESIS OUTCOMES

International Journals Publications/Submissions

1. S. Singh, Arun Kaushik, "IRIS Biometric Identification System Based on Modified Canny Edge Detection Algorithm", in IJCAT International Journal of Computing and Technology, Volume 1, Issue 4, May 2014 ISSN : 2348 6090

ABSTRACT

A biometric identification system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the an individual. Biometric information is used in computer science to authenticate some kind of access control. Most of biometric systems have been developed based on fingerprints, facial features, hand geometry, handwriting, voice and retina pattern etc. This technology makes use of physiological or behavioral characteristics to establish identify of an individual. A biometric system is a pattern recognition system that includes acquiring the biometric feature from an individual, extracting its feature vector from the raw data and comparing this feature vector with another feature vector stored in the database. We are living in an age in which demands increased security levels are increasing day by day. Consequently, biometric recognition came into existence, which is a safe, reliable and convenient technology for personal recognition. In this thesis the iris pattern has been investigated to design a biometric identification systems that works similar to that of voice recognition system or face identification system, in which sound signal or facial image is captured and then recognition is processed.

Major design steps involved in iris recognition system are given as follows:

Information/pattern Acquisition: This involves the acquisition of eye images from a group of persons. In this work, a database is created by collecting only left eye images and saved in .jpg file format.

Image Segmentation: This is a technique that excludes the artifacts and locates the circular iris region approximated by two circles; one for iris and another for Pupil boundary. The eyelashes and eyelids normally occlude the upper and lower parts of the iris region. The inner and the outer boundaries of the iris are determined algorithmically using Hough Transform after the edge detection.

Normalization: The iris images of different or same person normally captured differ in sizes and illuminations, etc. The normalization process produce iris regions with same fixed dimensions so have similar characteristic features at various spatial locations.

Binarization: In current techniques, the binarization is usually performed either globally or locally. However some hybrid methods have also been proposed in the recent literature. The global binarization methods use one pre-calculated threshold value to distinguish image pixels into object and background classes. Whereas the local binarization schemes may have many different adapted threshold values selected according to the local area information. Hybrid methods use both global and local information to decide the pixel label. In binarization, each pixel is converted into one bit having 1 or 0 value depending upon the mean of all adjacent pixels.

Feature Extraction: Significant features of an iris are required to be extracted so as to compare their templates images. Most of iris recognition systems make use of a band pass decomposition of an iris image to create a biometric template. It provides texture information in the form a feature vector, i.e., a ordered sequence of features extracted from the iris image.

Improved Canny Edge Detection: Canny Edge Detection algorithm is well known algorithm for optimal edge detection. It works on three main principle; low error rate, well localization of edge point and one response to a single edge. To enhance the edge detection methods. Canny proposed two new techniques in his algorithm, viz. Non maximum suppression and Double threshold to select the edge points. However, these two threshold value are set experimentally.

Authentication is required when there is a need to know about a person who they claim to be. It is a procedure which involves a person making a claim about his identity and then

providing evidence to prove it. In this thesis, iris biometric identification system has been implemented in MATLAB environment that uses modified Canny Edge Detection algorithm for segmentation, binarization and cropping. Feature extraction is done by normalization and feature encoding process followed by matching process based on manhattan distance. Experimental simulation results are analysed on the basis of (False Acceptance Rate) FAR and (False Rejection Rate) FRR and found better. Modified Canny Edge Detection algorithm provides accuracy up to 99.08 on the basis of FAR and FRR.

Place: Ferozepur | Arun Kaushik

Date: October 14, 2014

ABBREVIATIONS

Abbreviations	Description
FAR	False Acceptance Rate
FRR	False Rejection Rate
DCT	Discrete Cosine Transform
CRR	Correct Recognition Rate
ROC	Receiver-Operating Characterstic.
RGB	Red Green Blue
HD	Hamming Distance
MD	Manhattan Distance
CASIA	Chinese Academy of Sciences Institute of Automation
IRIS	Image Recognition Integrated Systems
UBIRIS	Upper Bound Image Recognition Integrated Systems
LBIRIS	Lower Bound Image Recognition Integrated Systems
RAD	Rapid Application Development

NOTATIONS

Symbols	**Description**
x	One data Point
y	Another Data Point
d	Distance
N	Number Of Element
xi	Maximum Possible data point
yi	Maximum possible another data point

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CHAPTER 1

INTRODUCTION

This thesis presents investigational studies in IRIS Biometric Identification optimization using Modified Canny Edge Detection Algorithm and their use in Iris Recognition System. This introductory chapter presents an overview of thesis. This includes introduction to research topic, motivation, methodologies, contributions, research findings and organization of thesis.

1.1 Introduction

A biometric system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric systems have been developed based on fingerprints, facial features, voice, hand geometry, handwriting, the retina and the one presented in this thesis, the iris. Biometric systems work by first capturing a sample of the feature, such as recording a digital sound signal for voice recognition, or taking a digital colour image for face recognition. The sample is then transformed using some sort of mathematical function into a biometric template. The biometric template will provide a normalised, efficient and highly discriminating representation of the feature, which can then be objectively compared with other templates in order to determine identity. Most biometric systems allow two modes of operation. An enrolment mode for adding templates to a database, and an identification mode, where a template is created for an individual and then a match is searched for in the database of pre-enrolled templates. A good biometric is characterised by use of a feature that is; highly unique so that the chance of any two people having the same characteristic will be minimal, stable so that the feature does not change over time, and be easily captured in order to provide convenience to the user, and prevent misrepresentation of the feature Abhyankar and Schuckers [2010].

1.1.1 The Human Iris

The iris is a thin circular diaphragm, which lies between the cornea and the lens of the human eye. The iris is perforated close to its centre by a circular aperture known as the pupil. The function of the iris is to control the amount of light entering through the pupil, and this is done by the sphincter and the dilator muscles, which adjust the size of the pupil. The average diameter of the iris is 12 mm, and the pupil size can vary from 10% to 80% of the iris diameter Wildes et al. [1994]. The iris consists of a number of layers, the lowest is the epithelium layer, which contains dense pigmentation cells. The stromal layer lies above the epithelium layer, and contains blood vessels, pigment cells and the two iris muscles. The density of stromal pigmentation determines the colour of the iris. The externally visible surface of the multi-layered iris contains two zones, which often differ in colour. An outer ciliary zone and an inner pupillary zone, and these two zones are divided by the collarette which appears as a zigzag pattern Vatsa et al. [2008].

1.2 Motivation

A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. Most commercial iris recognition systems use patented algorithms developed by Daugman, and these algorithms are able to produce perfect recognition rates. Especially it focuses on image segmentation and feature extraction for iris recognition process. The performance of iris recognition system highly depends on edge detection. The Canny Edge Detector is one of the most commonly used image processing tools, detecting edges in a very robust manner. For instance, even an effective feature extraction method would not be able to obtain useful information from an iris image that is not segmented properly. The used method determines an automated global threshold and the pupil center. Experiments are performed using iris images obtained from CASIA database (Institute of Automation, Chinese Academy of Sciences) and Matlab application for its easy and efficient tools in image manipulation.

1.3 Objectives

The primary objectives of this research work are summarized as follows:

1. Develop a environment of Iris Edge Detection having configurable parameters.
2. To study previous Iris Recognition System and their features.
3. Investigation in Canny Edge Detection algorithm with an application of optimizing Iris recognition.

1.4 Methodology

The methodology followed in this thesis is:

1. To detailed literature survey is done from eminent journals like IEEE, Elsevier and springer, etc. This will provide the basic and conceptual knowledge of the domain.
2. A MATLAB programming environment is used development of algorithm for Improved Canny Edge detection.
3. Improved Canny Edge Detection is supposed to be one of the most significant algorithm proposed in Iris Recognition.
4. Iris Recognition is again implemented with Improved Canny Edge Detection.
5. Parameters is re-investigated in this thesis.
6. A comparative analysis for various Iris Recognition parameters are then conducted.

1.5 Contributions

The main contributions of this report are:

1. To Develop a environment of Iris Edge Detection having configurable parameters.
2. To create Improved Canny Edge Detection Algorithm on MATLAB for optimizing its various parameters.
3. To explore Improved Canny Edge Detection for Iris Recognition.
4. To experiment the Iris Recognition with Improved Canny Edge Detection using MATLAB for better performance in terms of Edge Detection and Other parameters.

1.6 Thesis Outline

After the brief introduction to M.Tech thesis given in Chapter 1, detailed study of the historical research in optimizing, both single objective and multi-objective, Iris Recognition with Improved Canny Edge Detection techniques reported till date is represented in Chapter 2.

Chapter 3 is devoted to multiobjective problems, classical approaches used to solve these problems, Improved Canny Edge Algorithm solution to these set of problems.

Chapter 4 is dedicated to study of Edge Detection, literature of Canny Edge Detection, Improved Canny Edge Detection algorithms flow and its variants reported till date.

Chapter 5 devotes understanding of various Method of IRIS Recognition. Here FAR, FRR obtained during simulation results are also represented for better understanding.

Lastly, Conclusion and future scopes of this research are discussed in Chapter 6.

CHAPTER 2

LITERATURE SURVEY

The needed detailed literature survey, to get preliminary knowledge and search scope of investigation, to get preliminary knowledge and search scope of investigation, to design a Improved Canny Edge Detection for optimization of its various parameters, i.e., Segmentation, Feature extraction, Binarization, Manhatten distance simultaneously, is explained in this chapter. The principal concepts & developments that occurred till date, in these domains of research are presented in this chapter with a case built up for taking investigations that this thesis does.

2.1 Introduction

Human identification based on iris is becoming a famous tool rapidly as compared to other biometric recognition techniques due to its unique epigenetic pattern remains stable. The rapid development in the field of digital image processing makes it very affordable and automated for digitized iris images. Evenly, the characterization and classification spatial iris patterns help to recognize the individual comfortably. The cornea and the eyelid act as a shield for the iris and protect it from adverse environmental effects. These in all inherent properties makes iris recognition as the most suitably security solution. The very first automated iris recognition concept was given by Flom and Safir in the year 1987 based on the fact that varying the illumination to force pupil to a predetermined size to overcome with the problem of contraction and expansion of pupil. But the imaging conditions they addressed were not that practical. Then the most widely used methodology was developed by Daugman has used multi-scale quadrature wavelets to extract texture phase features of the iris to generate iris templates and compared the difference between a pair of those by computing their Hamming distance (HD). Another popular iris recognition system developed in the same year was Wildes' system which also provides high accuracy. Wildes et al. have represented the iris pattern with a Laplacian pyramid constructed with four different resolution levels and has used the normalized correlation to determine whether the input image and the test image are from the same class. Later, Boles and Boashash have used 1-D wavelet transform for calculating zero-crossing representation at various resolution levels of a virtual circle on an iris image to characterize the texture of the iris. The current iris recognition techniques basically comprise four main stages: segmentation, normalization, feature extraction and matching Boles and Boashash [1998].

2.2 Survey on Improved Canny Edge Detection for Iris Recoginition

Iris Recognition is one of the most powerful biometrically based technologies for human identification and verification that utilizes the iris patterns which exhibits uniqueness for every individual. In this manuscript, a new algorithm is proposed for iris recognition on distant images. The novelty of this algorithm includes recognition through iris patterns based on both the left and right eye of an individual so as to improve the recognition accuracy and computational efficiency. Experimental tests were performed using CASIA Iris Distance Database which a subset of CASIA V4 Database. The methodology found encouraging development in the field of Iris RecognitionChen et al. [2006].

Applications such as immigration control, aviation security, bank and other financial transactions, access to defence organization requires a more reliable and authentic identification system. Iris is now considered to be one of the most time invariable biometric features of a person for recognition. Several iris recognition techniques were proposed with considerable focus on improving the false acceptance rate and minimizing false rejection rate. Most of the proposed techniques are tested with Mat lab and not keeping the detection and recognition time in mind. In this work we propose a novel iris recognition system with iris localization to segment and recognize color iris with highest speed and accuracy Chowhan et al. [2011]. Frequency domain magnitude and phase features are used for image feature representation. Support vector machines with winner takes it all configuration are used for classification. Tests shows 97% accuracy with average time of 31 milliseconds seconds for classifying each test image.

A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. In this paper, we describe the novel techniques we developed to create an Iris Recognition System, in addition to an analysis of our results. We used a fusion mechanism that amalgamates both, a Canny Edge Detection scheme and a Circular Hough Transform, to detect the irisboundaries in the eyes digital image. We then applied the Haar wavelet in order to extract the deterministic patterns in a persons iris in the form of a feature vector. By comparing the quantized vectors using the Hamming Distance operator, we determine finally whether two irises are similar. Our results show that our system is quite effective.

Biometrics has become important in security applications. In comparison with many other biometric features, iris recognition has very high recognition accuracy because it depends on iris which is located in a place that still stable throughout human life and the probability to find two identical iris's is close to zero. The identification system consists of several stages including segmentation stage which is the most serious and critical one. The current segmentation methods still have limitation in localizing the iris due to circular shape consideration of the pupil. In this research, Daugman method is done to investigate the segmentation techniques. Eyelid detection is another step that has been included in this study as a part of segmentation stage to localize the iris accurately and remove unwanted area that might be included. The obtained iris region is encoded using haar wavelets to construct the iris code, which contains the most discriminating feature in the iris pattern. Hamming distance is used for comparison of iris templates in the recognition stage. The data set which is used for the study is UBIRIS database. A comparative study of different edge detector operator is performed. It is observed that canny operator is best suited to extract most of the edges to generate the iris code for comparison. Recognition rate of 89% and rejection rate of 95% is achieved.

2.3 Developments in Hierarchical for iris recoginition

The richness and apparent stability of the iris texture make it a robust biometric trait for personal authentication. The performance of an automated iris recognition system is affected by the accuracy of the segmentation process used to localize the iris structure. In case of wrong segmentation, wrong features will be extracted and hence, may lead to false identification results. Most of the authors propose Circular Hough Transform to localize the boundary of IRIS. But the problem with this technique is its high consumption of time and memory. It also requires a precise estimated range of the boundary and it fails to localize the IRIS if the correct estimation is not provided. The proposed technique follows a basic strategy and obtains the major boundaries, by using canny edge detector. Features have been extracted using Curvelets Transform; Principal Component Analysis is then used to reduce the dimension of the features. Then SVM has been used as classifier. The implementation of recognition method has shown encouraging results.

Doye et al. [2002] proposed This paper proposes algorithms for iris segmentation,quality enhancement, match score fusion, and indexing to improve both the accuracy and the speed of iris recognition. A curve evolution approach is proposed to effectively segment a nonideal iris image using the modified MumfordShah functional. Different enhancement algorithms are concurrently applied on the segmented iris image to produce multiple enhanced versions of the iris image. A support-vector-machine-based learning algorithm selects locally enhanced regions from each globally enhanced image and combines these good-quality regions to create a single high-quality iris image. Two distinct features are extracted from the high-quality iris image. The global textural feature is extracted using the 1-D log polar Gabor transform, and the local topological feature is extracted using Euler numbers. An intelligent fusion algorithm combines the textural and topological matching scores to further improve the iris recognition performance and reduce the false rejection rate, whereas an indexing algorithm enables fast and accurate iris identification. The verification and identification performance of the proposed algorithms is validated and compared with other algorithms using the CASIA Version 3, ICE 2005, and UBIRIS iris databases.

A human iris coding technique is reported based upon differences in the power spectrum of fragments from normalized iris images. The procedure has been applied to a set of 2174 images from 308 eyes and tuned over a range of parameters. For identity recognition, 100% correct recognition is achieved using a weighted Hamming Distance metric. For identity verification, a variable threshold is applied to the distance metric and the False Acceptance and False Rejection Rates are recorded. After tuning the various parameters, the method achieves the lowest False Acceptance Rate at the point of first False Rejection amongst the three algorithms tested, as well as the lowest complexity.

Du [2006] proposed This paper presents a novel iris coding method based on differences of discrete cosine transform (DCT) coefficients of overlapped angular patches from normalized iris images. The feature extraction capabilities of the DCT are optimized on the two largest publicly available iris image data sets, 2,156 images of 308 eyes from the CASIA database and 2,955 images of 150 eyes from the Bath database. On this data, we achieve 100 percent Correct Recognition Rate (CRR) and perfect Receiver-Operating Characteristic (ROC) Curves with no registered false accepts or rejects. Individual feature bit and patch position parameters are optimized for matching through a product-of-sum approach to Hamming distance calculation. For verification, a variable threshold is applied to the distance metric and the False Acceptance Rate (FAR) and False Rejection Rate (FRR) are recorded.

Gonzalez et al. [2004] proposed A novel eyelash removal method for preprocessing of human iris images in a human iris recognition system is presented. The method filters each occluded pixel along an axis perpendicular to the eyelash direction, and accepts the filtered value if it changes by more than a certain threshold. This allows partially occluded regions of the iris to be included in iris coding which would previously have been excluded. The method is applied with three iris coding algorithms on an extended 308 class CASIA database and large improvements are shown in the matching performance of two methods, with a modest improvement in the third.

Jain et al. [2000] proposed Edge detection process has a widespread usage in computer vision applications. But it has a different output when its input image changes from color to grayscale. This changeability of results make us add modification on edge detection process procedures to correctly detect all those edges in color images that cant be detected in gray ones. This research reviews the proposed solution of Dutta and Chaudhuri on color edge detection algorithm that works using RGB color space, detects problem of a huge set of undetected edges by their proposed algorithm and find solutions for that, and applies complexity and performance analysis and experiments to compare the proposed algorithm with Canny and Sobel edge detection algorithms Zhao et al. [1998].

Kanth and Giridhar [2010] proposed By introducing rotation compensation into a human iris matching system, improved matching is demonstrated while reducing both the computational complexity and storage requirements. This is achieved by using Fourier domain cross correlation to estimate the relative rotation of two iris images. This eliminates the need to store and compare codes from multiple orientations of the same image. Instead, only one code is stored, plus the Discrete Fourier Transform of an annular segment derived from the iris. In addition, the cross correlation function can be used as a biometric either on its own or in combination with other iris codes. A Peak to Sidelobe Ratio metric is used to discriminate matching and non-matching correlation functions. Used to preselect irises for matching, the method greatly reduces feature-vector comparisons. Alternatively a cascaded classifier approach can be used, with the correlation stage tuned to make no false rejections, followed by a Hamming distance metric on a standard iris code. The performance and robustness of the new technique are tested on the CASIA iris image database synthetically altered to generate rotated, noisy and randomly occluded normalized iris images. Improved matching performance is achieved with a 21 times reduction in matching time.

Gonzalez et al. [2004] proposed Iris recognition is a rapidly expanding method of biometric authentication that uses pattern- recognition techniques on images of irises to uniquely identify an individual. been extensively deployed in commercial iris recognition systems for various security applications and more than 50 million persons have been enrolled using Iris Code recognition is the most promising for high environments among various biometric techniques (face, fingerprint, palm vein, signature, palm print, iris, etc.) because of its unique, stable, and noninvasive characteristics code is a set of bits, each one of which indicates whether a given bandpass texture filter applied at a given point on the iris image has a negative or nonnegative results. Unlike other biometrics such as fingerprints and face, the distinct aspect of iris comes from randomly distributed features. The iris patterns of the two eyes of an individual or those of identical twins are completely independent and uncorrelated. Irises not only differ between identical twins, but also between identical twins, but also between the left and right eye. Another characteristic which makes the iris difficult to fake is its responsive nature. cameras used for iris acquisition are less intrusive compared to earlier iris scanning devices. Iris detection is one of the most accurate, robust and secure means of biometric identification while also being one of the least invasive. The iris has the unique characteristic of very little variation over a lifes period yet a multitude of variation between individuals.

Kanth and Giridhar [2010] proposed biometric recognition is a common and reliable way to authenticate the identity of a living person based on physiological or behavioral characteristics. A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, hand silhouette, etc. This kind of measurement is basically unchanging and unalterable without significant duress. A behavioral characteristic is more a reflection of an individuals psychological makeup as signature, speech pattern, or how one types at a keyboard. The degree of intra-personal variation in a physical characteristic is smaller than a behavioral characteristic. For examples, a signature is influenced by both controllable actions and less psychological factors, and speech pattern is influenced by current emotional state, whereas fingerprint template is independent. Nevertheless all physiology-based biometrics dont offer satisfactory recognition rates (false acceptance and/or false reject rates, respectively referenced as FAR and FRR). The automated personal identity authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods. We consider that the probability of finding two people with identical iris pattern is almost zero. Thats why iris recognition technology is becoming an important biometric solution for people identification in access control as networked access to computer application.Compared to fingerprint, iris is protected from the external environment behind the cornea and the eyelid. No subject to deleterious effects of aging, the small-scale radial features of the iris remain stable and fixed from about one year of age throughout life.

Tian et al. [2004] proposed In this paper we propose a new biometric-based Iris feature extraction system. The system automatically acquires the biometric data in numerical format (Iris Images) by using a set of properly located sensors. We are considering camera as a high quality sensor. Iris Images are typically color images that are processed to gray scale images. Then the Feature extraction algorithm is used to detect IRIS Effective Region (IER) and then extract features from IRIS Effective Region (IER) that are numerical characterization of the underlying biometrics. Later on this work will be helping to identify an individual by comparing the feature obtained from the feature extraction algorithm with the previously stored feature by producing a similarity score. This score will be indicating the degree of similarity between a pair of biometrics data under consideration. Depending on degree of similarity, individual can be identified. Authentication is also a major concern area of this thesis. By considering Biological characteristics of IRIS Pattern we use Statistical Correlation Coefficient for this IRIS Pattern recognition where Statistical Estimation Theory can play a big role.

Boles and Boashash [1998] proposed The human iris recently has attracted the attention of biometrics-based identification and verification research and development community. The iris is so unique that no two irises are alike, even among identical twins, in the entire human population. Automated biometrics-based personal identification systems can be classified into two main categories: identification and verification. In a process of verification (1-to-1 comparison), the biometrics information of an individual, who claims certain identity, is compared with the biometrics on the record that represent the identity that this individual claims. The comparison result determines whether the identity claims shall be accepted or rejected. On the other hand, it is often desirable to be able to discover the origin of certain biometrics information to prove or disprove the association of that information with a certain individual. This process is commonly known as identification (1-to-many comparison). Actual iris identification can be broken down into four fundamental steps. First, a person stands in front of the iris identification system, generally between one and three feet away, while a wide angle camera calculates the position of their eye. A second camera zooms in on the eye and takes a black and white image. After the iris system has one's iris in focus, it overlays a circular grid (zones of analysis) on the image of the iris and identifies where areas of light and dark fall. The purpose of overlaying the grid is so that the iris system can recognize a pattern within the iris and to generate points within the pattern into an eyeprint. Finally, the captured image or eyeprint is checked against a previously stored reference template in the database. The time it takes for a iris system to identify your iris is approximately two seconds. In the iris alone, there are over 400 distinguishing characteristics, or Degrees of Freedom (DOF), that can be quantified and used to identify an individual. Although, approximately 260 of those are possible to captured for identification. These identifiable characteristics include: contraction furrows, striations, pits, collagenous fibers, filaments, crypts (darkened areas on the iris), serpentine vasculature, rings, and freckles. Due to these unique characteristics, the iris has six times more distinct identifiable features than a fingerprint.

A human iris coding technique is reported based upon differences in the power spectrum of fragments from normalized iris images. The procedure has been applied to a set of 2174 images from 308 eyes and tuned over a range of parameters. For identity recognition, 100% correct recognition is achieved using a weighted Hamming Distance metric. For identity verification, a variable threshold is applied to the distance metric and the False Acceptance and False Rejection Rates are recorded. After tuning the various parameters, the method achieves the lowest False Acceptance Rate at the point of first False Rejection amongst the three algorithms tested, as well asthe lowest complexity.

Wildes et al. [1994] proposed The resilience of identity verification systems to subsampling and compression of human iris images is investigated for three high-performance iris-matching algorithms. For evaluation, 2156 images from 308 irises from the extended Chinese Academy of Sciences Institute of Automation database were mapped into a rectangular format with 512 pixels circumferentially and 80 radially. For identity verification, the 48 rows that were closest to the pupil were taken and images were resized by subsampling their Fourier coefficients. Negligible degradation in verification is observed if at least 171 circumferential and 16 radial Fourier coefficients are preserved, which would correspond to sampling the polar image at 342×32 pixels.With JPEG2000 compression, improved matching performance is observed down to 0.3 b/pixel (bpp), attributed to noise reduction without a significant loss of texture. To ensure that the iris-matching algorithms studied are not degraded by image compression, it is recommended that normalized iris images should be exchanged at 512×80 pixel resolution, compressed by JPEG 2000 to 0.5 bpp. This achieves a smaller file size than the ANSI/INCITS 379-2004 iris image interchange format.

Vatsa et al. [2008] proposed A new approach to iris recognition system is proposed in this paper. The iris images are captured using digital camera. The edges of the eye image are traced using canny edge detection. Segmentation is done to find the inner and outer edge of the iris region. Segmentation is done by selecting appropriate threshold approximately in the range 60 to 80 and applying Extended Minima transform. Binary code representation via phase of Daubechies wavelet is computed from each iris image and a minimum Euclidean distance classifier is applied for matching process. This approach is proved to be efficient and has less error rate for iris images captured using digital camera. Biometrics analyze human body characteristics, such as DNA, eye retinas and irises, finger print, voice patterns, facial patterns and hand measurements for authentication purposes. The method of identification based on biometric characteristics is preferred over traditional passwords and PIN based methods. Iris recognition has been recently given greater attention in human identification and it's becoming increasingly an active topic in research. Iris patterns are well protected from the external environment and cannot be stolen, copied, stored or imitated. John Daugman developed and introduced the application and usage of iris as a biometric characteristic for individual identification. He has used 2D Gabor filters and phase coding to obtain 2048 binary feature code and tested his algorithm on many images successfully. The iris texture is unique from one person to other ones. Wildes proposed iris recognition, as an emerging biometric technology. The motivation for this endeavour stems from the observation that the human iris provides a particularly interesting structure on which to base a technology for non-invasive biometric assessment. Since the iris is an overt body, its appearance is amenable to remote examination with the aid of a machine vision system.

Rakshit and Monro [2007] proposed This paper presents a human iris recognition system in unconstrained environments in which an effective method is proposed for localization of iris inner and outer boundaries. In this method, after pre-processing stage, circular Hough transform was utilized for localizing circular area of iris inner and outer boundaries. Also, through applying linear Hough transform, localization of boundaries between upper and lower eyelids occluding iris has been performed. In comparison with available iris segmentation methods, not only has the proposed method a relatively higher precision, but also compares with popular available methods in terms of processing time. Experimental results on images available in CASIA database show that the proposed method has an accuracy rate of 97.50%.

Miyazawa et al. [2005] proposed A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. Most commercial iris recognition systems use patented algorithms developed by Daugman, and these algorithms are able to produce perfect recognition rates. Especially it focuses on image segmentation and feature extraction for iris recognition process. The performance of iris recognition system highly depends on edge detection. The Canny Edge Detector is one of the most commonly used image processing tools, detecting edges in a very robust manner. For instance, even an effective feature extraction method would not be able to obtain useful information from an iris image that is not segmented properly. This paper presents a straightforward approach for segmenting the iris patterns. The used method determines an automated global threshold and the pupil center. Experiments are performed using iris images obtained from CASIA database (Institute of Automation, Chinese Academy of Sciences) and Matlab application for its easy and efficient tools in image manipulation.

Monro and Rakshit [2007] proposed In this work, improved performance is obtained in human iris matching systems using a Fourier-based description to approximate non-circular pupil boundaries in human eyes. The study also leads an analysis of pupil shape. Excellent fitting is obtained for non-ideal cases such as oblong, irregular, off-centre and dilated pupils, and improved iris normalization is obtained compared to best fit circles. The method is applied to 1912 eye images of 478 eyes from the Bath database and the effect of increasing the number of Fourier coefficients on the pupil outline accuracy is studied. The RMS pixel error between the outline and actual edge points is seen to decrease from 1.48 (for circles) to 0.34 (for 9 coefficients). Only 21 cases are found to produce low deviations from a circular boundary, indicating that a majority of pupils (98.9%) are non-circular. The Equal Error Rate (EER) in verification using the new method is estimated to be significantly reduced, at 7.5×10^5 compared to 1.2×10^4 for pupils fitted as circular.

Das et al. [2009] proposed An iris coding method based on zero crossings of Discrete Cosine Transform (DCT) coefficients between rectangular patches from normalized iris images is shown to provide excellent matching performance at low complexity. The method is applied to two sets of normalized iris images; 2156 images of 308 eyes from the CASIA database and 2955 images of 150 eyes from the Bath database. A product-of-sum approach to Hamming distance calculation is taken and 100% Correct Recognition Rate (CRR) achieved for identification. For verification, a variable threshold is applied to the distance metric and the False Acceptance and False Rejection Rates (FAR, FRR) recorded. The method achieves perfect Receiver Operating Characteristics (ROC), i.e. no false accepts or rejects are registered. A new metric for evaluating practical system performance is proposed and the theoretical equal error rate (EER) estimated from the Hamming Distance distributions is found to be as low as 2.59×10^4.

Tisse et al. [2002] proposed By introducing rotation compensation into a human iris matching system, improved matching is demonstrated while reducing both the computational complexity and storage requirements. This is achieved by using Fourier domain cross correlation to estimate the relative rotation of two iris images. This eliminates the need to store and compare codes from multiple orientations of the same image. Instead, only one code is stored, plus the Discrete Fourier Transform of an annular segment derived from the iris. In addition, the cross correlation function can be used as a biometric either on its own or in combination with other iris codes. A Peak to Sidelobe Ratio metric is used to discriminate matching and non-matching correlation functions. Used to preselect irises for matching, the method greatly reduces feature-vector comparisons. Alternatively a cascaded classifier approach can be used, with the correlation stage tuned to make no false rejections, followed by a Hamming distance metric on a standard iris code. The performance and robustness of the new technique are tested on the CASIA iris image database synthetically altered to generate rotated, noisy and randomly occluded normalized iris images. Improved matching performance is achieved with a 21 times reduction in matching time.

2.4 Parameters in Iris Recognition

We have successfully developed a new Iris Recognition system capable of fulfilling all the respective stages of iris recognition efficiently. Our experimental result shows that using a fusion of canny operator and Hough transform we have localized our iris better than Daugmans integro-differential operator and also the Harr transform is better than Daugmans Gabor transform technique. A Sclera recognition system can also be designed for biometric identification purpose.

2.5 Conclusion

In the proposed system a new technique is used at level of segmentation. Matching of the system is on the basis of Manhattan Distance. In this the first step of recognition system is segmentation. Which can be performed by both canny and Improved canny to measure compare the performance. The second step is feature extraction and then preparing a template which can be used for matching at testing phase. Performance of Improved canny based iris recognition system is better than the Canny based iris recognition system which can be calculated by calculating accuracy. The accuracy of the proposed system is 99.08%. Future work could go in the direction of using more than one modality to increase the level of security.

CHAPTER 3

IMPROVED CANNY EDGE DETECTION ALGORITHM

In this chapter, the multiobjective problems and the derived optimization techniques are discussed. In two objective problem, both the objectives can be maximized, minimized or there can be a conflict for maximizing one objective and minimizing another objective. This chapter is dedicated to obtain the solutions for such conflicting objective problems.

3.1 Introduction

Pattern recognition algorithms generally provide a reasonable answers for all possible inputs and to perform matching of the inputs, taking into account their statistical variation. This is opposite to pattern matching algorithm that provides the interclass and intra class variability. Iris recognition technique is based on biometric information of the subject and used to authenticate the access control. Iris is located between the cornea and lens of eye. It provides personal identification of an individual based on a unique features possessed by human iris. Iris recognition system involve image acquisition localization and pattern Matching. Image acquisition is the process which deals with the capturing of a high quality image of the iris with the help of a digital camera. Iris localizations is the process which delimits the iris from rest of acquired image. Whereas in pattern matching involves segmentation and feature extraction and determination and manhattan distance from the previously stored information in the database. In this work, we use Improved edge detections and compared with that of Canny Edge Detector performing the segmentation. This is a new technique in iris recognition field that helped novel approach applied recognition performance. We use MATLAB tool to implement our work with samples of iris image collected samples from 5 people are used for training and testing purposes Jain et al. [2000].

3.2 Application of Canny in Iris recognition

A biometric identification system provides automatic recognition of an individual based on some sort of unique feature or characteristic possessed by the individual. Biometric information is used in computer science to authenticate same kind of access control. Biometric systems have been developed based on fingerprints, facial features, hand geometry, handwriting, voice, retina and the one presented in this thesis the iris this biometric identification systems works in the same way as that of voice recognition system pattern. Where sample sound signal is recorded and facial colored digital image is captured for face recognition system. Many of the biometric identification systems follow two modes of operation. Firstly sample is transformed using some mathematical function into a biometric template that provides normalized and high discriminating feature representation. Secondly those features than objectively compared with other present in the database in order to determine identity. Many of the biometric systems allow two modes of operation. We are living in the age in which the demand on security is increasing day by dayKanth and Giridhar [2010]. Consequently, biometric recognition came into existence, which is a safe, reliable and convenient technology for personal recognition. This technology makes use of physiological or behavioral characteristics to establish identify of an individual. A biometric system is a pattern recognition system that includes acquiring the biometric feature from an individual, extracting its feature vector from the raw data and comparing this feature vector with another feature vector store in the database. Face, Fingerprint, palm-prints,iris, gait, speech and signature are widely used biometric features. Biometric recognition are used in computer network login, internet access, ATM, credit card, national ID card, driver's license and so on. Nowadays, fingerprint recognition is widely and successfully used. Face recognition is studied by many scholars and experts. Iris recognition is a relatively new branch of biometric recognition. The human iris is the annular part between pupil and sclera. That has distinct feature such as freckles, coronas, stripes, and furrows, etc

3.2.1 Improved Canny edge Detection: General Principles

Authentication is required when there is a need to know about a person who they claim to be. It is a procedure which involves a person making a claim about their identity and then providing evidence to prove it. In this paper, iris biometric identification system has been presented that uses modified Canny Edge Detection algorithm for segmentation, binarization

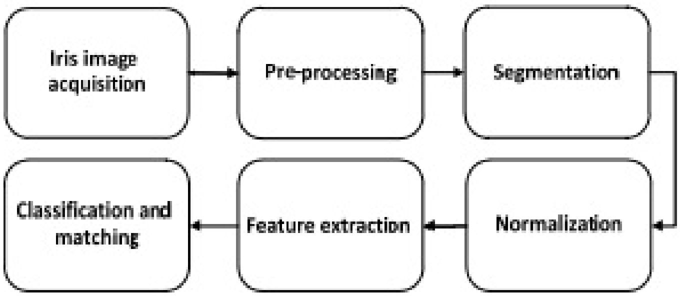

Figure 3.1: Block diagram of an iris recognition system

and cropping. Feature extraction is done by normalization and feature encoding process followed by matching process based on manhattan distanceMaltoni et al. [2009].

Figure shows block diagram for a biometric system of iris recognition in unconstrained environments in which each blocks function is briefly discussed as follows:

1. Image acquisition: in this stage, a photo is taken from iris.
2. Pre-processing: involving edge detection, contrast adjustment and multiplier.
3. Segmentation: including localization of iris inner and outer boundaries and localization of boundary between iris and eyelids.
4. Normalization: involving transformation from polar to Cartesian coordinates and normalization of iris image.
5. Feature extraction: including noise removal from iris image and generating iris code.
6. Classification and matching: involving comparing and matching of iris code with the codes already saved in database. Regarding the fact that in an unconstrained environment iris may have occlusions caused by upper or lower eyelids or eyes may roll left and rightwards, as the paper goes on, these blocks are introduced and such issues are solved.

3.2.2 Image acquisition

Taking a photo from iris is the initial stage of an iris-based recognition system. Success of other recognition stages is reliant on the quality of the images taken from iris during image acquisition stage. Images available in CASIA database lack reflections in pupil and iris areas because infrared was used for imaging. Additionally, if visible light is used during imaging for those individuals whose iris is dark, a slight contrast comes to existence between iris and pupil which makes it hard to separate these two areas.

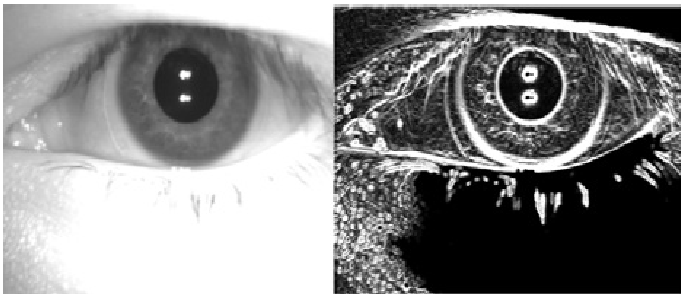

FIGURE 3.2: An eye image from CASIA database and the results of preprocessing performed.

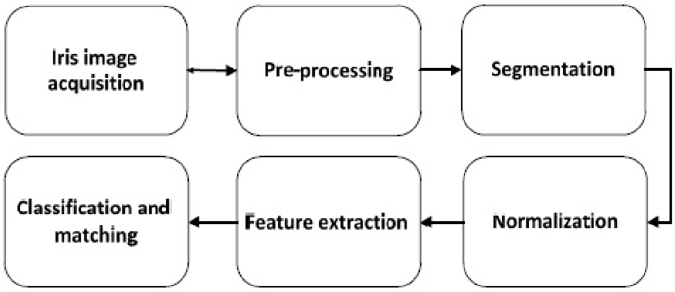

FIGURE 3.3: Block diagram of segmentation stage.

3.2.3 Pre-processing

Initially, in order to improve and facilitate later processing, a primary processing is performed on iris images. In pre-processing stage, Canny edge detection is used to enhance iris outer boundary that is not recognized well in normal conditions, and a multiplier function is used to enhance Canny iris points, also image contrast adjustment is performed to make its pixels brighter. Figure shows a sample of an eye image and the results of preprocessing stage performed.

3.2.4 Segmentation

Precise iris image segmentation plays an important role in an iris recognition system since success of the system in upcoming stages is directly dependent on the precision of this stage. The main purpose of segmentation stage is to localize the two iris boundaries namely, inner boundary of iris-pupil and outer one of iris-sclera and to localize eyelids. Figure shows block diagram of segmentation stage. As it could be seen in this figure, segmentation.

stage includes three following steps:

1. Localization of iris inner boundary (the boundary between pupil and iris).
2. Localization of iris outer boundary (the limbic border between sclera and iris).
3. Localization of boundary between eyelids and iris.

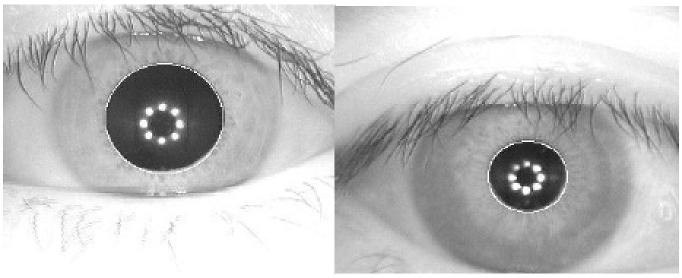

Figure 3.4: Iris inner boundary localized for two eye images.

3.2.5 Iris inner boundary localization

Regarding that illumination intensity is very different in pupillary inner and outer parts, and pupil is darker compared with iris, the use of Canny edge detection in pre-processing stage results in determining points in iris pupil boundary. Figure shows the results of performing Canny edge detection on an eye image as pre-processing output. As it could be observed, pupillary boundary is almost completely detected. After determining edge points, by the use of circular Hough Transform, the center and radius of iris circle are obtained. Figure shows iris inner boundary which has been achieved via this method for two eye images.

3.2.6 Iris outer boundary localization

The most important and challenging stage of segmentation is detecting the boundary of iris and sclera. Firstly, because there is usually no specific boundary in this area and illumination intensity distinction between iris and sclera is very low at the border. Secondly, there are other edge points in eye image in which illumination intensity distinction is much more than that of the boundary of iris and sclera. As a result, edge detection algorithms which are able to detect outer iris edges identify those points as edge. Therefore, in order to detect iris outer boundary, these points have to be identified and eliminated. In this paper, available boundaries are initially enhanced and then extra edge points are identified and eliminated. At the end, through circular Hough transform, outer iris boundary is obtained. In order to enhance iris outer boundary edges, Canny edge detection is performed on eye image in preprocessing stage. By performing such edge detection, a matrix is obtained with the same dimensions as of the image itself which its elements are high in areas where there is a definite boundary and the elements are low in areas where there is no perfectly definite boundary, such as iris outer boundary. Through multiplying of 2.76 in the matrix of pixel values of iris image and intensifying light in eye image, the edges are enhanced. Applying Canny edge detection and multiplying that to the constant value of 2.76 result in better revelation of iris outer boundary edge points. Results of such application on two eye images are shown in Figure.

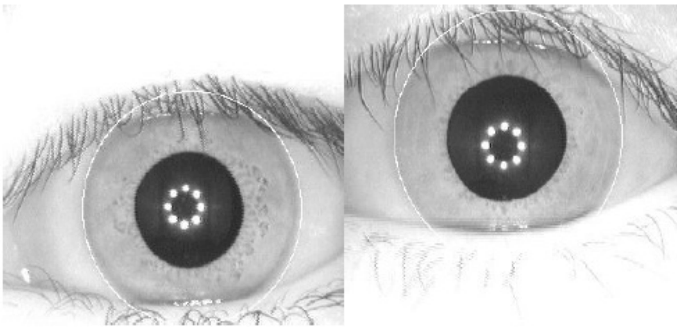

FIGURE 3.5: Iris outer boundary localized for two eye images.

The only issue of this method is sclera boundary not being circular which is the result of angled or sideward imaging and in these cases, some information are lost or clutter comes to existence. In this stage, after identifying iris inner and outer boundaries, the results of these two stages are combined. Figure hows the results obtained. As it could be seen in this figure, iris inner and outer boundaries are correctly identified in CASIA Iris Image-Interval database.

3.2.7 Localization of boundary between eyelids and iris

One can consider the boundary between eyelids and iris as two lines with first order estimate. To localize them, after detecting edges and by the use of linear Hough transform, the properties of the line could be obtained. To do this, initially eyelids boundary should be detected by using of Canny edge detection. There are only pupillary edge points between the two eyelids and since pupillary boundary has been already obtained, these points are eliminated. Figure shows few boundaries localized through this method for some eye images. This method could result in a false outcome only for some images which have too many patterns in iris tissue when the edges of these patterns are detected by Canny edge detection. As they are observable in Figure, the method localizes eyelids with relatively high precision.

3.2.8 Iris Normalization

The fourth phase of the iris recognition system is the normalization process. The segmented iris region obtained is normalized to obtain to unwrap the iris region. Daugmans rubber sheet model is used for iris normalization using Daugmans rubber sheet model. This transformation will project the iris disk to a rectangular region with prefixed size. Figure shows the normalization process. The re-mapping of the iris region from (x,y) Cartesian coordinates to the normalized non-concentric polar representation is modelled as in Eqn. 3 and Eqn 4.

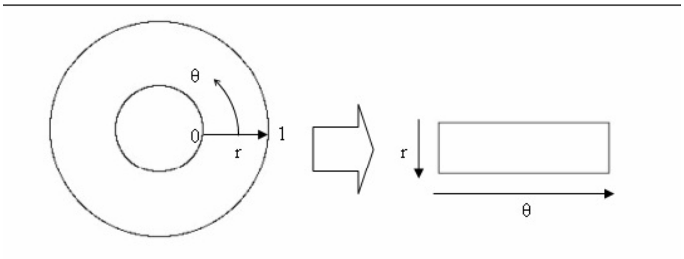

FIGURE 3.6: Mapping Cartesian to Polar Co-ordinates

$$x_i(\theta) = x_{i0}(\theta) + r_i \cos(\theta)$$

$$y_i(\theta) = y_{i0}(\theta) + r_i \sin(\theta)$$

3.2.9 Feature extraction and iris encoding

In order to extract features, two-dimensional Gabor Filters are utilized in this paper. Through performing Gabor Filters to the image from different orientations, ultimate feature vector is obtained. In this stage, the dimensions of the feature vector extracted from iris area have to be as small as possible. Regarding high dimensions of the image drawn, Wavelet transform was performed in order to decrease the dimensions in the way that important information existing in tissue can be preserved in spite of downsizing image dimensions. By performing Wavelet transform twice on an image of 256×512, already obtained after pre-processing stage, we will have a smaller one of 16×32, and later this image is used to extract features vector. The encoding obtained in this stage with dimensions of 80×240 enters the next stage of the system namely matching stage. Regarding that some sections of the area chosen for feature extraction may have occlusions caused by eyelids and eyelashes and since it is possible that, because of error in segmentation stage, some parts of sclera be detected as iris area, it is required that a measure be taken to remove these points from the feature by error when detecting iris outer boundary, 20% of the lower section of the image is eliminated and to resolve the first issue, points of the image that are placed in this section are eliminated from encoding. To do this, we produce a binary encoding which detects occlusion points. We use this encoding in matching stage and these points are eliminated in that stage. Two outputs are generated in this stage. First output belongs to transformation of iris to iris encoding and another output belongs to transforming iris noises into encodings.

3.2.10 Iris Localization

At each edge point we draw a circle with center in the point with the desired radius. This circle is drawn in the parameter space, such that our x axis is the value and the y axis is the b value while the z-axis is the radii. The coordinates belong to the perimeter of the drawn circle. We increment the value in our accumulator matrix which essentially has the same size as the parameter space. In this way we sweep every edge point in the input image drawing circles with the desired radii and incrementing the values in our accumulator. When every edge point and every desired radius is used, we can turn our attention on accumulator. The accumulator will now contain numbers corresponding to the number of circles passing through the individual coordinates. Thus the highest numbers correspond to the center of the circles in the image.

3.2.11 Image Matching

The Manhattan distance function computes the distance that would be traveled to get from one data point to the other if a grid-like path is followed. The Manhattan distance between two items is the sum of the differences of their corresponding components.

The formula for this distance between a point x=(x1, x2, etc.) and a point y=(y1, y2, etc.)

$$d = \sum_{i=1}^{n} |x_i| - |y_i|$$

3.3 Conclusion

In the proposed system a new technique is used at level of segmentation. Matching of the system is on the basis of Manhattan Distance. In this the first step of recognition system is segmentation. Which can be performed by both canny and Improved canny to measure compare the performance. The second step is feature extraction and then preparing a template which can be used for matching at testing phase. Performance of Improved canny based iris recognition system is better than the Canny based iris recognition system which can be calculated by calculating accuracy. The accuracy of the proposed system is 99.08%. Future work could go in the direction of using more than one modality to increase the level of security.

Algorithm 1 improved canny edge detection

Step1: Select the input **(i)**
I:-input iris image sample
Step 2: Apply the segmentation on **(i)** and find the
Circles **(c_n).**
Step 3: Apply binarization on **c_n**.
Step 4: For all the row & columns in matrix **(i)**
Convert into corresponding bit patteren (**0 &1**)
Apply Normalization on **R.**
Step 5: Apply gradient formula on **R.**
Which will give **[g_x, g_y].**
Step 6: **g_x, g_y** are taken into Gaussian formula.
Step 7: if result is apply convertion to fast fourier Transform.
Else
Normal canny will be executed.
Step 8: FFT create the waves of sine & cosine.
Step 9: Apply Manhathen distance by converting the
Waves into grid of **x** & **y**.
Step 10: **if** d == 0 **image matched**
d ≠ 0 **image not matched.**
Stop.

CHAPTER 4

IMPLEMENTATION

In this chapter, firstly,Data Acquisition, developed the acquisition of eye images, is presented. Secondly, Segmentation,Feature Extraction,Binarization conflicting objectives is presented. Thirdly, algorithmic flow of Improved canny edge detection, are discussed, in detail.

4.1 Introduction

Pattern recognition algorithms generally provide a reasonable answers for all possible inputs and to perform matching of the inputs, taking into account their statistical variation. This is opposite to pattern matching algorithm that provides the interclass and intra class variability. Iris recognition technique is based on biometric information of the subject and used to authenticate the access control. Iris is located between the cornea and lens of eye. It provides personal identification of an individual based on a unique features possessed by human iris. Iris recognition system involve image acquisition localization and pattern MatchingSun et al. [2005]. Image acquisition is the process which deals with the capturing of a high quality image of the iris with the help of a digital camera. Iris localizations is the process which delimits the iris from rest of acquired image. Whereas in pattern matching involves segmentation and feature extraction and determination and manhattan distance from the previously stored information in the database. In this work, we use Improved edge detections and compared with that of Canny Edge Detector performing the segmentation. This is a new technique in iris recognition field that helped novel approach applied recognition performanceTian et al. [2004]. We use MATLAB tool to implement our work with samples of iris image collected samples from 5 people are used for training and testing purposes.

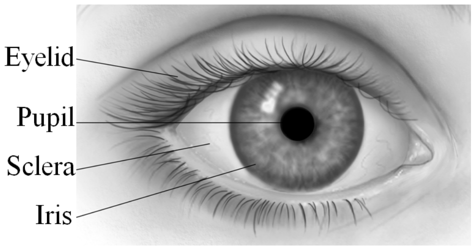

FIGURE 4.1: Eye Artifacts

4.2 MATLAB Environment

The simulation is carried out using custom built Iterative Based simulator in MATLAB 7.12.0.635(R2011a) which simulates the sending, Receiving,dropping and data forwarding etc. MATLAB is a high level technical computing language and interactive environment for algorithm development, data visualization, data analysis and numeric computation. Using the MATLAB product technical computing problems can be sold faster then with traditional programming languages, such as C, C++ and Fortran. It is use in a wide range of application, including signal and image processing, communication, control design, test and measurement, financial modeling an analysis. Add-on toolboxes (collection special purpose MATLAB function available separately) extend the MATLAB environment to solve particular classes of problems in these application areas.

MATLAB provides a number of features for documentary work. MATLAB code can be integrated with order languages and application, and give out various new algorithm and application. It's Features include:

1. High -level language for technical computing

2. Development environment for managing code , files and data

3. Interactive tools for iterative exploration, design, and problem solving.

4. Mathematical functions for linear algebra, statistic, Fourier analysis, filtering, optimization, and numerical integration.

5. Tools for building custom graphical user interfaces.

4.3 Algorithmic Flow Implementation

Data acquisition involves the acquisition of eye images from a group of live person, in this paper. In the work a database is created by collecting left eye image and saved as .jpg files.

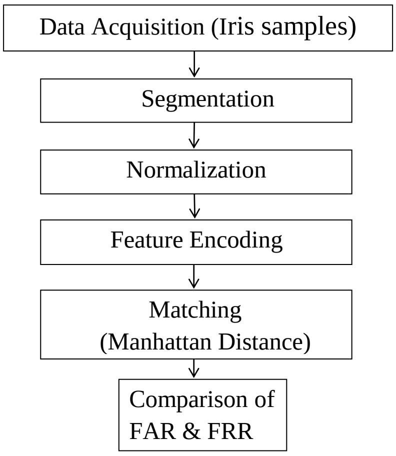

FIGURE 4.2: This recognition system flow graph

4.3.1 Segmentation

This step involves determination of circle coordinates and line coordinates followed by Binarization,edge detection and cropping as shown in Fig. 4.3 The process of edge detection is experimented using Improved Canny edge detection algorithm.

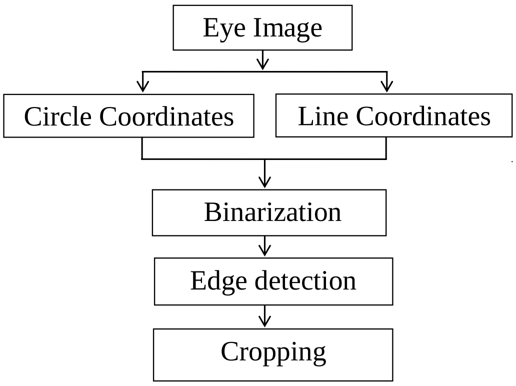

FIGURE 4.3: Segmentation Process

4.3.2 Binarization

In current techniques the binarization is usually performed either globally or locally. Some hybrid methods have also been proposed. The global methods use one calculated threshold value to divide image pixels into object or background classes. Whereas the local schemes can use many different adapted values selected according to the local area information. Hybrid methods use both global and local information to decide the pixel label. In binarization each pixel is converted into one bit. Assign 1 or 0 depending upon the mean value of all the pixels. If the value is greater then mean value then its 1 otherwise 0. The binarization is done by sigma and scaling center co-ordinates of each image.

4.3.3 Feature Extraction

This step performs feature extraction process by using normalization encoding and then save all the features in the database. It is also known to as a training phase sectionBinarization In current techniques the binarization is usually performed either globally or locally. Some hybrid methods have also been proposed. The global methods use one calculated threshold value to divide image pixels into object or background classes. Whereas the local schemes can use many different adapted values selected according to the local area information. Hybrid methods use both global and local information to decide the pixel label. In binarization each pixel is converted into one bit. Assign 1 or 0 depending upon the mean value of all the pixels. If the value is greater then mean value then its 1 otherwise 0. The binarization is done by sigma and scaling center co-ordinates of each image Proena and Alex [2007].

4.3.4 Improved canny edge detection

Improved canny's edge detection algorithm is well known as the optimal edge detection method. It works on three main principle, low error rate well localization of edge point and one response to a single edge. To enhance the older edge detection methods. Canny proposed two new techniques in his algorithm. Non maximum suppression and double thresholding to select the edge points Sheela and Vijaya [2010]. However these two thresholds use the gradient image are set experimentally.

4.4 Conclusion

In the proposed system a new technique is used at level of segmentation. Matching of the system is on the basis of Manhattan Distance. In this the first step of recognition system is segmentation. Which can be performed by both canny and Improved canny to measure compare the performance. The second step is feature extraction and then preparing a template which can be used for matching at testing phase. Performance of Improved canny based iris recognition system is better than the Canny based iris recognition system which can be calculated by calculating accuracy. The accuracy of the proposed system is 99.08%. Future work could go in the direction of using more than one modality to increase the level of security

CHAPTER 5

RESULTS AND DISSCUSSIONS

As already discussed, The results of the proposed system can be analyzed by implementing the whole methodology using simulation tool MATLAB. The comparative convergence performance of stochastic Improved Canny Edge detection algorithms.

5.1 Introduction

The first stage of iris recognition is to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as locating the circular iris region. The success of segmentation depends on the imaging quality of eye images. Images in the CASIA iris database do not contain specular reflections due to the use of near infra-red light for illumination. However, the images in the LEI database contain these specular reflections, which are caused by imaging under natural light. Also, persons with darkly pigmented irises will present very low contrast between the pupil and iris region if imaged under natural light, making segmentation more difficult. The segmentation stage is critical to the success of an iris recognition system, since data that is falsely represented as iris pattern data will corrupt the biometric templates generated, resulting in poor recognition rates.

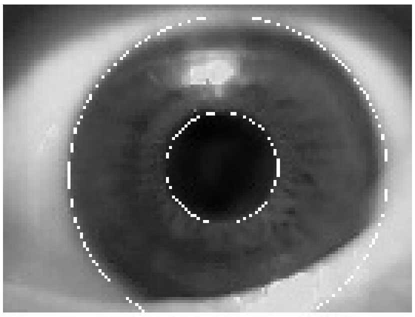

FIGURE 5.1: Segmentation Iris

5.2 Segmentation Iris

It was decided to use circular Hough transform for detecting the iris and pupil boundaries. This involves first employing Canny edge detection to generate an edge map. Gradients were biased in the vertical direction for the outer iris/sclera boundary, as suggested by Wildes et al. [4]. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary. A modified Canny edge detection MATLAB function was implemented, which allowed for weighting of the gradients. The range of radius values to search for was set manually, depending on the database used. For the CASIA database, values of the iris radius range from 90 to 150 pixels, while the pupil radius ranges from 28 to 75 pixels. In order to make the circle detection process more efficient and accurate, the Hough transform for the iris/sclera boundary was performed first, then the Hough transform for the iris/pupil boundary was performed within the iris region, instead of the whole eye region, since the pupil is always within the iris region. After this process was complete, six parameters are stored, the radius, and x and y centre coordinates for both circles. Eyelids were isolated by first fitting a line to the upper and lower eyelid using the linear Hough transform. A second horizontal line is then drawn, which intersects with the first line at the iris edge that is closest to the pupil. This process is done for both the top and bottom eyelids. The second horizontal line allows maximum isolation of eyelid regions. Canny edge detection is used to create an edge map, and only horizontal gradient information is taken. The linear Hough transform is implemented using the MATLAB Radon transform, which is a form of the Hough transform. If the maximum in Hough space is lower than a set threshold, then no line is fitted, since this corresponds to non-occluding eyelids. Also, the lines are restricted to lie exterior to the pupil region, and interior to the iris region. A linear Hough transform has the advantage over its parabolic version, in that there are less parameters to deduce, making the process less computationally demanding.

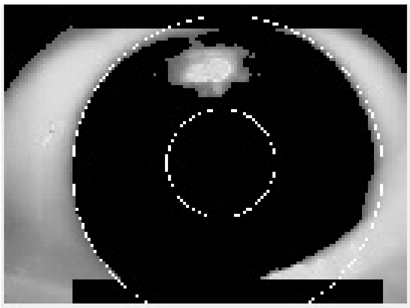

Figure 5.2: Normalisation

5.3 Normalization

For normalization of iris regions a technique based on Daugmans rubber sheet model was employed. The center of the pupil was considered as the reference point, and radial vectors pass through the iris region. A number of data points are selected along each radial line and this is defined as the radial resolution. The number of radial lines going around the iris region is defined as the angular resolution. Since the pupil can be non-concentric to the iris, a re-mapping formula is needed to re-scale points depending on the angle around the circle. A constant number of points are chosen along each radial line, so that a constant number of radial data points are taken, irrespective of how narrow or wide the radius is at a particular angle. The normalised pattern was created by backtracking to find the Cartesian coordinates of data points from the radial and angular position in the normalised pattern. From the doughnut iris region, normalisation produces a 2D array with horizontal dimensions of angular resolution and vertical dimensions of radial resolution. Another 2D array was created for marking reflections, eyelashes, and eyelids detected in the segmentation stage. In order to prevent non-iris region data from corrupting the normalised representation, data points which occur along the pupil border or the iris border are discarded.

5.4 Feature Encoding

Feature encoding was implemented by convolving the normalised iris pattern with 1D Log-Gabor wavelets. The 2D normalised pattern is broken up into a number of 1D signals, and then these 1D signals are convolved with 1D Gabor wavelets. The rows of the 2D normalised pattern are taken as the 1D signal, each row corresponds to a circular ring on the iris region. The angular direction is taken rather than the radial one, which corresponds to columns of the normalised pattern, since maximum independence occurs in the angular direction.

The intensity values at known noise areas in the normalised pattern are set to the average intensity of surrounding pixels to prevent influence of noise in the output of the filtering. The output of filtering is then phase quantised to four levels using with each filter producing two bits of data for each phasor. The output of phase quantisation is chosen to be a grey code, so that when going from one quadrant to another, only 1 bit changes. This will minimise the number of bits disagreeing, if say two intra-class patterns are slightly misaligned and thus will provide more accurate recognition.

The encoding process produces a bitwise template containing a number of bits of information, and a corresponding noise mask which corresponds to corrupt areas within the iris pattern, and marks bits in the template as corrupt. Since the phase information will be meaningless at regions where the amplitude is zero, these regions are also marked in the noise mask. The total number of bits in the template will be the angular resolution times the radial resolution, times 2, times the number of filters used.

5.5 Input Testing

The first test was to confirm the uniqueness of iris patterns. Testing the uniqueness of iris patterns is important, since recognition relies on iris patterns from different eyes being entirely independent, with failure of a test of statistical independence resulting in a match. Uniqueness was determined by comparing templates generated from different eyes to each other, and examining the distribution of Manhattan Distance values produced. This distribution is known as the inter-class distribution.

According to statistical theory, the mean Manhattan distance for comparisons between inter-class iris templates. This is because, if truly independent, the bits in each template can be thought of as being randomly set, so there is a 50% chance of being set to 0 and a 50 % chance of being set to 1. Therefore, half of the bits will agree between two templates, and half will disagree, resulting in a Manhattan distance. The templates are shifted left and right to account for rotational inconsistencies in the eye image, and the lowest Manhattan distance is taken as the actual Manhattan distance. Since the lowest Manhattan distance out of several comparisons between shifted templates is taken. As the number of shifts increases, the mean Manhattan distance for inter-class comparisons will decrease accordingly.

5.6 Query Testing

Performance of the biometric systems is measured by their accuracy in identification, which is calculated using false rejection rate and false acceptance rate. As shown in the Table 1, the FAR and FRR are calculated. Tests are run on the data set of 5 users. Features are generated by using modified Canny Edge Detection Algorithm. Results are reported in the

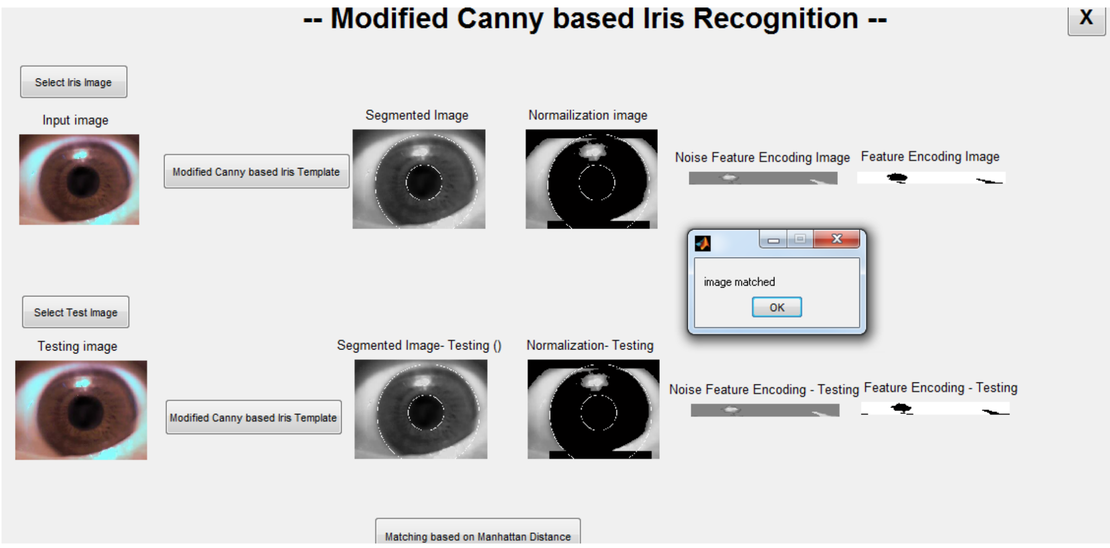

FIGURE 5.3: Modified Canny Based Iris Recognition

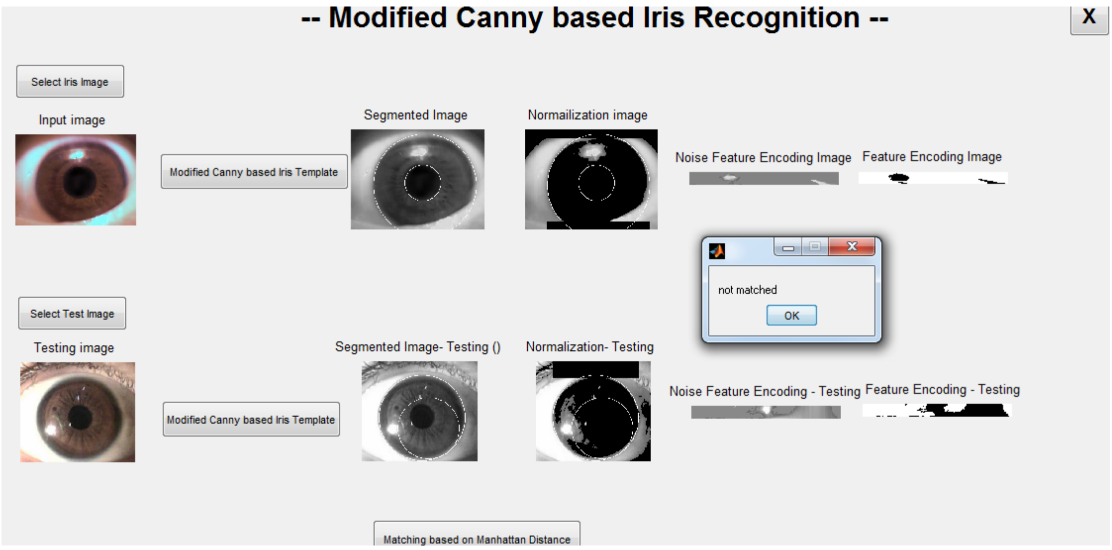

FIGURE 5.4: Modified Canny Based Iris Recognition

form of FAR and FRR which are obtained for the different values of threshold is calculated. Accuracy is calculated for new proposed technique, which is compared with the accuracy of previous implemented technique canny at segmentation level.

Table 5.1: Accuracy for Canny Vs modified Canny edge detection

Parameters	**Canny Based Iris Recognition**	**Improved Canny Iris Recognition**
FAR	0.96%	0.92%
FRR	0.72%	0%
Accuracy	98.32%	99.08%

CHAPTER 6

CONCLUSIONS AND FUTURE SCOPE

Research is an iterative process very similar to Canny Edge Detection where researchers keep testing ideas based on their previous successes and the successes observed by other researchers in the area. The work in this thesis is no exception. Various research observations are presented at the end of each chapter as conclusions but limited to the scope of that chapter only. This chapter aims to conclude the thesis, as a whole, and to aggregate all the offshoots found throughout the work.

6.1 Introduction

The highlights of this thesis are:

1. In this the first step of recognition system is segmentation. Which can be performed by both canny and Improved canny to measure compare the performance.

   2. The second step is feature extraction and then preparing a template which can be used for matching at testing phase.

   3. Performance of Improved canny based iris recognition system is better than the Canny based iris recognition system which can be calculated by calculating accuracy.

   4. Accuracy is calculated for new proposed technique, which is compared with the accuracy of previous implemented technique canny at segmentation level.

5. Results are reported in the form of FAR and FRR which are obtained for the different values of threshold is calculated.

6. The accuracy of the proposed system is 99.08%. Future work could go in the direction of using more than one modality to increase the level of security

6.2 Future Scope

The system presented in this publication was able to perform accurately, however there are still a number of issues which need to be addressed. First of all, the automatic segmentation was not perfect, since it could not successfully segment the iris regions for all of the eye images in the two databases. In order to improve the automatic segmentation algorithm, a more elaborate eyelid and eyelash detection system could be implemented. An improvement could also be made in the speed of the system. The most computation intensive stages include performing the Hough transform, and calculating Hamming distance values between templates to search for a match. Since the system is implemented in MATLAB, which is an interpreted language, speed benefits could be made by implementing computationally intensive parts in C or C++. Speed was not one of the objectives for developing this system, but this would have to be considered if using the system for real-time recognition. Another extension to the system would be to interface it to an iris acquisition camera. Now rather than having a fixed set of iris images from a database, a frame grabber can be used to capture a number of images, possibility improving the recognition rate. An optimization whose feasibility could be examined with use of an acquisition camera would be the use of both eyes to improve the recognition rate. In this case, two templates would be created for each individual, one for the left eye and one for the right eye. This configuration would only accept an individual if both eyes match to corresponding templates stored in the database. The recognition rates produced for this optimization would need to be balanced with the increased imaging difficultly, and inconvenience to the user.

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