Optimization in Image Based Iris Recognition

Pooja V Bidwai
Department of Computer Engineering
AISSMS IOIT University of Pune, India

Abstract- *This paper presents a comparative study of few of the existing methods in optimization for Iris recognition. Biometric systems rely on specific data about unique biological traits in order to work effectively. They would involve running data through algorithms for a particular result, usually related to a positive identification of a user or other individual. Human iris is considered to be the most reliable biometric trait. Iris recognition system stores the discriminant and complete information of a particular iris in a compact form known as iris code, because of security reasons. This Paper gives a comparative analysis of various optimization methods in Iris recognition considering various criteria's like Acceptance ration, test beds, feature extraction and accuracy of identification.*

Keywords- Iris, Iris Recognition, Optimization, Genetic algorithm, feature vector.

I. INTRODUCTION

In general, biometrics is any use of biological data in technology. Biometric systems focusing exclusively on the identification of humans have become the major kind of biometric system in today's IT world. Governments, businesses and organizations can use biometric systems to get more information about individuals. Biometrics is the measurement and statistical analysis of people's physical and behavioral characteristics. The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. The technology is mainly used for identification and access control, and for identifying individuals that are under surveillance. The basic premise of biometric authentication is that everyone is unique and an individual can be identified by his or her intrinsic physical or behavioral traits. The term "biometrics" is derived from the Greek words "bio" meaning life and "metric" meaning to measure. The iris is a muscle within the eye that regulates the size of the pupil, controlling the amount of light that enters the eye. It is the colored portion of the eye with coloring based on the amount of melatonin pigment within the muscle. Iris comes in variety of color like blue, black, brown etc (Figure 1.1).

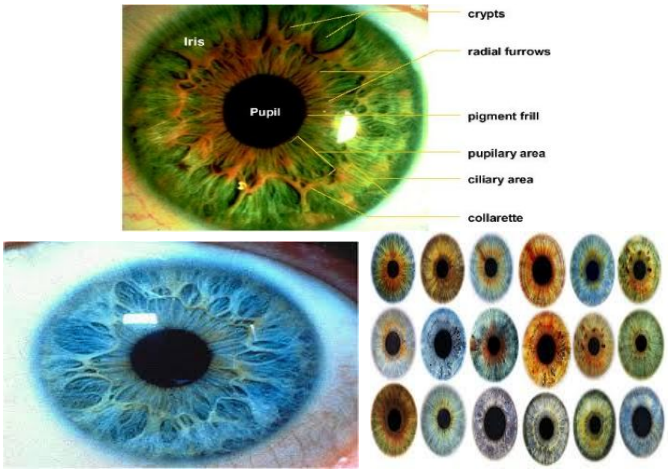

Figure 1: Iris Structure

Although the coloration and structure of the iris is genetically linked, the details of the patterns are not. The iris develops during prenatal growth through a process of tight forming and folding of the tissue membrane. Prior to birth, degeneration occurs, resulting in the pupil opening and the random, unique patterns of the iris. Although genetically identical, an individual's irides are unique and structurally distinct, which allows for it to be used for recognition purposes. Iris recognition has become authentication system of choice because of the following characteristics: **Stable** – the unique pattern in the human iris is formed by 10 months of age, and remains unchanged throughout one's lifetime.

Unique – the probability of two rises producing the same code is nearly impossible

Flexible – iris recognition technology easily integrates into existing security systems or operates as a standalone

Reliable – a distinctive iris pattern is not susceptible to theft, loss or compromise

Non-Invasive – unlike retinal screening, iris recognition is non-contact and quick, offering unmatched accuracy when compared to any other security alternative, from distances as far as 3″ to 10″

Many biometric systems are developed for security applications. An airport scanning device, a "bio-password" system, or an internal data gathering protocol is an example of

a biometric system that uses identifying data for a security result. There are two main types of biometric identifiers: Physiological characteristics: The shape or composition of the body. Behavioral characteristics: Based on the behavior of a person.

Examples of physiological characteristics used for biometric authentication include fingerprints; DNA; face, hand, retina or ear features; and odor. Behavioral characteristics are related to the pattern of the behavior of a person, such as typing rhythm, gait, gestures and voice. Certain biometric identifiers, such as monitoring keystrokes or gait in real time, can be used to provide continuous authentication instead of a single one-off authentication check. Other areas that are being explored in the quest to improve biometric authentication include brainwave signals, electronic tattoos, and a password pill that contains a microchip powered by the acid present in the stomach. Once swallowed, it creates a unique ID radio signal that can be sensed from outside the skin, turning the entire body into a password. IRIS recognition has the advantages of uniqueness, stableness, antispoof, non invasiveness and efficiency so it is widely applied in e-passport, banking, forensics, internet access and control. [1] Of all the biometric technologies. used for human authentication today, it is generally conceded that iris recognition is the most accurate. Coupling this high confidence authentication with factors like outlier group size, speed, usage/human factors, platform versatility and flexibility for use in identification or verification modes – as well as addressing issues like database size/management and privacy concerns – iris recognition has also shown itself to be exceedingly versatile and suited for large population applications.

II. IRIS RECOGNITION

The Iris Access employs iris recognition technology to provide accurate identity authentication without PIN numbers, passwords or cards. Iris technology is based on pattern recognition and the pattern-capturing methodology is based on video camera technology similar to that found in camcorders commonplace in consumer electronics. Like these cameras, the image capture process does not require bright illumination or close-up imaging. Iris recognition is the process of recognizing a person by analyzing the random pattern of the iris. A typical iris recognition system consists of four main modules as shown in Fig 1.2.

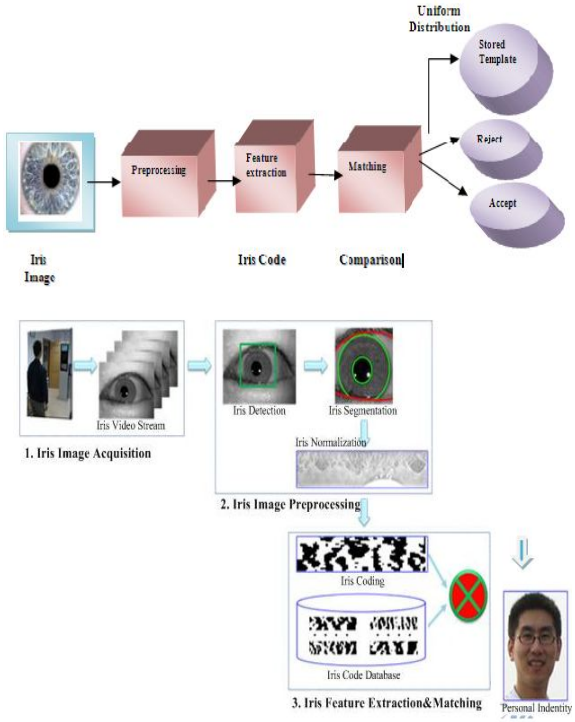

Fig 2 Iris Recognition Systems [4, 8]

A. Image Acquisition

The first module, *Image Acquisition* deals with capturing sequence of iris images from the subject using cameras and sensors. An image acquisition consists of illumination, position and physical capture system. The occlusion, lighting, number of pixels on the iris are factors that affect the image quality [8].

B. Image Preprocessing

The second module, *Preprocessing* involves various steps such as iris liveness detection, pupil and iris boundary detection, eyelid detection and removal and normalization. Several methods can be used like Hough transformation, integrodifferential operator, gradient based edge detection to localize the portions of iris and the pupil from the eye image. The contours of upper and lower eyelids are fit using the parabolic arcs resulting the eyelid detection and removal. It is essential to map the extracted iris region to a normalized form. The iris localization methods are based on spring force, morphological operators, gradient, probability and moments. The inner boundary is detected by applying threshold, image opening and closing operators. The outer boundary is detected by applying threshold, closing and opening operators. The clustering algorithms like self-organizing maps, kmeans and fuzzy k-means were used to segment the image to produce as output the clusters-labeled images.[8]

C. Feature extraction

The third module, *Feature extraction* identifies the most prominent features for classification. Iris provides abundant texture information. A feature vector is formed which consists of the ordered sequence of features extracted from the various representation of the iris images. Some of the features are x-y coordinates, radius, shape and size of the pupil, intensity values, orientation of the pupil ellipse and ratio between average intensity of two pupils.[8] The features are encoded to a format suitable for recognition. Gabor filters, Wavelet Transform, Laplacian of Gaussian Filter are some of the methods used for feature Extraction

D. Matching

The fourth module, *matching* recognition achieves result by comparison of features with stored patterns. The interclass and intra-class variability are used as metrics for pattern classification problems.

III. OPTIMISATION

Optimization technique plays a major role in the iris system. The optimized feature gives an optimized template for matching process and these optimized template increases the identification rate of iris system. Optimization is a process that finds a best, or optimal, solution for a problem. The Optimization problems are centered around three factors:

1. An objective function which is to be minimized or maximized.
2. A set of unknowns or variables that affect the objective function.
3. A set of constraints that allow the unknowns to take on certain values but exclude others.

An optimization problem is defined as: Finding values of the variables that minimize or maximize the objective function while satisfying the constraints.[8] Genetic Algorithms represent an intelligent exploitation of a random search used to solve optimization problems.

A. Search Optimization Algorithms:

Search optimization algorithms are classified into mainly three types calculus based techniques, guided random search techniques and enumerative techniques which are further again then classified as shown in fig 3.1. Evolutionary algorithms form a part of guided random search techniques. They deals with describing the process of search, implementing and carry out search, elements required to carry out search and different search strategies

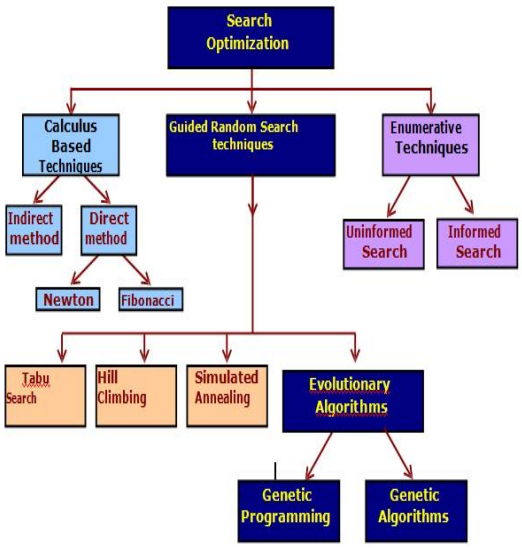

Fig 3 Search Optimization Techniques.

The Evolutionary Algorithms includes Genetic Algorithms and Genetic Programming.

B. Evolutionary Algorithm (EAs):

Evolutionary Algorithm (EA) is a subset of Evolutionary Computation (EC) which is a subfield of Artificial Intelligence (AI). Evolutionary Computation (EC) is a general term for several computational techniques. Evolutionary Computation represents powerful search and optimization paradigm influenced by biological mechanisms of evolution that of natural selection and genetic. EAs refer to Evolutionary Computational models using randomness and genetic inspired operations. EAs involve selection, recombination, random variation and competition of the individuals in a population of adequately represented potential solutions. The candidate solutions are referred as chromosomes or individuals. Genetic Algorithms (GAs) represent the main paradigm of Evolutionary Computation.

3.2 Genetic Algorithm

Genetic algorithms (GAs) are the main paradigm of evolutionary computing. GAs are inspired by Darwin's theory about evolution–the "survival of the fittest. GAs are the ways of solving problems by mimicking processes nature uses; i.e., Selection, Crosses over, Mutation and Accepting, to evolve a solution to a problem. GAs is adaptive heuristic search based on the evolutionary ideas of natural selection and genetics. GAs is intelligent exploitation of random search used in optimization problems and GAs, although randomized; exploit historical information to direct the search into the region of better performance within the search space.

C. Biological Background–Basic Genetics

Every organism has a set of rules, describing how that organism is built. All living organisms consist of cells. In each cell there is same set of chromosomes. Chromosomes are strings of DNA and serve as a model for the whole organism. A chromosome consists of genes, blocks of DNA. Each gene encodes a particular protein that represents a trait feature e.g., color of eyes. Possible settings for a trait (e.g. .blue, brown) are called alleles. Each gene has its own position in the chromosome called its locus. Complete set of genetic material (all chromosomes) is called a genome. Particular set of genes in a genome is called genotype. The physical expression of the genotype (the organism itself after birth) is called the phenotype, its physical and mental characteristics, such as eye color, intelligence etc. When two organisms mate they share their genes; the resultant offspring may end up having half the genes from one parent and half from the other. This process is called recombination (crossover). The new created offspring can then be mutated. Mutation means, that the elements of DNA are a bit changed. These changes are mainly caused by errors in copying genes from parents. The fitness of an organism is measured by success of the organism in its life (survival). [9]

Working Principles

Chromosome is a set of genes which contains the solution in form of genes. Gene is a part of chromosome; it contains a part of solution. It determines the solution. E.g.16743 is a chromosome and 1,6,7,4 and 3 are its genes. Individual is same as chromosome. Population is number of individuals present with same length of chromosome and Fitness is the value assigned to an individual based on how far or close a individual is from the solution greater the fitness value better the solution it contains. Fitness function is a function that assigns fitness value to the individual. It is problem specific. Breeding is taking two fit individuals and then intermingling there chromosome to create new two individuals. Mutation is changing a random gene in an individual. Selection is selecting individuals for creating the next generation. Genetic algorithm begins with a set of solutions (represented by chromosomes) called the population. Solutions from one population are taken and used to form a new population. This is motivated by the possibility that the new population will be better than the old one. Solutions are selected according to their fitness to form new solutions (offspring); more suitable they are, more chances they have to reproduce. This is repeated until some condition (e.g. number of populations or improvement of the best solution) is satisfied. [9]

a. Basic Genetic Algorithm

1. [Start] Generate random population of **n** chromosomes (i.e. suitable solutions for the problem).
2. [Fitness] Evaluate the fitness **f(x)** of each chromosome **x** in the population.
3. [New population] Create a new population by repeating followings teps until the new population is complete.

   a. [Selection] Select two parent chromosomes from a population according to their fitness (better the fitness, bigger the chance to be selected)
   b. [Crossover] With a cross over probability, cross over the parents to form new offspring (children). If no cross over was performed, offspring is the exact copy of parents .
   c. [Mutation]With a mutation probability, mutate new offspring at each locus (position in chromosome).
   d. [Accepting] Place new offspring in the new population
   e. [Replace] Use new generated population for a further run of the algorithm
   f. [Test] If the end condition is satisfied, stop, and return the best solution in current population [Loop] Gotostep2[9]

b. Flowchart for Genetic Algorithm:

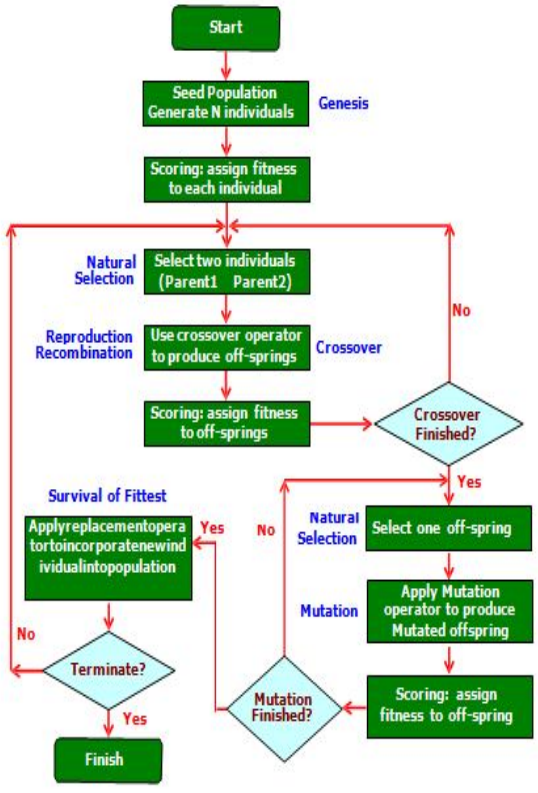

Fig. 3.6 Genetic algorithm–program flowchart

IV. COMPARISON OF METHODS

In this section comparison of various optimization methodologies is done based on various criteria's like preprocessing is applied on the datasets, feature extraction performed by which method, time required for query execution, average correct recognition rate etc. In the first methodology optimizing the Genetic Algorithm to resynthesize iris Patterns from iris Code Template is discussed [3]. Here different crossover techniques are used to optimize the genetic algorithm to synthesize iris images from similar iris codes and their performance is evaluated through a commercial matcher by estimating the probability of successfully matching the synthetic iris images with its corresponding real images. Here Image Pre-processing is done using Image acquisition, Segmentation and then normalization. Encoding process maps the normalized iris image to binary representation, various encoding methods are available and most of these use filtering techniques typically Log Gabor filtering technique before quantizing the phasor response of the filtered output and thus representing the iris images to binary form. In matching process the two iris codes i.e. the iris code of target iris image and that stored in the database are compared using bitwise operators such as hamming distance. Normalized image is of size HxL and this image is divided into PxQ blocks of size P/H x Q/L. Each of these PxQ blocks acts as genes of the chromosomes and these chromosomes are used to form the initial population. The fitness value of the chromosomes is equal to the matching score value. Three types of selection operators are applied independently over the initial population to find parent chromosomes viz, Rank Selection, Roulette Wheel Selection, Stochastic Universal Sampling. Uniform crossover technique is applied. In this crossover technique, a mask equal to the size of individual chromosome is chosen randomly and the value of first parent bit is assigned to child chromosome if value of corresponding mask bit is 1 and if value of mask bit is 0 then value of second parent bit is assigned to child chromosome. Random changes are then applied to the blocks of the new children with mutation probability pm.

This paper optimizes the genetic algorithm (used to reconstruct iris images from iris code), firstly by using different types of selection operators in the genetic algorithm, after that the results of the algorithm are analyzed and then based on the results the selection technique is used to optimize the ideal reconstruction method. In the second paper evolution of bird species has been regarded, and the intelligent behavior of birds during mating season has become an inspiration to devise a new heuristic optimization algorithm, named bird mating optimizer. BMO (Bird mating optimization) technique is implemented to improve the accuracy of an iris recognition system. This was a research project as it was never implemented and integrated with iris system. PSO (Particle swarm optimization) was also implemented & integrated with iris recognition system and it gave 96% of accuracy. BMO as per the research provides more accuracy than Ant colony optimization/Particle swarm optimization or any Genetic algorithm [4]. The method aims at improving the iris recognition and optimization system expected to have higher accuracy and optimized result. The system to be developed uses the combination of algorithm to meet its requirements. The BMO algorithm follows metaheuristic approach for optimization and then proceeds to follow different algorithm for normalization, feature extraction, template matching. The main goal is to develop a BMO-based learning algorithm to train ANNs. BMO is a recently devised population based optimization algorithm which imitates the mating behavior of bird species for breeding superior broods and provides different Strategies to effectively seek the search space. So BMO was implemented and integrated it with the iris recognition system but when integrated with IRIS system it was observed that PSO with iris system provides more accuracy. [4]

In the third Paper a new optimization and recognition process of iris features selection by using proposed Modified ADMM and Deep Learning Algorithm (MADLA) is proposed for improving the performance of the security with feature extraction, the proposed algorithm is designed and used to extract the strong features identification of iris of the person with less time, better accuracy, improving performance in access control and in security level. The evaluations of iris data are demonstrated the improvement of the recognition accuracy. In this proposed methodology, the recognition of the iris features has been improved and it incorporates into the iris recognition systems. [5]

V. CONCLUSION

In the first method accuracy, robust method and various selection techniques are taken into consideration. This method optimizes the genetic algorithm (used to reconstruct iris images from iris code), firstly by using different types of selection operators in the genetic algorithm, after that the results of the algorithm are analyzed and then based on the results the selection technique is used to optimize the ideal reconstruction method. In the second method the methodology aims at improving the iris recognition and optimization system expected to have higher accuracy and optimized result. The system to be developed uses the combination of algorithm to meet its requirements. It was observed that PSO with iris system provides more accuracy than BMO.

In the last Paper a new optimization and recognition process evaluations of iris features selection by using proposed Modified ADMM and Deep Learning Algorithm (MADLA) have demonstrated the improvement of the recognition accuracy. Recognition of the iris features has been improved and it incorporates into the iris recognition systems.

VI. FUTURE SCOPE.

Optimization in Iris recognition can be better by considering two factors mainly Speed and Accuracy. This can be achieved by reducing feature vector size and optimization. Besides this various research issues are based on optimization on Reverse the Iris Boundary Detection Order, Reduce the Number of Edge Points, and Modification to voting etc. It is required to achieve lowest false rejection rate fastest composite time for matching.

REFERENCES

[1] Rohini Baburao Jadhao , Aarti Bakshi "Optimization Technique for Improving Iris Recognition System" INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT, January, 2015 Vol 4 Issue 1 ISSN 2278 – 0211Note that the journal title, volume number and issue number are set in italics.

[2] Rao R.V. and Kalyankar V.D., "Multi-objective multi-parameter optimization of the industrial LBW process using a new optimization algorithm", Journal of Engineering Manufacture, 2012, DOI: 10.1177/ 0954405411435865

[3] Rajwinder Kaur†* and Prabhpreet Kaur "Optimizing the Genetic Algorithm to resynthesize iris Patterns from iris Code Template", International Journal of Current Engineering and Technology 2016 E-ISSN 2277 – 4106, P-ISSN 2347 – 5161 Vol.6.

[4] A modified particle swarm optimizer, in: Proceedings of the 1998 IEEE International Conference on Evolutionary Computation: Y. Shi, R. Eberhart, IEEE World Congress on Computational Intelligence, 1998, pp. 69–73

[5] S. Pravinthraja1, K. Umamaheswari2, "Optimized Features Extraction of IRIS Recognition by Using MADLA to Ensure Secure Authentication"Scientific Reserch Publishing Circuits and Systems, 2016, 7, 1927-1933

[6] Alireza Askarzadeh: Bird mating optimizer: An optimization algorithm inspired by bird mating strategies. A. Askarzadeh /Commun Nonlinear Sci Numer Simulat 19 (2014) 1213–1228

[7] Rohini Baburao Jadhao, Aarti Bakshi "Optimization Technique for Improving Iris Recognition System" INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT January, 2015 Vol 4 Issue 1

[8] Dr. Sudeep D. Thepade, Pooja Bidwai, "Iris Recognition using Fractional Coefficients of Cosine, Walsh, Haar, Slant, Kekre Transforms and Wavelet Transforms", International Journal of Emerging Technologies in Computational and Applied Sciences, June- August, 2013, pp. 141-146.

[9] FundamentalsofGeneticAlgorithms:AICourseLecture39–40,notes,slideswww.myreaders.info/,RCChakraborty,e-mailrcchak@gmail.com,June01**,2010**

[10] Shah and A. Ross, (2006), Generating Synthetic irises by feature agglomeration,, in: Proc. IEEE Int. Conf. on Image Processing (ICIP), pp. 317-320

[11] Venugopalan and M. Savvides, (2011), How to generate spoofed irises from an iris code template, IEEE Trans. Inform. Forens. Secur., pp. 385-394.

[12] Zuo, N. Schmid, and X. Chen, (2007) On Generation and Analysis of Synthetic Iris Images, IEEE Trans.Inform.Forensic Secur., vol. 2, no. 1, pp. 77-90