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Performance Evaluation of Iris Recognition System using Genetic Algorithm Optimization

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Abstract:

The Genetic Algorithm based optimization combines computer vision, pattern recognition, statistical inference, and optics. Its purpose is real-time, high confidence recognition of a person's identity by mathematical analysis of the random patterns that are visible within the iris of an eye. The proposed system takes an image of the eye, detects the iris and extracts it. Then a binary image of the extracted iris is created in order to form an equivalent binary template. The matching criteria are hamming distances. The system is implemented in MATLAB. The inclusion of Genetic Algorithms which acts as averaging system achieve a 100% recognition rate and 100% database compatibility for CASIA Database, but the performance was not up-to the mark for UBIRIS as only 82.6% of Database compatibility resulted in errors though achieving accurate matches for all the 124 images compatible out of 150 images. The system is tested on two different databases and the comparative performance evaluation of results on both the databases is also achieved. The comparative result analysis for 10 test images for each database shows 100% performance for CASIA and 80% performance for UBIRIS. On increasing the numbers of test images to 150 the results still show a 100 % performance for CASIA and 82.6% performance for UBIRIS. The performance depicted a slight increase of 2.6% on increasing number of test images to 150 for UBIRIS database and show the scope for improvement as the number of test images is further increased.

Keywords **— Genetic Algorithm, Iris Recognition, MATLAB, CASIA, UBIRIS**

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I. INTRODUCTION

The Genetic algorithms are an approach to optimization and learning based loosely on principles of biological evolution, these are simple to construct, and its implementation does not require a large amount of storage, making them a sufficient choice for an optimization problems. Optimal scheduling is a nonlinear problem that cannot be solved easily yet, a GA could serve to find a decent solution in a limited amount of time Genetic algorithms are inspired by the Darwin's theory about the evolution **"survival of fittest"**, it search the solution space of a function through the use of simulated evolution (survival of the fittest) strategy. Generally the fittest individuals of any population have greater chance to reproduce and survive, to the next generation thus it contribute to improving successive generations However inferior individuals can by chance survive and also reproduce,

Genetic algorithms have been shown to solve linear and nonlinear problems by exploring all regions of the state space and exponentially exploiting promising areas through the application of mutation, crossover and selection operations to individuals in the population. The development of new software technology and the new software environments (e.g. MATLAB) provide the platform to solving difficult problems in real time. It

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integrates numerical analysis, matrix computation and graphics in an easy to use environment. The figure below shows a simple flow chart of genetic algorithm [1].

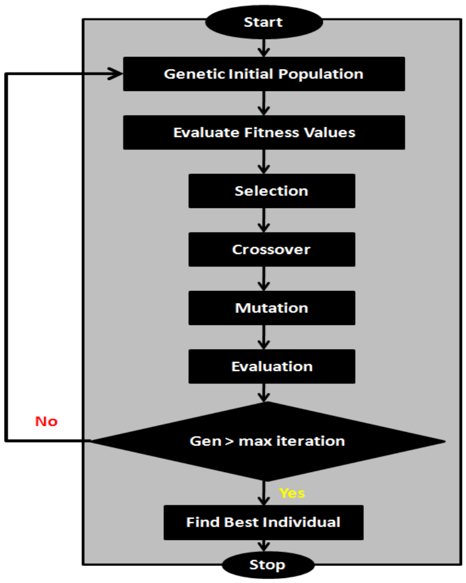

Fig.1 Flowchart Depicting Simple Genetic Algorithm

II. LITERATURE REVIEW

S.Kalaiselvi et.al. advancements in research methodologies used by different researchers for iris localization, iris segmentation, feature extraction, and classification and encryption of the Iris images are discussed [2].

Habibah Adamu Biu et.al. publish that iris recognition is considered to be one of the best and accurate form of biometric measurements compared to others, it has become an interesting research area. Iris recognition and authentication has a major issue in its code generation and verification accuracy, in order to enhance the authentication process, a binary bit sequence of iris is generated, which contain several vital information that is used to calculate the Mean Energy and Maximum Energy that goes into the eye with an adopted Threshold Value [3].

Mourad Moussa et.al. publish that feature selection (FS) is a global optimization problem in machine learning, which reduces the number of features, removes irrelevant, noisy and redundant data, and results in acceptable recognition accuracy. It is the most important step that affects the performance of a face recognition system. Genetic Algorithms (GA), one of the most recent techniques in the field of feature selection, are a type of evolutionary algorithms that can be used also to solve this issue. The application of a GA in the resolution of a problem requires the coding of the potential solutions to this problem in finite bit chains in order to constitute the chromosomes coming from a population formed by candidate points [4].

Suleiman Salihu Jauro et.al. state that iris region segmentation and also classification are the most contentious problem present inside the iris recognition system since the poor results in these stages will spoil or shatter its effectiveness. Image characteristics, like, the varying pigmentation levels, brightness and also contrast, occlusion by eyelids and/or eyelashes, united with the differing sensor and also environmental circumstances, cause iris segmentation vast additionally a hard task. Therefore, there stands a requirement to discuss the problems of iris recognition to apply a new efficient algorithm [5].

Akshay Singh et.al. publish that iris recognition system is an accurate biometric system. As of late, iris recognition is created to a few dynamic zones of research, for example, Image Acquisition, restoration, quality assessment, image compression, segmentation, noise reduction, normalization, feature extraction, iris code matching, searching large database, applications, evaluation, performance under varying condition and multi-biometrics [6].

Shubhangi D C et.al. state that iris recognition is an invasive biometric technique which imposes various challenges in accurate iris segmentation and feature extraction techniques to provide many opportunities for researchers in pursuing their research work in this area [7].

S. Sandhiya et.al. present a hybrid approach in selecting a best architecture of artificial neural networks to compare various medical images like lung segments, nodules, etc., Artificial neural networks are widely used for segmentation of

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tissues and structures from medical images. Through this study we can prove the effectiveness of the neuro Genetic approach in medical image segmentation [8].

Rechu Sharma et.al. used a technique which involves Gabor filters based optimal feature extraction method has been presented for iris recognition system. Later, the Gabor filters resultant iris images will be optimized using particle swarm optimization and Genetic Algorithm optimization technique. Initially in the pre-processing step the image is binarized and normalized to rectangular blocks which are then decomposed by the optimal Gabor filters using HCT [9].

Maria De Marsico et.al. publish that a cross-comparison of two parameters, feature complexity vs. learning effectiveness, in the context of different learning algorithms, would require an unbiased common benchmark [10].

Ali Abdulhafidh Ibrahim et. al. propose a fast and accurate iris pattern recognition system by using wireless network system. The paper consists of three parts: the first part includes two methods of the iris pattern recognition system: Libor Masek and genetic algorithms, the second part includes the compression-decompression process of iris image using Principal Component Analysis (PCA) as a data reduction method, in order to reduce image size, and the third part talks about wireless network [11].

Gafar Zen Alabdeen Salh et. al. holds a presentation of a system, which is recognizing peoples through their iris print and that by using Linear Discriminant Analysis method. Which is characterized by the classification of a set of things in groups, these groups are observing a group of features that describe the thing, and is characterized by finding a relationship which give rise to differences in the dimensions of the iris image data from different varieties, and differences between the images in the same class and are less [12].

III. METHODOLOGY

All This study is presented as an iris recognition system, which is developed using **MATLAB** and is tested on at least two different databases for Iris Images.

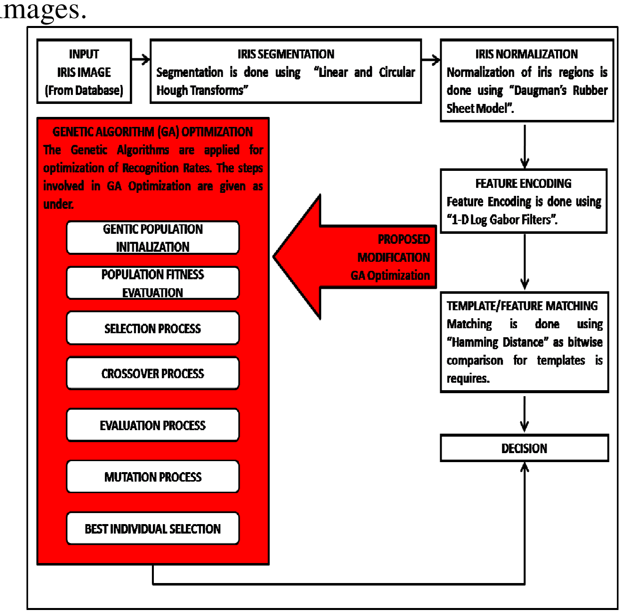

Fig. 2 System Design

The system developed here is an iris recognition method based on genetic algorithms (GA) for the optimal features extraction. The accurate iris patterns classification has become a challenging issue due to the huge number of textural features extracted from an iris image with comparatively a small number of samples per subject. The traditional feature selection schemes like principal component analysis, independent component analysis, singular valued decomposition etc. require sufficient number of samples per subject to select the most representative features sequence; however, it is not always realistic to accumulate a large number of samples due to some security issues. Here a GA based application is implemented to improve the feature selection by optimal filtering.

The main objectives are to apply **MATLAB** to achieve following goals:

Image Segmentation: Implement an **automatic segmentation algorithm** to localize the iris region from an eye image and isolate eyelid, eyelash and reflection areas.

Image Normalization: The segmented iris region is to be normalized to eliminate dimensional inconsistencies between iris regions. This will be achieved by implementing a version of **Daugman's Rubber Sheet Model.**

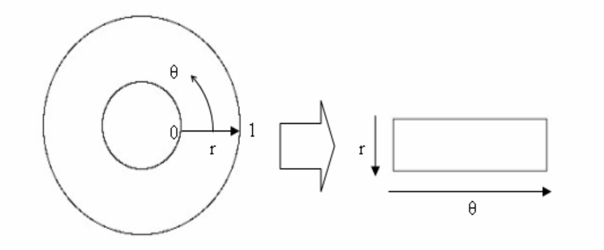

Fig. 3 Daugman's Rubber Sheet Model

Feature Extraction & Encoding: Features of the iris will be encoded by convolving the normalized iris region with **1-D Log Gabor Filters** and phase quantizing the output in order to produce a bit-wise biometric template.

Genetic Algorithm Optimization: Features encoded are optimized using genetic algorithms for improving recognition rates. Firstly the feature optimization is done using GA. The method incorporates fitness function for feature reduction. In the algorithm, fitness function works to find the best possible solution for the image and stores the value for further comparison and findings. Various functions like mutation function, crossover function etc helps to find the best possible solution of the image.

Template Matching: The **Hamming Distance** was chosen as a matching metric, which gave a measure of how many bits disagreed between two templates. A failure of statistical independence between two templates would result in a match, that is, the two templates were deemed to have been generated from the same iris if the Hamming Distance produced was lower than a set Hamming Distance.

Testing: The tested results will be logged for accuracy and efficiency of the system on variation of images and population. Results will also contain an analysis of false matches on the two databases CASIA and UBIRIS.

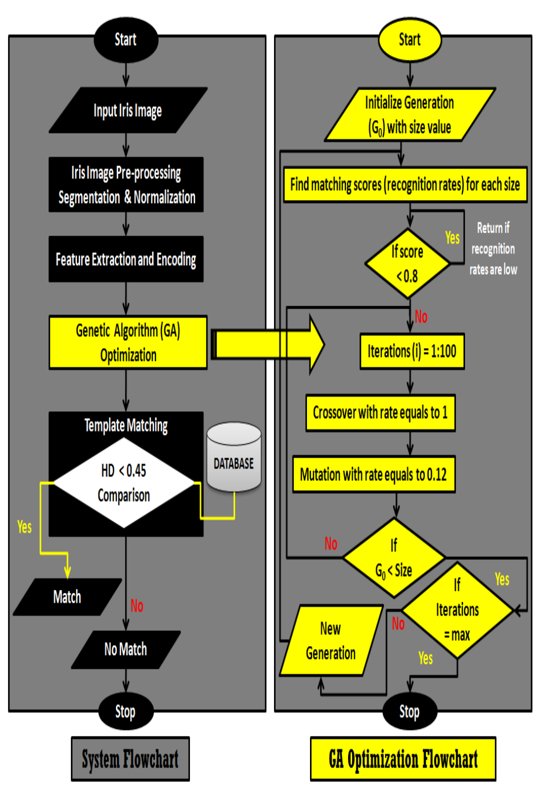

Fig. 4 Flowchart for Complete System and GA Optimization

IV. RESULTS

The GUI developed using MATLAB GUIDE is shown below.

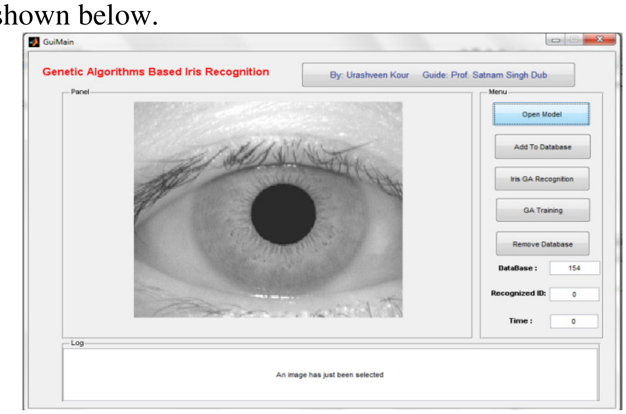

Fig. 5 MATLAB (GUIDE) based GUI

The programmatically developed GUI is shown below.

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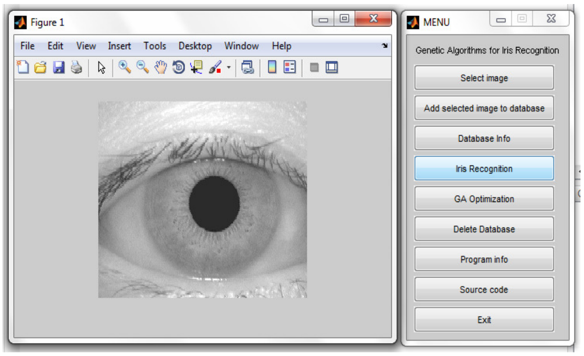

Fig. 6 MATLAB Programmatically based GUI

Analysis Graph 1: Database Compatibility Analysis

The graph is plotted for analysis performed for database compatibility check. For CASIA Iris Database there were zero rejections and all 154 images were found compatible with the application where as for UBIRIS database 124 out of 150 images were found to be compatible with total 26 rejections

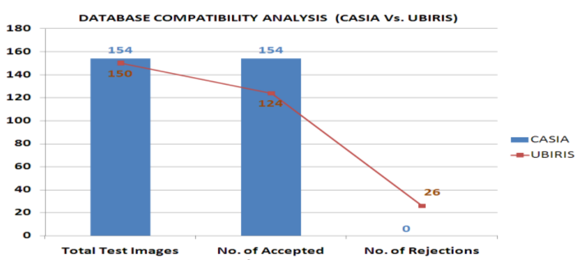

Fig. 7 Database Compatibility Analysis (CASIA versus UBIRIS)

Analysis Graph 2: GA Optimized Hamming Distance (CASIA Database)

The figure below shows GA Optimized Hamming Distances obtained for 154 test images for CASIA Database. The graph is scatter plot depicting a scatter pattern of hamming distances for 154 input images.

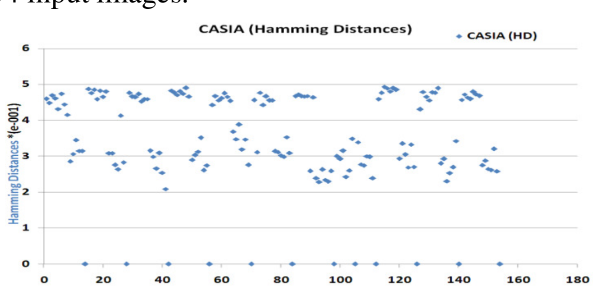

Fig. 8 GA Optimized Hamming Distance (X-Y Scatter Plot) (CASIA Database)

Analysis Graph 3: GA Optimized Hamming Distance (UBIRIS Database)

The figure below shows GA Optimized Hamming Distances obtained for 150 test images for UBIRIS Database. The graph is scatter plot depicting a scatter pattern of hamming distances for 124 input images as an error was found for 26 input images which is depicted as unmatched values denoted by -1.

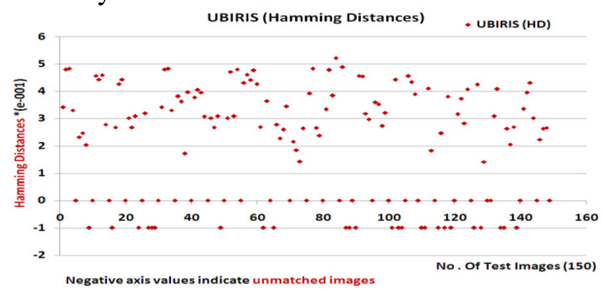

Fig. 9 GA Optimized Hamming Distance (X-Y Scatter Plot) (UBIRIS Database)

Analysis Graph 4: Performance Parameters

The figure below shows Performance Parameters such as Total Test Images, Total Accepted Images, Accurate Matches and Errors.

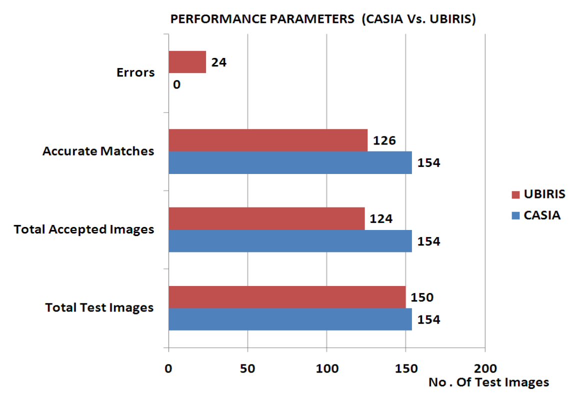

Fig. 10 Performance Parameters (CASIA Vs. UBIRIS Database)

Analysis Graph 5: Recognition Rate%, Match% and Error%

The figure below shows Performance Evaluation based on Recognition Rate %, Match % and Error%. The Recognition Rate is 100% for both databases as for all images added to the database the correct output was obtained. The Match% was calculated to be 100% for the CASIA database and 82.6% for UBIRIS Database. The Error% for CASIA Database was 0%. and for UBIRIS it was 17.3%.

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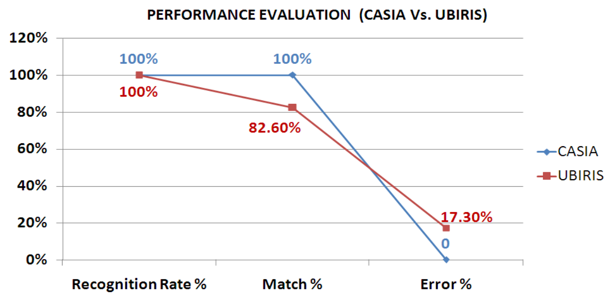

Fig. 11 Performance Evaluation based on Recognition Rate %, Match % and Error%

Analysis Graph 6: Error Map

The figure below shows Accurate Matches and Error Map for UBIRIS Database. The CASIA Database has shown 100% accuracy in recognition rate as shown above.

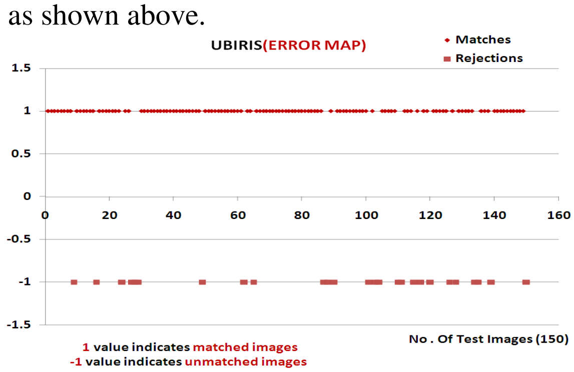

Fig. 12 Error Map for UBIRIS

Analysis Graph 7: GA Optimized Recognition Time (CASIA)

Figure below shows the GA Optimized Recognition Time for all 154 inputs for CASIA Database. The Recognition Time once optimized range between 05 seconds to 22 seconds.

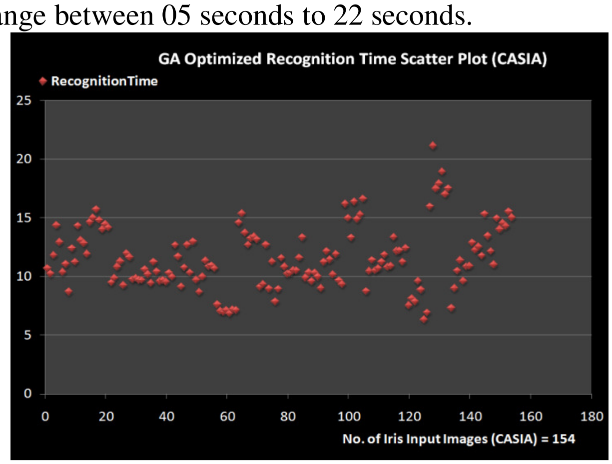

Fig. 13 GA Optimized Recognition Time Scatter Plot (CASIA)

Analysis Graph 8: GA Optimized Recognition Time (UBIRIS)

Figure below shows the GA Optimized Recognition Time for 124 inputs out of 150 inputs for UBIRIS Database as 26 inputs showed no database compatibility with the application. The Recognition Time once optimized range between 02 seconds to 06 seconds.

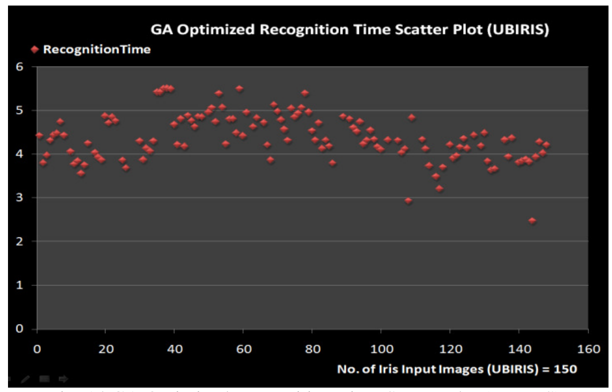

Fig. 14 GA Optimized Recognition Time Scatter Plot (UBIRIS)

Analysis Graph 9: GA Optimized Recognition Time (CASIA Vs UBIRIS)

Figure below shows the GA Optimized Average Recognition Time for 22 classes for CASIA Database and 30 Classes for UBIRIS Database. The average recognition time variations were more for CASIA Database and it remained moreover consistent for UBIRIS Database.

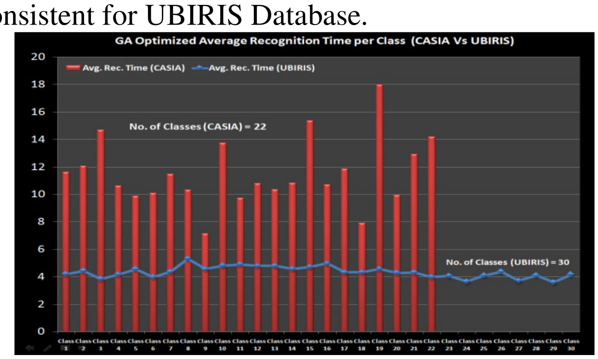

Fig. 15 GA Optimized Average Recognition Time per Class (CASIA Vs UBIRIS)

Analysis Graph 10: GA Optimized Overall Average Recognition Time (CASIA Vs UBIRIS)

Figure below shows the GA Optimized Overall Recognition Time for all 154 inputs for CASIA Database and 124 inputs out of 150 inputs for UBIRIS Database as 26 inputs showed no database compatibility with the application. The overall

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Average Recognition Time once optimized was calculated to be 11.663 seconds for CASIA Database and 4.38 seconds for UBIRIS Database.

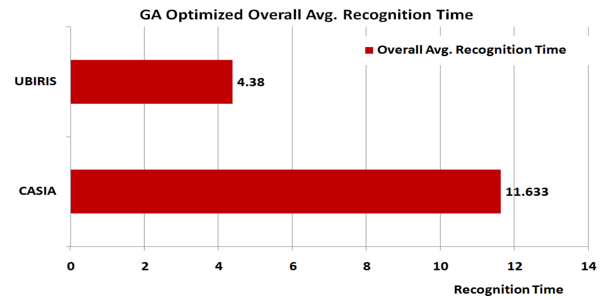

Fig. 16 GA Optimized Overall Average Recognition Time (CASIA Vs UBIRIS)

V. CONCLUSION

This paper has presents an iris recognition system, which was enhanced using Genetic Algorithm Optimization for feature selection resulting is improved recognition time and tested using two different databases namely CASIA Database for 154 of grayscale eye images and UBIRIS Database for 150 of grayscale eye images in order to verify the claimed performance of iris recognition technology.

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