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Iris Recognition using Gabor Filters Optimized by Genetic Algorithm and Particle Swarm Optimization

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Abstract: In this paper, 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. Experimental results show that the performance of the proposed method is encouraging in comparison to the traditional method .This whole simulation is being done in MATLAB 2010a environment with FAR, FRR and accuracy as parameters.

Keywords: Iris Recognition, Genetic Algorithm, Particle Swarm Optimization, Fusion, Gabor Filters.

1. INTRODUCTION

Iris recognition for security purpose has become very important these days because of its precision, unwavering quality and effortlessness when contrasted with other biometric attributes. The human iris is an annular area between the pupil (by and large darkest part of the eye) and sclera [1]. It has numerous minute attributes, for example, spots, crowns, stripes, wrinkles, graves thus on [2]. These minute features for each individual is unique and different. These properties make iris biometric more acceptable in the society [3]. A complete iris recognition framework can be partitioned into four phases: image procurement, division, improvement and matching. The image procurement step catches the iris pictures. The iris division step confines the iris locale in the picture. The presence of noise in iris templates is frequently incorporated into the division stage. Possible sources of segmentation noise are eyelid occlusions, eyelash occlusions, specular highlights, and shadows. Most segmentation algorithms are gradient based; that is, they involve finding the edges between the pupil and iris, and the iris and sclera. Thus optimization is needed at every step..

Fig.1: Iris Template

In this paper, particle swarm optimization (PSO) and Genetic Algorithm (GA) is proposed along with Gabor filters (GF) with the ideal parameters. For the iris recognition, the enhanced Gabor filters are utilized to separate the iris highlight, and a compelling component encoding strategy is proposed to create a reduced iris code [4]. At long last, the Hamming distance is used to gauge the separation between couples of iris highlight vectors. Our test results demonstrate that the proposed iris acknowledgment has an empowering execution with a little length of the element vector [5].

In the Section II, we quickly survey the Gabor filters along with the PSO and GA calculations. The feature extraction, the encoding method for getting biometric templates and the iris matching of the proposed iris recognition system by using hamming distance strategy are depicted in Section III. Exploratory results and correlations are accounted in Section IV. Segment V contains the conclusion and finish of this paper.

2. BASIC CONCEPTS IN PROPOSED WORK

2.1 Hough man Circular Transform (HCT)

Acquired image is pre-processed and then utilized to get the inner and the outer part of the iris. First step is iris localization in which rectangular block is detected after that the center of pupil is used to get the outer radius of iris. Various steps involved in localization are [6]:

1. Pupil detection;
2. External Iris localization

Before application of HCT, the iris image has to be converted into grayscale image. After application of HCT the obtained rectangular block has the highest intensity illumination area and edges can be obtained easily. Problem of binarization arises in case of person having dark iris [7].

Thus the localization of pupil fails in such cases. In order to overcome these problems Circular Hough Transformation for pupil detection can be used.

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Usage of HCT is to obtain the outer and inner circle of the pupil. The edge image is scanned for pixel (A) having true value and the center is determined with the help of the following equations

$$xc = x - r * \cos(\theta)$$
$$yc = y - r * \sin(\theta) \quad (1)$$

Where x, y are the coordinates at pixel A and r is the possible range of radius values, θ ranges from [0: π].

2.2 Gabor Filters

The Gabor filters have been widely applied to many image processing and feature extraction applications. The general impulse response function of the 2-D Gabor filter is defined as following [8]:

$$\begin{matrix} x \\ y \end{matrix} = \begin{bmatrix} \cos Q & \mathrm{Sin} Q \\ -\mathrm{Sin}\, Q & \mathrm{Cos} Q \end{bmatrix} \begin{matrix} x \\ y \end{matrix} \quad (2)$$

Where θ indicates the orientation of the Gabor filter, x and y are the Gaussian envelope along x and y axes, respectively. It is obvious that parameters θ, δ x and δ y, of each Gabor filter should be designed for different applications. Moreover, the number of Gabor filters need to be determined to optimize [9].

2.3 Particle Swarm Optimization (PSO)

Particle Swarm Optimization is evolutionary algorithm based on swarms and it has been introduced by Kennedy. PSO shares many features with other evolutionary algorithms. The system is initialized with number of populations. Then searching for optima is done. Unlike GA, PSO has no operators like mutation, fitness etc. In PSO, there are potential solutions called PSO. Each particle in PSO moves after another particle in its space for searching for new solutions. Each particle has its own coordinate and velocity and the entire particles move through the search space. Each particle has vector x, that is moving with velocity v.

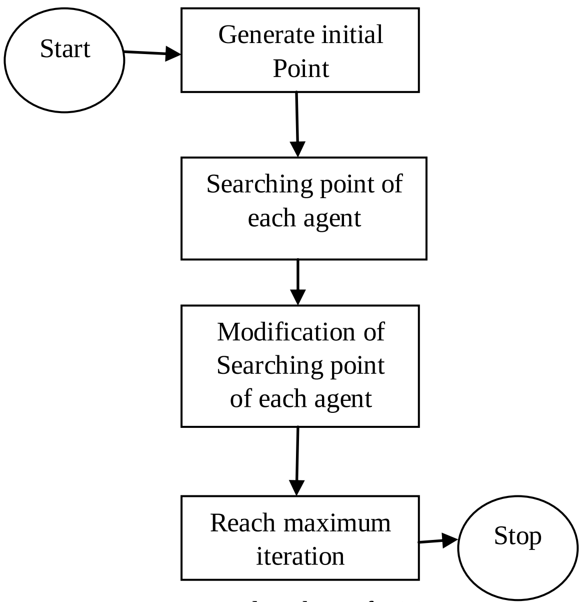

Fig.2: Flowchart of PSO

Let's suppose search space is in m- dimensional. An individual can be represented as [10];

$$X_o = \{X_o 1, X_o 2, \ldots \ldots \ldots \ldots . . X_o m\} \quad (3)$$
$$V_o = \{V1, V_o 2, \ldots \ldots \ldots \ldots . . V_o m\} \quad (4)$$

O=1, 2, 3…………m.

Where m is the size of the swarm population. Previous experience can be represented as below;

$$A_{of}\_f = \{A_{of}\_f1, A_{of}\_f2 \ldots\ldots\ldots A_{of}\_fm\} \quad (5)$$

The PSO algorithm can be represented as below;

Create initial particles.
Evaluate the objective function of each particle.
Choose new velocities
Update each particle location.
Iterate until a solution is reached

2.4 Genetic Algorithm (GA)

The genetic algorithm is a replica of machine learning which follows its actions as of metaphor process of development in nature [11]. This is completed by the formation inside a machine of a population of individuals shown by chromosomes by a set of character strings which are similar to the base-4 chromosomes.

```
// startwithaninitialtime
t := 0;
// initialize a usually random population
initpopulation P (t);
// evaluate fitness of all initial individuals
                evaluate P (t);
    //test for termination criterion (time, fitness)
while not done do
// increase the time counter
  t := t + 1;
// select a sub − population for offspring production
  P′ := selectparents P (t);
// recombine the "genes" of selected parents
                recombine P′ (t);
    // perturb the mated population stochastically
  mutate P′ (t);
      // evaluate it′s new fitness evaluate P′ (t)
end GA
```

3. IRIS RECOGNITION SYSTEM

In this work, we have developed a system for iris recognition based on PSO and Genetic algorithm. Firstly iris localization is done then feature extraction of iris templates using Gabor filters. Gabor filters extract the magnitude and direction of individual parts and give the complex values. Later, feature reduction is done using GA as well as PSO and the comparison will be done between the two by judging the parameters taken. In the end matching of templates will be done based on hamming distance.

Following are the steps that are followed in order to develop iris recognition system.

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3.1 Preprocessing

In this method the localization of pupil is done using canny edge detection operator and HCT method. Canny is used to get the edges of the iris templates that helps in segmentation of the image then the HCT application is done to get the inner and outer iris circle.

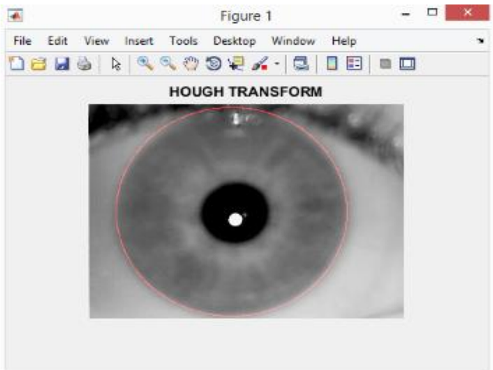


Fig.3: HCT Application

3.2 Feature Extraction

After segmentation and getting the radius boundaries feature extraction method is applied on the images and are decomposed into filtered images with pixels generated by Gabor filters. Gabor filters are used to give the complex values of the pixels in terms of magnitude and direction. These will be further used by PSO and GA for optimization. In the figure given below each block represents the normalized iris block.

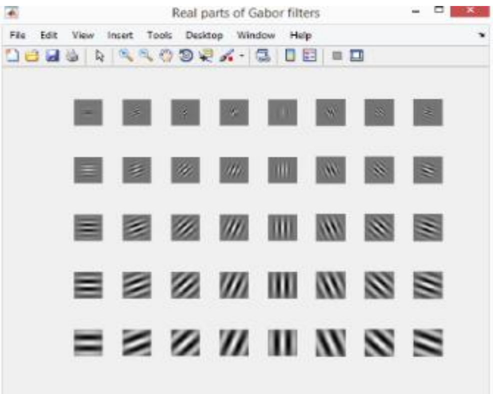
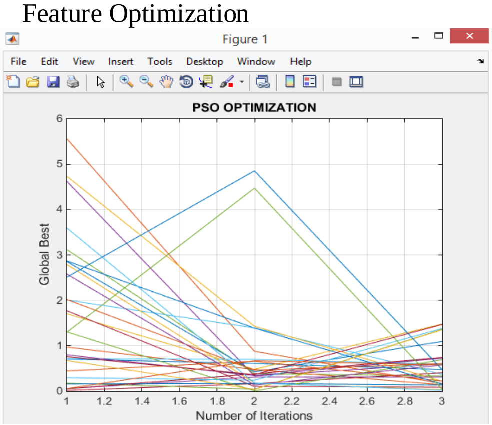
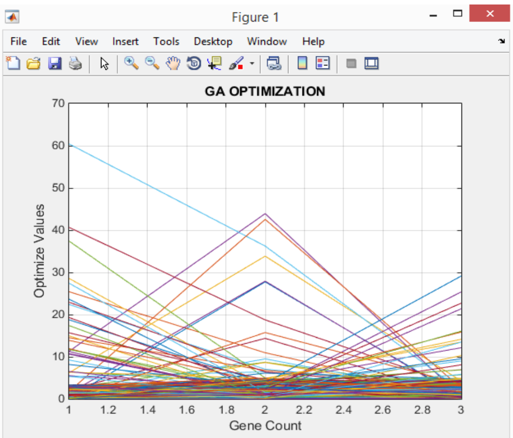


Fig.5: Gabor Filters Application

3.3 Feature Optimization



(a) PSO Optimization



(b) GA Optimization

Fig.6: Optimization of Iris

In this step firstly the feature optimization is done using GA and then it is done using PSO. Both methods use fitness function for feature reduction. In both the algorithms, 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.

3.4 Simulation Model

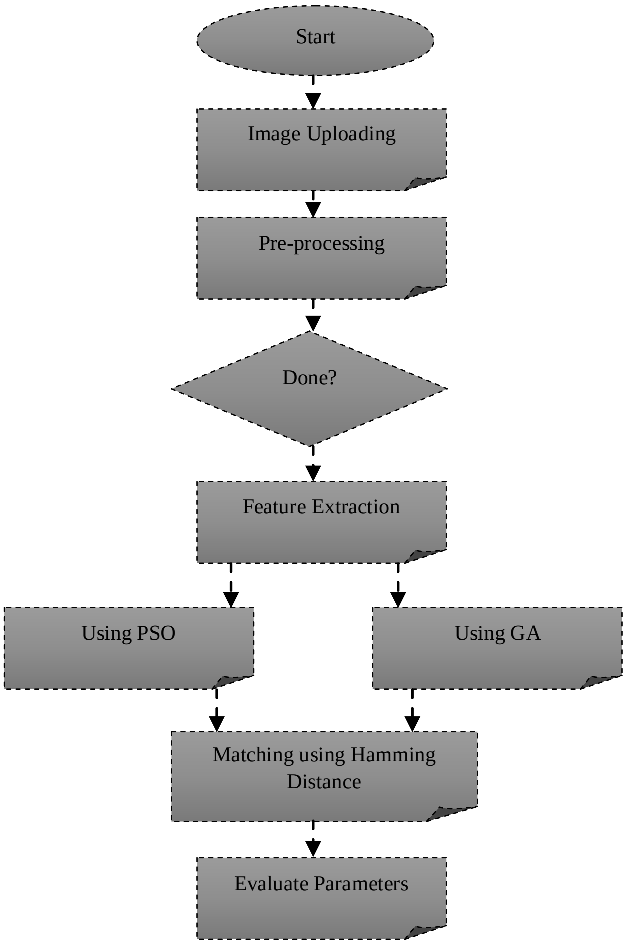


Fig.3: Proposed Working Model

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3.5 Matching

After the feature optimization, the major process is the matching process in which two iris templates will be matched using proposed matching method. In this system Hamming distance technique is used for matching purpose which looks for the difference in bits of new acquired image and all the stored images. For best possible match hamming distance should be minimum. For example if we take f1= 101011 and f2=101010 then only last bit has a difference and thus the hamming distance is 1.

4. RESULTS AND ANLYSIS

In this section, we will implement the proposed work model after that the parameter evaluation will be done in two cases: verification and identification. Simulations show that our iris recognition system can have comparable performance to most of the well-known systems with a smaller iris code.

In the iris verification, the receiver operating characteristic (ROC) curve that is a curve of FAR versus FRR is used to evaluate the performance of the proposed system. The FAR is the probability of accepting an imposter, and the FRR is the probability of rejecting a genuine user. The smaller FAR and FRR indicates the better performance of a biometric verification system.

Table.1 Parameters Values

Parameters	Using GA (%)	Using PSO (%)
FAR	.0654	.095
FRR	.00032	.0010
Accuracy	93.41	90.36

From simulation graph it has been seen that GA has better results than PSO because of the optimal solution measurement based on fitness function.

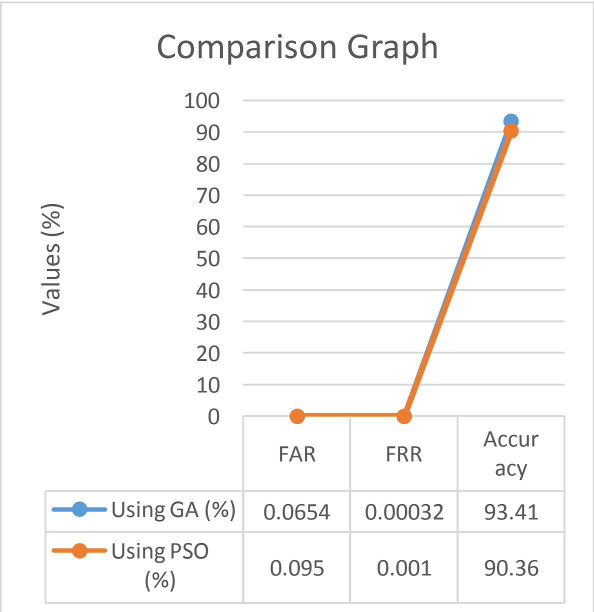

Fig. 4 Comparison Graph between GA versus PSO

5. CONCLUSION

In the proposed system comparison between PSO and GA feature optimization technique is generated at feature level for feature reduction and iris verification system to increase the accuracy of the authentication systems. In this Gabor features are extracted for iris, then classification of iris templates are done using hamming distance. This proposed method decreased the FAR as well as FRR, & has increased the system performance on the given iris data set using GA over PSO.

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