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Application of Ants Colony Algorithm for Nonideal Iris Image Segmentation

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ABSTRACT

As a dependable biometric technology, identity recognition through iris has attracted attentions of researchers. Ants Colony Algorithm has been adopted to solve vast variety of optimization problems. Segmentation is of the most important parts in identity recognition system where even a tiny error is not compensable but is moved from part to part toward the end of the operation. Four optimization parameters are defined for optimal segmentation of iris using Ant Colony Algorithm (i.e. longitudinal location of center, latitudinal location of center, inner radius of iris, and outer radius of iris).The map adopted in the present study is based upon Daugman method.1877 images from 241 persons in JPEG format were obtained from UBIRIS.v1 database for analyzing nonideal iris images. Angular method was adopted in order to choose an angle of iris with lower probability of wink where overall radius (i.e. pupil to iris) is considered. Also, normalized image of Haar wavelet coefficients were used in the present study. The results obtained from the present study showed that more considerable results are achieved by using the algorithm and has got proper precision and efficiency.

KEYWORDS: Ants Colony Algorithm, iris image segmentation, feature extraction.

1- INTRODUCTION

Ants Colony Algorithm was first presented by Dorigo (1996) to solve optimization problems. Then, Dorigo adopted the algorithm to solve traveling salesman problem. Ants Colony Algorithm has been inspired from natural behavior of ants in colonies. In this algorithm, operators are artificial ants which act as natural ants do and they can achieve good results through coordination with each other. The algorithm has been adopted to solve vast variety of optimization problems [6]. It is one of the most efficient algorithms to solve composite optimization problems. Ants Colony Algorithm may be used for traveling salesman problem, routing problem in long-distance telecommunication networks, intra- and inter-urban routing, routing between high-voltage electricity distribution networks posts, and computer networks routing.

When ants leave colony to find food, they randomly find their route and ants cannot find their food resources on themselves because they lack power of sight and they make connections through inhalation of a chemical called pheromone. Colony behavior based upon chemical circumstances according to pheromone secretion is considered positive feedback. Ants adopt the positive feedback when trying to opt for their pathwhile finding their optimal route. Therefore, when an ant is attracted by optimal route, it leaves some pheromone on the route. It attracts more ants which leave more pheromones. This process goes on so that the route is saturated and optimal route is selected. Thus, positive feedback increases the chance of an ant to select the route previous ants had chosen.

In addition, there is a negative feedback in ants' behaviors while trying to find food which is caused by pheromone evaporation. Pheromone evaporation results in elimination of the information related to old and deserted routes causing interference in food search trend.

If positive feedback, which is run on good solutions as increased pheromone level, occurs solely, elevation of pheromone level without evaporation brings about cease, early convergence, and algorithm deflation. As a result, negative feedback in the form of pheromone evaporation is used on all routes and sometimes only on bad routes. These two characteristics result in formation of very high flexibility in Ants Colony Algorithm to solve all optimization problems. Therefore, it is not necessary for algorithm to resolve the problem if a problem occurs in problem solving; but, ants can find the optimal route after a short time from the place the problem had occurred.

Ants Colony Algorithm has memory; that is, the chosen ant's route remains until several iterations later so that the secreted pheromone takes several iterations for full evaporation on this route. Positive and negative feedbacks in Ants Colony Algorithm make very high flexibility of the algorithm to solve all optimization problems. Whenever the problem status is subjected to a variation, the algorithm matches itself to the new status.

As a dependable biometric technology, identity recognition through iris has attracted attentions of researchers [3,4,7,8]. Complicated tissue of iris and its considerable consistency can enthusiastically indicate to more utilization of identity recognition systems based upon iris in various applications such as borders control,

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court investigations, airports, security offices such as banks, official organizations, and coding. Use of other visual properties and face features along with iris may make it possible to perform remote biometric identity recognition with proper precision. Identity recognition through iris, especially in military applications which need quick identity recognition in crowded locations, seems to have brilliant future.

2- NONIDEAL IRIS SEGMENTATION

Segmentation is of the most important parts in identity recognition system [1,2,5] where even a tiny error is not compensable but is moved from part to part toward the end of the operation. The present paper studies all edges. The smaller size of the image, the more limited operation time; thus, the image size is reduced to perform circle recognition method and it is brought back to its original size at the end of the operation.

For nonideal iris segmentation, centers of iris and pupil circles have to be obtained. For this, the centers should be found in the ranges defined experimentally according to the pixels of the first image. Considering the fact that the first image was 200×150 pixels, the following ranges can be experimentally defined:
Iris radius: R1=20-60
Pupil radius: R2=5-15
Center X=40-80
Center Y=50-110

Considering the above-mentioned ranges, a few circles are drawn on pupil and iris and intersection points are considered the border of iris and pupil. Circles with different radiuses are drawn in the distances of unknown area and then, the overall circle of iris and pupil is found through conformity of the circles. The highest intersection points are considered the center and subsequently, optimization is performed via ACO, R1, and R2. Although very time-consuming, segmentation by this method has high accuracy.

3- IRIS OPTIMAL SEGMENTATION BY ANT COLONY ALGORITHM

For optimal segmentation of iris, accurate location of center and radius of two circles is needed for separating iris pixels from other points of the image. Therefore, four optimization parameters are defined for optimal segmentation of iris using Ant Colony Algorithm (i.e. longitudinal location of center, latitudinal location of center, inner radius of iris, and outer radius of iris). Consequently, each ant must opt for an amount for each parameter in order to provide a solution for the problem. Cost of the ant with R1 and R2 is obtained so as to turn R1 and R2 to min.

For segmentation of nonideal iris images through Ant Colony Algorithm with 100 iterations, cost=0.1149, and conformity time=25 sec, this method was able to define borders of iris and pupil with maximum precision.

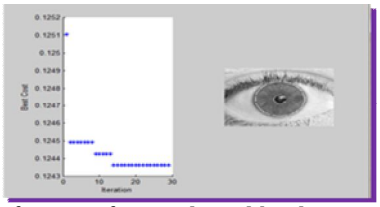

Figure 1: a sample of conformity of iris and pupil border using Ant Colony Algorithm

Table 1: the results obtained from running Ant Colony Algorithm

Algorithm	Testing time(s)	Best cost	Iteration
ACO	25	0.1149	100

4- THE ADOPTED NORMALIZED METHOD FOR IRIS IMAGES

The map adopted in the present study is based upon Daugman method. In this method, each pixel from iris is mapped into one point (r,Θ). This method readily maps iris image on a page with fixed dimensions in various statuses without considering pupil contraction and expansion; this facilitates comparison.

Following segmentation operation, the next step is transferring iris area into coordination with fixed dimensions in order to compare easily. In normalized method, spherical image of iris is cleaved and turned into a rectangular band. Here, iris loses its spherical form and turns to a Cartesian form. Furthermore, iris area is mapped onto a 100×400 band (respectively along r,Θ).

5- FEATURE EXTRACTION

The normalized image is raw information which is not suitable for making comparison. The information inside the images should be extracted in a way that suitable pattern is provided for comparison. Therefore, the

information with higher priority and effect on iris pattern formation should be extracted in order to ensure accuracy of comparison and results. Several iris recognition systems make use of filters in order to provide a suitable pattern for making comparison. One of the most important properties of feature extraction systems is keeping the pattern dimensions fixed for easy comparison between various patterns. The properties should be chosen in a way that suitable distance exists between similar and dissimilar irises so as to make a correct decision based upon similarity or dissimilarity of irises.

The obtained arrow should only code important information in iris tissue in order to perform a successful comparison between inlet image and stored codes. Majority of identity recognition systems produce proper codes through analysis of the information of middle band of iris tissue in frequency zone. Feature extraction is the most important part of identity recognition system where obtained feature arrow should not only involve all important information in iris tissue but also it should contain smaller dimensions if possible because larger arrows not merely need big space for storing but they impose high calculation volume during extraction and conformity to system as well.

6- DATABASE

1877 images from 241 persons in JPEG format were obtained from UBIRIS.v1 database for analyzing nonideal iris images. The images were 200×150 pixels with 24 colored bits. Localization was performed on 100 images from 20 persons.

7- ANGULAR METHOD

This method aims at choosing an angle of iris with lower probability of wink where overall radius (i.e. pupil to iris) is considered. In this method, mask is not used and storing volume is lower because pixel levels are lower. Here, fewer pixels are involved and precision is presumably reduced. However, higher precision is also possible due to lack of wink. The results obtained from localization will vividly approve this claim.

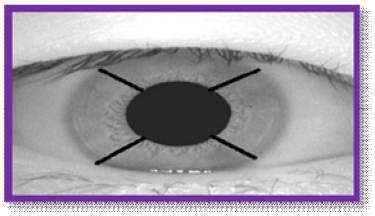

Figure 2: Angular method

8- HAAR TWO-DIMENSIONAL VIOLET

Normalized image of Haar wavelet coefficients are used in the present study. Haar wavelet has a compact support in frequency domain and it is non-derivative and continuous. Haar violet is adopted for feature extraction. 100×400 image is obtained from normalized stage and is turned to 25×50 by use of haar violet. The present paper uses the haar violet with the coefficient 4. The jumps exceeding 3 are considered; the higher the jumps, the lower the information volume. Levels should be reduced to a level where the neural network is capable of working properly. Haar violet is used mainly to compact the image and reduce the size of the image. Data in neural network should be reduced to an extent where neural network is able to perform Train operation properly; otherwise, accuracy will not be ensured.

In order to guarantee elimination of winks, the columns with the probability of wink existence are removed; then, wavelet transform is drawn once from the overall image and compared. Subsequently, transforming the wavelet, the overall image becomes smaller and only important parameters are stored. Finally, the coefficients are given to the neural network for training.

9- RESULTS AND CONCLUSION

The present study aimed at determining the effect of Ants Colony Algorithm usage on nonideal iris image segmentation. Incorporation of strong image processing with the metaheuristic optimization algorithm in nonideal iris image recognition showed that more considerable results are achieved by using the algorithm.

In this paper, a major approach was presented to optimize iris borders, reduce selected features, and increase precision. In the approach which is related to determination of iris and pupil borders, the best result was obtained through localization of Ant Colony Algorithm with the best precision. As expected, localization with the metaheuristic optimization algorithm surpassed other methods in terms of precision. Considering the results obtained from the system in which image processing incorporation with the metaheuristic optimization algorithm was performed, the lowest cost was achieved in terms of both precision and reduction of number of selected features.

Comparison of figures and results showed that the presented metaheuristic optimization algorithm has got proper precision and efficiency. However, this method needs more work and precision in order to present a solution to reduce recognition time along with high precision. In the meanwhile, practical opportunities still exist about this topic such as recognition of moving people by iris in various distances. One of other investigational solutions about iris is disease diagnosis from iris (iridology) and recovery of patients' background in patients from their irises; this attracts researchers' attention although it seems to be time-consuming.

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