Iris Feature Detection using Split Block and PSO for Iris Identification System

Nurul Akmal Hashim, Zaheera Zainal Abidin, Abdul Samad Shibghatullah
Optimization, Modelling, Analysis, Simulation and Scheduling (OptiMASS) Research Group,
Fakulti Teknologi Maklumat & Komunikasi, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.
samad@utem.edu.my

***Abstract*—The past decade has seen the rapid development of iris identification in many approaches to identify unique iris features such as crypts. However, it is noted that, unique iris features change due to iris aging, diet or human health conditions. The changing of iris features creates the mismatch in comparison phase to determine either genuine or not genuine. Therefore, to determine genuinely, this study proposes a new model of iris recognition using combinational approach of a split block and particle swarm optimization (PSO) in selecting the best crypt among unique iris features template. The split block has been used in this study to separate the image with the part that very important in the iris template meanwhile, the particles in PSO searches the most optimal crypt features in the iris. The results indicate an improvement of PSNR rates, which is 23.886 dB and visually improved quality of crypts for iris identification. The significance of this study contributes to a new method of feature extraction using bio-inspired, which enhanced the ability of detection in iris identification.**

***Index Terms*—Iris Identification; Crypts; PSO; Iris; Bio-Inspired.**

I. INTRODUCTION

In biometric, there are two types of features which are physiological and behavioral. An example of behavioral biometric is handwriting and voice recognition. Besides that, an example of physiological is thumbprint, fingerprint, iris recognition and etc. However, the most popular nowadays among researcher is Iris recognition. Human iris contains unique texture and is complex enough to be used as a biometric signature [1]. Compared with other biometric features such as face and fingerprint, iris patterns are unique and reliable. It is unique to people and stable with age [1,2]. Moreover, in iris recognition system it has been evolving from the first generation into the second generation just to find the uniqueness of iris in each person. The example of human iris shows in Figure 1.

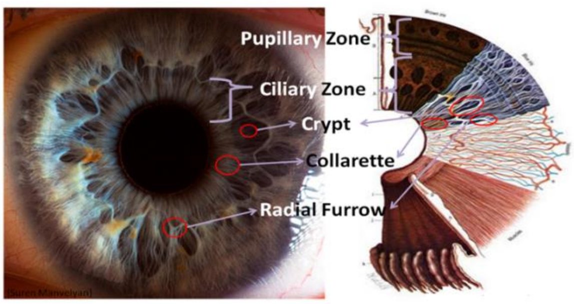

Figure 1: Human iris [6]

The human iris, as shown in Figure 1, has an extraordinary structure and provides abundant texture information. The uniqueness of iris features comes from the texture in iris images, such as pectinate ligaments adhering into tangled mesh revealing striations, ciliary, crypts, rings, furrows, a corona, sometimes freckles, vasculature and other features. The spatial patterns that are apparent in the iris are unique to each individual. Individual differences that exist in the development of anatomical structures in the body result in the uniqueness.

Even though the unique iris features look very accurate, but it also has a period of time before the next acquisition of iris features. Iris features constantly change in slow motion based on the human condition such as aging or health condition. Besides that, technical fault also one of the factors that contribute to the changing of iris feature. These always changing iris features create difficulties in comparison phase to determine either genuine or non-genuine.

In reality, the difference happens in iris features [3], it does grow sooner or later [4] and usually develops slowly [5]. It has been revealed that the iris feature is aging or has a certain growth which makes the iris recognition is the failure to matching over time [6]. According to Downing in 2001, he stated that various iris features such as freckles, pigment blotches and color also change with time. This situation makes the genuine user being rejected by the biometric system and claimed as the non-genuine user. All of these iris problems cause the "failure-to-match" condition in the existing iris recognition system which is the failure over time.

The objectives of this paper are to overcome the genuine user problem by introducing a new model of iris recognition which is the combination of split block and PSO.

II. RELATED WORK

A considerable amount of literature has been published on iris identification with the same objective to overcome the rejected genuine issue [7]. Well, known examples of methods which have been used by other researcher are image enhancement [8,9,10], multiple biometric modality analysis [11,12,13] and features extraction [14,15,16] are more popular nowadays. Thus, split block and PSO has been proposed to solve the problem in determining either genuine or vice versa.

The split block has been used in this study to separate the image with the part that very important in the iris template. According to Miyazawa in 2008, he used the split block at the matching phase to reduce the size of the iris image. Besides that, Guang Zhu in 2006 has used sub-block to identify eyelids and eyelashes type in the iris template. Due to their study split the image into block has given more accurate in terms of performance of the system. The iris template will be split into 4 blocks and only the upper left block will be used to identify the crypt using PSO. Particle Swarm Optimization (PSO) algorithm is used to identify the significant and unique iris features, which is according to the birds flocking or fish schooling behavior.

In the proposed method as in Section 2, the existing technique of PSO has been understudied and evaluated. Particle swarm optimization (PSO) was introduced by Eberhart, R., Kennedy in 1995. Particle swarm optimization is used to solve the optimization problems. Particle Swarm Optimization is objected to search using a population (swarm) of individuals (particles) that will be updated from iteration. Particle Swarm Optimization colonies were inspired by the social behavior of animals such as termites, bees, fish or birds. It has been used in iris recognition to find the feature in iris template by a few researchers. It is because PSO is easier to be implemented and have fewer parameters to be adjusted [18]. Besides that, PSO is easier to be implemented and have fewer parameters to be adjusted. Other than that, PSO only selects the 'best' particle that shares the information to others [19]. It is a one-way information sharing mechanism; the evolution is determined to provide the best solution.

III. Proposed Method

In the proposed research methods, the technique of split block and PSO have been understudied and evaluated.

A. *Split Block of Iris Feature Template*

The split block is a technique that splits a 2D image into the new size of iris feature template image. In this method, iris template that in size [h x w] will be split into four blocks and each of the blocks will be in new size [h' x w']. A 2D illustration of how split block work is shown in Figure 2.

The equation for split image as shown below:

- X, area of the iris template
- h, the height of iris template
- w, the width of the iris template
- n, the number of blocks

$$X = (h \times w)/n \qquad (1)$$

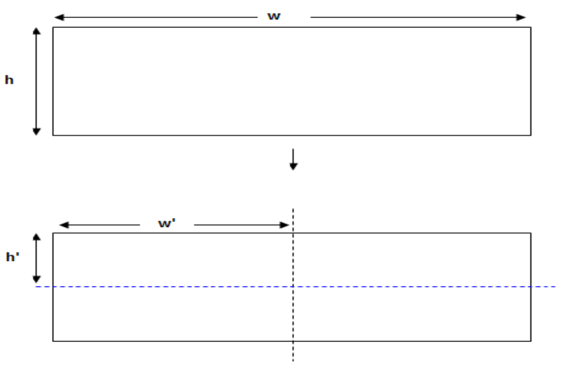

Figure 2: A 2D image on how split block works

B. *Particle Swarm Optimization (PSO)*

In PSO the performance of each particle is measured using a fitness function which depends on the optimization problem[15,16]. Each particle i fly through the n-dimensional search space Rn and maintain the following information:

- Xi, the current position of the particle i(x-vector)
- Pi, The personal best position of the particle i(p-vector).
- Vi, the current velocity of the particle i(v-vector).

The personal best position associated with a particle i is the best position that the particle has visited so far. If f denotes the fitness function, then the personal best of particle i at a time step t is updated as:

$$Pi(t+1) = \begin{cases} Pi(t) & if \ f(xi\,(t+1)) \geq f(Pi(t)) \\ x_i(t+1) & if \ f(xi\,(t+1)) < f(Pi(t)) \end{cases} \qquad (2)$$

In order to locate the position of yielding the lowest error among all the Pi is called the global best position and is denoted as gbest. It is shown in the Equation 3 below.

$$\begin{aligned} gbest \ &\in \{P0(t), P1(t), \ldots., Pm(t)\} \\ &= min\{f(P0(t)), f(P1(t)), \ldots., f(Pm(t))\} \end{aligned} \qquad (3)$$

$$F = ma$$

The velocity updates are calculated as a linear combination of position and velocity vectors. Thus, the velocity of particle I is updated using Equation 4 and the position of particle I is updated using Equation 5:

$$x_i(t+1) = x_i\,(t) + v_i(t+1) \qquad (4)$$

$$v_i(t+1) = wv_i\,(t) + c_1 r_1 (p_1\,(t) - x_i(t) + c_2 r_2 \, crypt - x_i(t)) \qquad (5)$$

v_i must be in a predefined range [V_{min}, V_{max}], where if $v_i > V_{max}$ then $v_i = V_{max}$, and if $v_i < V_{min}$ then $v_i = V_{max}$.

In the formula, w is the inertia weight, c_1and c_2 are the acceleration constant and r_1and r_2 are random numbers in the range [0, 1]. Moreover, pi is the personal position of the particle i and crypt are the updated crypt.

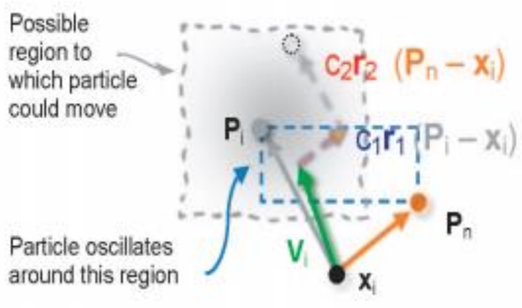

Figure 3: A 2D illustration shows, on how the velocity will move and update the equation and regions [16].

IV. Experiment Result

To determine crypts in iris image template using a combination of split block an experiment has been arranging.

A. *Test Image Set*

In these experiments, a set of iris template images were used from the CASIA which example of images is shown in

Figure 4, 5, and 6. Figure 4 shows a normalization image of iris template size [20 x 240] is taken from CASIA database and split it into four block size [10 x 120]. Then the first blocks are taken and apply PSO to find the best edge of the crypt. Figure 5 shows a transformation of the split block using a different type of method. Some of the objects' intensity is very similar to the background of the image and some shapes are more unequal. In Figure 4, iris template image of size [20 x 240] have been split into 4 blocks of size [10 x 120] using mat2cell, indexing, block proc and matrix technique. The result shows the image quality improvements of matrix method as compared to others mentioned. The result shows the image that employing the enhancement can help in identification of iris image pattern matching techniques.

B. Result

The experiment results have been grouped into high quality (CASIA).

C. PSO Parameter Setting

PSO parameter setting is based on Table 1. All the values were chosen based on the common setting and an observed search from initial experiments [16].

Table 1
Setting for PSO parameter

Population	50
Iteration	100
C1	2.05
C2	2.05

a. Casia for High-Quality Image

The ‘PSNR' in Table 2 is the peak signal to noise ratio of the iris template image. In Table 2 the summarized of PSNR values of different methods is shown. The PSNR value for each method is calculated which 23.886 are for a matrix, 23.5671 for block proc method, 23.5604 for indexing method, and 22.4205 for mat2cell method.

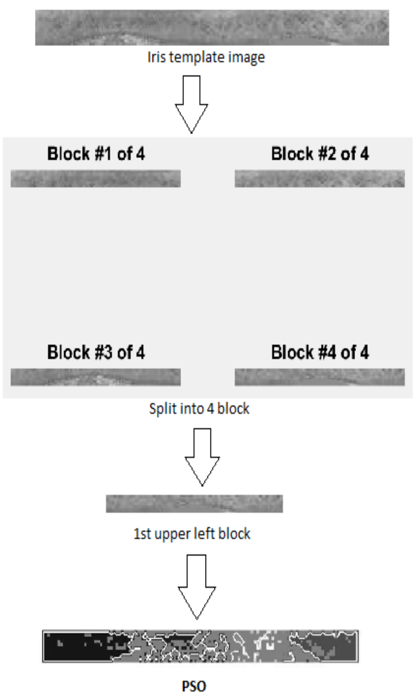

Figure 4: Transformation of iris template image into 4 blocks (CASIA)

Table 2
Results of split block after using different method of enhancement

Method	PSNR Value
Matrix	23.8860
Block procs	23.5671
Indexing	23.5604
Mat2cell	22.4205

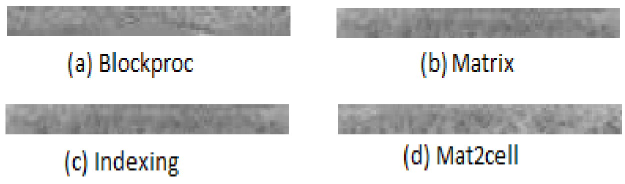

Figure 5: 1st block of iris template image (CASIA) after applying four different methods. (a) Block procs, (b) Matrix, (c) Indexing and (d) Mat2cell

Figure 5 shows the first block of iris template after applying four methods. The left upper most had been choose because based on the observation on the iris template in the pre-processing phase it shows that most of the features is located in the upper block and at the lower block it’s only contains the eyelids and pupil. Even though the quality of each image looks like same but it does shows the different values after applying PSNR.

Figure 6 shows the comparison in column graph that performance of proposed method is better as compared to conventional methods for high quality iris image.

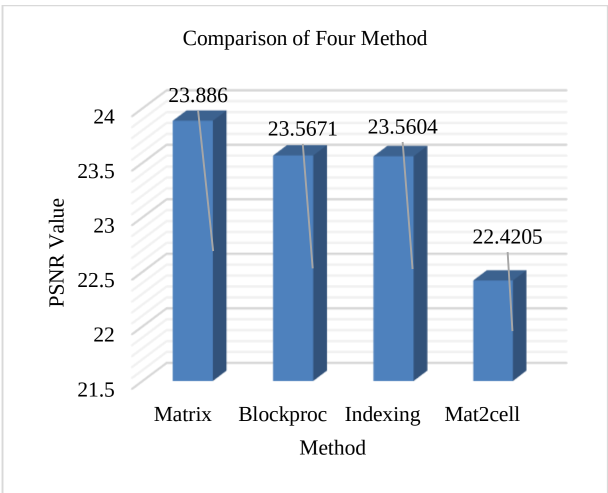

Figure 6: Comparison of PSNR Value between four Method

V. CONCLUSION

The proposed method is a combination technique for identifying the crypts in iris images template in order to aid the recognition process of iris recognition system. The results showed value has improved the capability and visually crypts images with the proposed method as compared to other methods. Besides that by using this technique it can reduce the size of iris image and it can save a lot of space in the database.

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