Improved Iris Matching Technique Using Reduced Sized of Ordinal Measure of DCT Coefficients

Fitri Arnia, Khairul Munadi, Roslidar, M. Fujiyoshi and H. Kiya, *Member, IEEE*

Abstract—**This paper presents an ongoing research on the use of ordinal measure of discrete Cosine Transform (DCT) coefficients as a feature for iris recognition. We proposed to reduce number of DCT coefficients from each 8x8 DCT block that is used to form ordinal measure. The aims were to increase matching rate while minimizing feature size. Four simulation rounds were conducted using CASIA database, each with different coefficients, namely 48, 32, 16 and 8 AC coefficients. It turned out that using as many as 8 AC coefficients from each DCT block resulted in a higher matching rate than using other number of AC coefficients of the block. The proposed method can increase averaged matching rate as much as 5% when using 8 AC coefficients. Furthermore, the proposed technique can reduce the feature size by approximately 80%.**

I. INTRODUCTION

A biometric system based on iris can achieve higher security level due to iris unique patterns that is stable over time and comprises of high amount of discriminating information [1]. Recently, one crucial issue in biometric-based applications was reducing feature size to save storage and support faster processing [2]. Furthermore, matching rate as a function of feature size has been considered as an important constraint of a biometric based approach [3].

The discrete cosine Transform (DCT) has been used in prominent JPEG image compression scheme, and more recently in other applications including image classification/retrieval [4] and recognition [5, 6]. One common reason of the using of DCT in those applications was that the DCT can compact image's energy into only a few first coefficients, which are one DC and several AC coefficients. Using the DCT's compactness characteristics, it was shown in [7] that reducing feature size and gaining higher matching rate can be achieved at the same time. Furthermore, it was shown that using all DCT coefficients may affect matching rate, since higher DCT's frequency components may act as noises.

Based on the requirements to reduce feature size and increase matching rate, we presented an ongoing research on the use of ordinal measure of DCT coefficients for iris recognition [8, 9]. The feature size was reduced by reducing number of DCT coefficients from each 8x8 DCT block that is used to form ordinal measure. The proposed method is illustrated in Fig. 1. First of all, normalized iris image was tiled into blocks of 8x8 pixels and the DCT was applied. Then a reduced number of DCT's AC coefficients were determined to form ordinal measure, which is the feature of the method. Furthermore, distances between all DCT blocks of input image and those of images in the database were calculated using Minkowski distance metrics. Finally, all block distances were averaged to obtain a matching score. Iris features of all other images were extracted in the same manner and previously saved in the database. Simulation results showed that the proposed method can improve matching rate by nearly 5%. While at the same time, approximately as much as 80% of the feature size can be reduced.

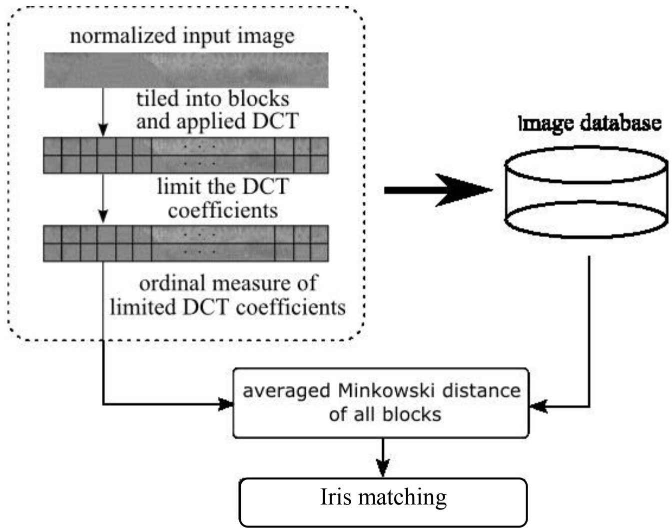

Fig 1. Proposed Method

II. BACKGROUNDS

A. Ordinal Measure of DCT Blocks

The 1-D DCT formula is shown is Eq. 1.

$$X_k = \sum_{n=0}^{N-1} x_n \cos\left[\frac{\pi}{N}\left(n+\frac{1}{2}\right)k\right] \qquad k = 0,1,2,\ldots N-1 \tag{1}$$

In this paper, a limited number of AC coefficients were used to form ordinal measure. The ordinal measure (OM) of a DCT coefficient block was adopted from [10] and can be defined as descending order of AC coefficient magnitudes of each DCT block, which is given by Eq.2.

$$OM = \Delta\left(\left|X_{k-AC}\right|\right) \qquad k = 1,2,\ldots M \tag{2}$$

here, Δ denoted the descending ordering operation, $X_{k\text{-}AC}$ denoted DCT's AC coefficient and M represented number of AC coefficients. If all AC coefficients in a block are used, M is equal to 63.

B. Minkowski Distance

The Minkowski distance d between two DCT blocks is defined as

$$d(t,b) = \sum_{j=1}^{N}\left|t_j - b_j\right| \tag{3}$$

here, t and b are ordinal measures of two corresponding blocks in a test image and database image respectively, and M is number of AC coefficient used in the block.

TABLE I
MATCHING RATE OF THE PROPOSED TECHNIQUE, COMPARED WITH THE METHOD IN [9]; MEASURED IN PERCENTAGE

	Number of AC coefficients	Class of Input Iris Image										
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Average
Proposed Method	8	**86**	**80**	**38**	**69**	**74**	**62**	**33**	**57**	**59**	**80**	**63.8**
	16	86	80	29	71	71	62	31	53	55	71	60.9
	32	86	76	29	71	71	57	27	57	51	71	59.6
	48	84	76	27	71	69	57	27	57	51	71	59.0
Previous method [9]	63	90	78	27	71	69	49	27	57	51	71	59.0

III. RESULTS AND DISCUSSIONS

The proposed method was simulated using CASIA version 1 database [11]. The database consisted of 108 classes, in which each class consisted of 7 iris images, resulted in a total of 756 images. From the database, 10 image classes were randomly selected as test class, and all 7 images from each class, which are called test images, were passed to the algorithm. Thus there were 70 simulation rounds. The ten image classes were denoted as C1-C10. The DCT coefficients were calculated based on Eq. 1, with extension to 2-D. We experimented with as many as 48, 32, 16 and 8 AC component of DCT coefficients respectively. In subsequent part in this section, m AC component of DCT coefficients will be denoted as *m-AC*.

Performance of the proposed method was measured by calculating matching rate. The matching rate was defined as percentage of total image number from a test class that has closest distance to the corresponding test image, when the test image was passed to the algorithm. Averaged matching rate was calculated by averaging the matching rate of all seven test images in the corresponding class. In implementation, a threshold value to separate images in one class from images of other classes has to be determined.

The simulation results were summarized in Fig. 2. In general, the matching rate of the proposed method with different number of DCT coefficients was higher than that of previous method [9]. As for the proposed method itself, there was an increment in matching rate as the numbers of DCT coefficients were reduced. The averaged matching rate of the previous method and the proposed method, when 48-AC, 32-AC and 16-AC were used, resulted in a moderate increment, nearly 1-2%. The highest matching rate was achieved when as many as 8-AC were used, and compared to [9], the increment was nearly 5%. Moreover, regarding the feature size, the previous method [9] used all DCT's AC coefficients, i.e., 63-AC. Meanwhile, the proposed technique used only 8-AC. Therefore, the proposed technique with 8-AC can reduce as much as around 80% of the feature size.

Regardless of matching rate increment of the proposed method, there are two image classes, C3 and C7, which resulted in matching rate less than 50%. Observation of the images from those classes revealed that these images were lacked of iris patterns.

IV. CONCLUSIONS AND FUTURE DIRECTIONS

This paper presented an improved iris matching technique based on ordinal measure of DCT coefficients. The technique has lower feature size and higher matching rates. The simulations were conducted on CASIA database. It turned out that the matching rate of the proposed techniques when as many as 8 AC coefficients was used was approximately 5% higher than that of previous approach. Furthermore, using the same number of AC coefficients, approximately as much as 80% of feature size can be reduced. In the proposed scheme, all parts in normalized iris images including noises such as eyelids were extracted as feature. This may degrade the overall matching rate. In the future, a segmentation step to exclude the noises may be applied to enhance the matching rate.

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