Iris Image compression Using JPEG 2000 & It's Effect on Recognition Performance

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***Abstract*— In the present age of digital impersonation, biometric techniques are proved to be the best method to protect against identity thefts. In Biometric technologies Iris recognition is a proved to be most accurate means to identify people. Iris is regarded as the most reliable biometric feature in terms of its uniqueness and robustness .For Iris Recognition iris images from different person should be stored in the data base & called whenever required. So there is need for a large database of iris images is required. If available storage space is not enough for storing these images, compression will be a solution. Compression allows reduction in the space needed to store these iris images & also important when transferring these images through internet. The objective of this paper is to present the effects of image compression on the iris recognition performance. Normally, standard iris images are 600 times larger than the Iris Code templates which required larger space for storage .It is desired that iris data should be stored, transmitted, and embedded in media in the form of images rather than as templates so that it can be used in future. To obtain this goal with its implications for bandwidth and storage, a method is presented that combine region-of-interest isolation with JPEG 2000 at different compression factor. Study reveals that it is possible to compress iris images with minimal impact on recognition performance.**

***Keywords*—JPEG 2000 ,Iris Recognition ,ROC ,ROI, Template**

I. Introduction

Classical methods of human identification & verification such as using keys, certificates, passwords, etc., are hardly meet the requirements of identity verification and recognition in the modern society. These methods are based on what a person have (a physical key, ID card, etc.) or what a person knows (a secret password, etc.), and it has many weaknesses. Keys , ID cards may be lost, or passwords can forget . In today's modern society, biometric identification is getting importance from both academia and industry to overcome the draw backs of classical method of identification mention above [1]. Biometrics can be defined as features used for recognizing and identifying a person based on his physiological or behavioral characteristics; and today, it is a common and reliable method to authenticate the identity of a living person. The process matches the individual's pattern or template with the records known by the system. Iris patterns appear as an interesting alternative for reliable visual recognition of persons when imaging is done at distances of less than a meter (without contact) and when there is a need to search very large databases without any false matches. The pattern of human iris differs from person to person, even between twins. [2] The iris pattern can contain many distinctive features such as arching ligaments, furrows, etc. These patterns remain stable from a very young age, barring trauma or disease, allowing accurate identification with a very high level of confidence.

In order to use biometrics for identification, the biometric data must be collected by some means from the different persons in question. In some cases, this may be a costly and time consuming process, and the data obtained is important and must be protected. Also, the data collections can create a huge amount of data that puts a limit on the available storage. To deal this problem, one available option is compression. In many applications where compression is required, but no loss of information is acceptable (such as monetary transactions or some medical applications), lossless compression is necessary; that is, compression without loss of information. There are many lossless compression algorithms available that work best on certain types of data, such as predictive coding for one-dimensional waveform data and string coding for text. For images, JPEG2000 and lossless-JPEG have demonstrated very good lossless compression performance with most types of image. Unfortunately, lossless compression has a major drawback in that the reduction in file size is on the order of only 1.5:1 to 3:1 for many types of images. On the other hand, these algorithms can readily compress data further if some loss of information is tolerable. It is up to the user of the data to determine how much loss of information is acceptable. This paper, investigate the effects of compression on the ability of an iris recognition system to accurately identify individuals. The performance is evaluated by means of the change in Hamming distances between IrisCodes using an iris recognition implementation based on the Daugman algorithm. Image compression is also very important for efficient transmission and storage of images. Demand of communication of multimedia data through telecommunication network and data accessing through internet is explosively growing. Image compression is minimizing the size in bytes of a graphics file without degrading the quality of image to an unacceptable level.

In this paper JPEG 2000 compression schemes is used for compression of iris image that retain rectilinear image formats but achieve severe compression at different levels, still offers very good recognition performance on the CASIA publicly available iris image database.

II. JPEG 2000 Compression

The JPEG (Joint Photographic Experts Group) 2000 standard, was created by the Joint Photographic Experts Group committee in 2000 with the intention of superseding their original discrete cosine transform-based JPEG standard (created in 1992) with a newly designed, wavelet-based method, which offer more flexible modes of use, and achieving typically 20-30% more compression at any given image quality. Mathematically based on a Discrete Wavelet Transform (DWT) onto Daubecies wavelets rather than the Discrete Cosine Transform (DCT), JPEG2000 does not suffer as badly from the block quantization artifacts

Before applying the DWT, the source image is divided into components (colors) and each component is divided into tiles which are compressed independently, as though they are independent images and all the samples in the tile are DC level shifted. The DWT coefficients in different subbands are quantized and then composed into an embedded bit-stream following the EBCOT algorithm, the embedded bit-stream is composed of quality layers so as to offer both resolution and SNR scalability. The entropy coding is based on a context-adaptive arithmetic coder, known as MQ coder, which has error correction capability. The encoding process may be summarized as follows[4]

A. Tiling and its significance

Before applying the DWT, the image and its components are divided into smaller non-overlapping blocks, known as tiles, which can be coded independently, as if each tile is an independent image. All operations, such as component mixing, DWT, quantization and entropy coding are therefore done independently for each tile. Tiling has the advantage of reducing memory requirements for DWT and its processing and is amenable to parallelization.

B. Discrete Wavelet Transform

The Continuous Wavelet Transform maps a one dimensional signal on to a two –dimensional signal space, which is highly redundant. The time bandwidth product of the continuous transformation is the square of that signal for most applications, which seeks a signal description with as few components as possible, this is not efficient. To overcome this problem Discrete Wavelet analysis is required. Discrete Wavelets are not continuously scalable and transformable, but only be scaled and transformable in discrete steps.

Discrete wavelet transform (DWT) uses filters with different cut off frequencies to analyze a signal (image in our case) at different resolutions. The signal is passed through a series of high-pass filters, also known as wavelet functions, to analyze the high frequencies and it is passed through a series of low-pass filters, also known as scaling functions, to analyze the low frequencies. After filtering, the signal can therefore be sub-sampled by 2, simply by discarding every other sample. Thus, decomposition halves the time resolution (half the number of samples) and doubles the frequency resolution (half the span in the frequency band). Calculating wavelet coefficients at every possible scale is a fair amount of work, and it generates an awful lot of data. The scales and positions based on powers of two so-called *dyadic* scales and positions are selected then the analysis will be much more efficient and just as accurate. We obtain such an analysis from the *discrete wavelet transform* (DWT).[4]

The JPEG-2000 standard supports lossy as well as lossless encoding. Two types of wavelet filters are included in Part-I of the standard –

(a) *Irreversible*, where exact reconstruction will not be possible at the decoder and is used for lossy encoding. This is implemented using a 9/7 Daubechies filter.

(b) *Reversible*, where exact reconstruction at the decoder is possible and is therefore included for lossless JPEG-2000. This is implemented using a 5/3 filter.

C. Quantization

After transformation, all coefficients are quantized. Quantization is the process by which the coefficients are reduced in precision. This operation is lossy, unless the quantization step is 1 and the coefficients are integers, as produced by the reversible integer 5/3 wavelet. Each of the transform coefficients *ab (u, v)* of the subband *b* is quantized to the value *q b(u, v)* according to the formula

$$q_b(u,v) = sign(a_b(u,v))\left\lfloor \frac{|a_b(u,v)|}{\Delta_b} \right\rfloor$$

The quantization step-size *b* is represented relative to the dynamic range of subband *b*. In other words, the JPEG 2000 standard supports separate quantization step-sizes for each subband. However, one quantization step-size is allowed per subband.

D. Entropy Coding

Entropy coding is achieved by means of an arithmetic coding system that compresses binary symbols relative to an adaptive probability model associated with each of 18 different coding contexts. The recursive probability interval subdivision of Elias coding is the basis for the binary *arithmetic coding* process. With each binary decision, the current probability interval is subdivided into two subintervals, and the code stream is modified (if necessary) so that it points to the base (the lower bound) of the probability subinterval assigned to the symbol, which occurred[4]

E. Precincts and packets for JPEG-2000 bit-stream

The arithmetically coded quantized wavelet coefficients are arranged in *packets* and the packet partition locations are referred to as *precincts*. After quantization, each subband is divided into some non-overlapping rectangles. The data representing a specific tile, layer component, resolution and precinct appears in the code stream in a contiguous segment, called a *packet*. The data in a packet is ordered according to the subbands LL, HL, LH and HH and within each subband, the codeblocks are arranged in raster scanning order, confined within the bounds of the corresponding precinct[4]

III. PROPOSED WORK

In this paper first original image template is extracted. After that this original image is compressed by using different compression factor for JPEG 2000 scheme to obtain their templates. Then the original image templates with different compressed image templates are compared using Hamming Distance (HD) method. Based on this comparison the recognition performance is obtained.

1) Simple cropping

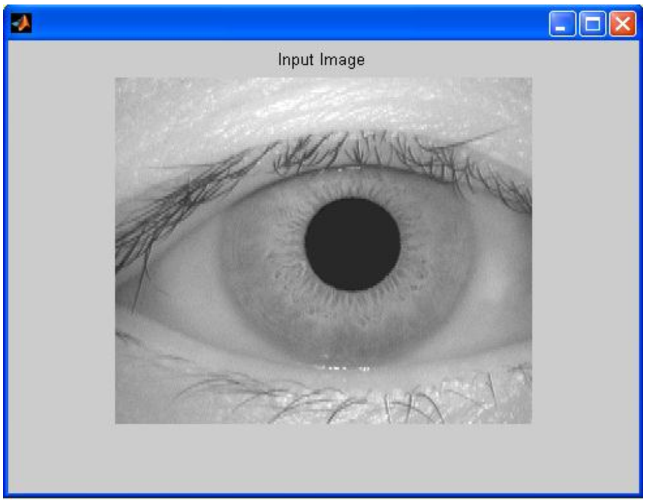

Figure 2. Original Eye Image

Our first step is to reduce image data size from the standard iris image format of 320 × 280 pixels with 8 bits grayscale data per pixel, consuming 89600 bytes, is to crop the image to a smaller region containing the iris, because the total eye image contain region which are not essential for iris recognition and then we perform JPEG 2000 compression on this cropped image. The original image is shown in figure 2 where as figure 3 shows copped image.

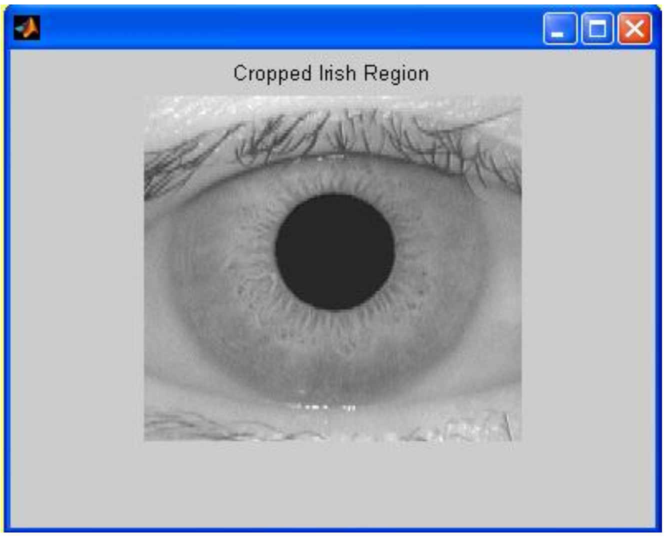

Figure 3. Cropped Eye Image

The cropping tool manually correctly localized the iris in all images and produced from each one a new cropped image with the iris centered in it. The new gallery of grayscale eye images with is obtained & then perform JPEG compression by various factors specified as compression factors (CF).

2) Region-of-interest (ROI) segmentation

The JPEG 2000 compression can be made more effective if we replaced all non-iris parts of the image with a uniform gray value. This kind of substitution of pixel values within a rectilinear image array is preferable, from the viewpoint of Standards bodies, than actual extraction and mapping of pixel data from a normalized ("unwrapped") iris because it is desirable to be as shape-agnostic and as algorithm-neutral as possible[8]. JPEG 2000 compression schemes study here fits themselves well with region-of-interest (ROI) differential assignment of the coding budget [8]. This idea was used for biometric face recognition by Hsu and Griffin [8], who demonstrated that recognition performance was degraded by only 2% for file sizes compressed to the range of 10,000 – 20,000 bytes with ROI specification. Here it is investigated that how much compression of iris images can be achieved with minimal impact on iris recognition performance, using the ROI idea without "unwrapping" the iris but retaining a rectilinear pixel array format. Figure 4 shows the cropped image same as figure 3 but now with region of interest (ROI) process. Non-iris regions must be encoded in a way that distinguishes sclera from eyelids or eyelashes regions, so that post-compression algorithms can still determine both types of iris boundaries. Since the substitution gray levels are uniform, their coding cost is minimum and could be further reduced by using larger data units.

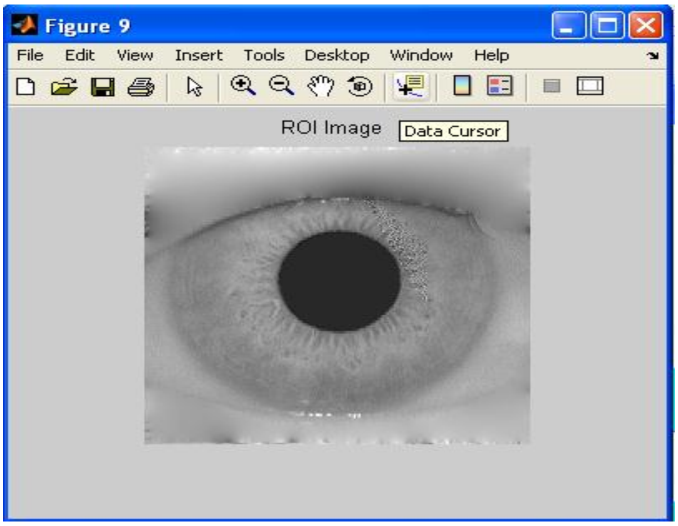

Figure 4 Cropped Eye Image with ROI

For any given specified CF, the result of iris ROI isolation is nearly a two-fold reduction in file size while maintaining a simple rectilinear image format and easy localization of eyelid boundaries in later stages. Substitution of non-iris regions by uniform gray levels prevents wasting the coding budget on costly irrelevant structures such as eyelashes.

IV. RESULT AND DISCUSSION

In this paper the effect of iris image compression on recognition performance by using JPEG 2000 as a compression algorithm was studied.

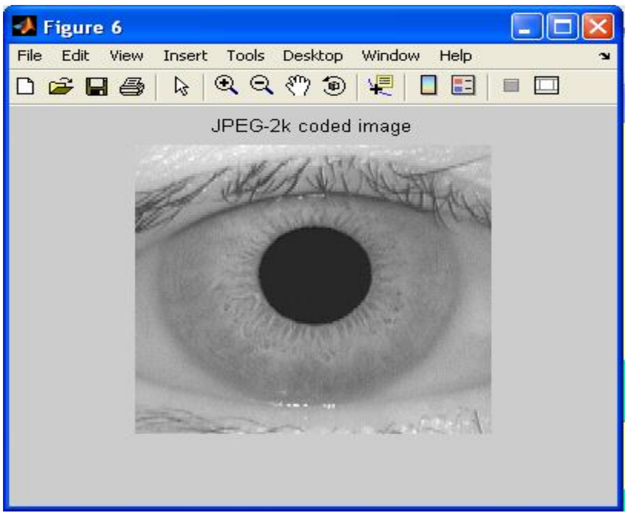

Figure 5. Cropped & JPEG 2000 compressed Eye Image

A cropped & JPEG 2000 compressed iris image is shown in figure 5 where as Figure 6 show the same image but now compressed by JPEG 2000 algorithm & ROI isolation .

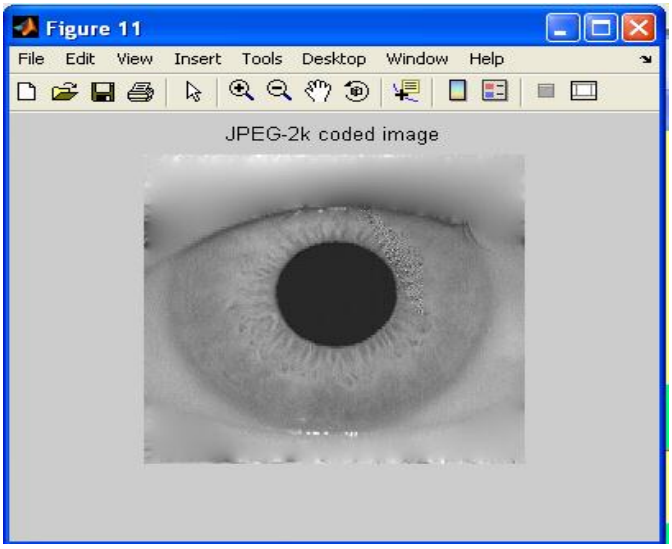

Figure 6. Cropped & JPEG 2000 compressed Eye Image with ROI

Biometric recognition performance is usually measured by generating ROC (Receiver Operating Characteristic) curves, which plot the trade-off between two error rates (False Accept and False Reject Rates, FAR and FRR, also called False Match and False non- Match Rates) as the decision threshold for similarity scores is varied from conservative to liberal[11]. It is common to tabulate specific points on such trade-off curves, such as the FRR when the decision threshold causes an FAR of 1 in 1,0000 or of 1 in 1,000 and the point at which the two error rates are equal, FRR = FAR = EER, the Equal Error Rate. Such ROC curves and tabulations are presented in Fig. 7 for the CASIA gallery, both for baseline performance (uncompressed and uncropped: Green curve) and for three JPEG 2000 compression factors (colored curves).

Figure 7 shows the ROC curve obtained for JPEG 2000 compression. Green line shows the performance of original image, blue line shows the performance of compressed image at quality factor of 72, black line shows performance of compressed image at quality factor of 35 & red line shows performance of compressed image at quality factor of 25. It has been observed from ROC curve that the recognition performance is degraded if we increase compression factor for JPEG 2000 compression.

Figure 8 shows the ROC curve obtained for JPEG 2000 compression with ROI. As seen from ROC curve we can analyze that performance will remain somewhat same as without ROI but advantage of ROI is that it reduces the size of iris image two times as compare to without ROI .

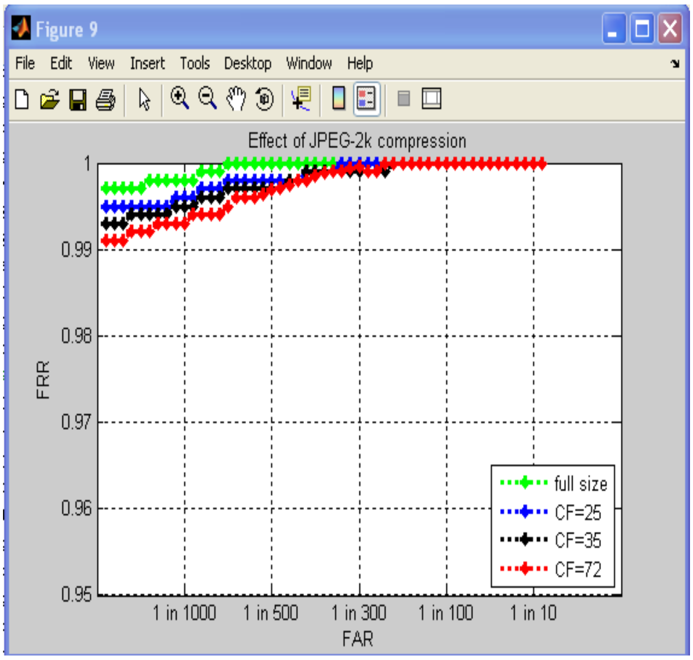

Figure 7 ROC curve for different compression Factor for JPEG 2000

It has been also observed from ROC curve of figure 8 that the recognition performance is degraded if we increase compression factor for JPEG 2000 compression.

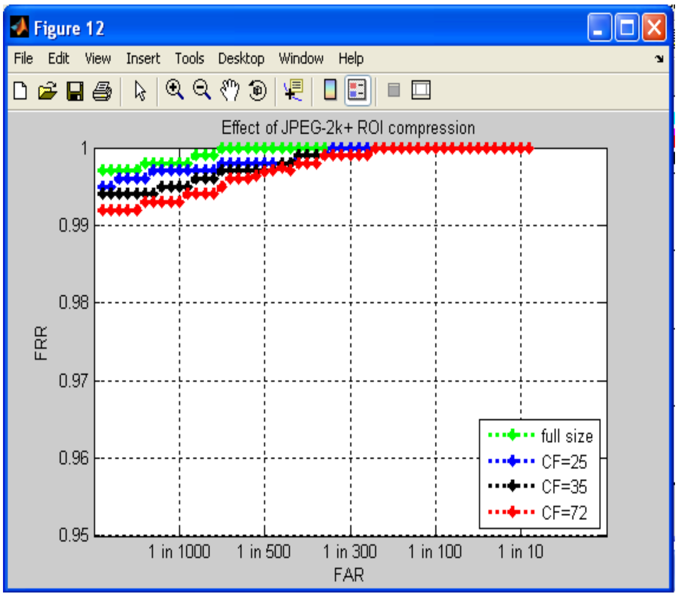

Figure 8 ROC curve for different compression Factor for JPEG 2000 with ROI

V. CONCLUSION

In this paper the effects of image compression on iris recognition performance by using JPEG 2000 as compression algorithm is studied. The iris template of each compressed image & original image, is compared using hamming distance method which leading to the surprising conclusion that even images compressed severely from their original full-size to few Kilo bytes (KB), by using different compression factor it remain perfectly serviceable.JPEG 2000 compression gives better recognition performance and higher compression ratio as compare to DCT based JPEG compression. If higher compression factor are used accordingly performance is degraded. It is important to use region-of-interest(ROI) isolation of the iris within the image so that the coding budget is allocated almost to the iris. The average HD between such IrisCodes obtained before and after image compression indicate that only about 2% to 3% of the IrisCode bits change as an effect of image compression even though the image is compressed to very small size using JPEG 2000.

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