PERFORMANCE ANALYSIS OF IRIS RECOGNITION BY USING CLASSICAL AND TRAPEZOIDAL SHAPED TEMPLATES WITH A STATE-OF-ART IRIS SEGMENTATION TECHNIQUE

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Abstract - Iris recognition is an automated process of authentication of individuals based on their unique characteristics of iris patterns. These characteristic features can be extracted and encoded by projecting them onto Gabor wavelets and transforming their phasor information into binary codes. These codes are used to identify or match the individuals by using some decision metrics. Hamming distance is one of the most known and used matching metric for identifying individuals. Iris recognition has four stages; image acquisition, image preprocessing, image feature extraction, and image matching. Proper segmentation of the iris region is an important step where researchers have to solve co-occurring effects such as eyelid occlusion, eyelashes, or reflection of lights. After the segmentation, the second step is creating an iris template. Here we modify the well-known rectangular iris template that is created by binary phasor information of individuals into a different trapezoidal iris template. The tests were conducted employing traditional and recently developed EPK_IRIS segmentation and different encoding schemes by new defined trapezoidal template under the different noise levels of Gaussian noise and Salt-and-pepper noise. We report better accuracy and equal error rate (EER) results at some specific noise levels. In this work, we conclude that the EPK_IRIS segmentation in both template types gives better results.

Index terms - Iris Recognition, Segmentation, Accuracy, EER, Hamming Distance, Iris Templates

I. INTRODUCTION

Pattern recognition algorithms have developed gradually. Algorithms are initially tested for nearly ideal images, are optimized for those cases, are fine-tuned for more complicated situations such as for more challenging backgrounds and can be adjusted for deformable objects such as in medical imaging [1]. The main challenges of the iris recognition are mostly solved, and developed algorithms have been tested on several iris databases. For the iris, the features that are extracted from the phase information are more important than the ones that are extracted from the intensity information. Daugman has developed the most efficient iris identification system since 1994 [2] and has been contributing ever since [3-5]. The latest works have focused largely on the improvement of the segmentation of the whole iris [6-8]. Other important developments have been done by using only a part of the iris instead of the whole [9], or the modification of the encoding and matching steps [10] by using rectangular iris templates. Here in this work we propose a new segmentation and a new trapezoidal iris template for encoding of the features of the phase space and adjust the major parameters as we try to optimize the accuracy in term of equal error (EER). Optimizing the accuracy is minimization the overlap of the histograms describing the intraclass and interclass comparisons [11]. In this work, we present performance analyses of the accuracy of the iris recognition by (i) adding different level of artificial noises to the CASIA dataset images, (ii) defining a trapezoidal shaped iris template, (iii) comparing results with classical and state-of-art segmentation techniques by using rectangular and trapezoidal shaped templates. State-of-art iris segmentation technique uses a metric to exclude candidate circles that deviate extensively from being concentric with the pupil during the localization of the iris [11]. We have added Gaussian noise and Salt-and-pepper noise at different noise levels (are shown in Figure 2&3). We have defined a trapezoidal shaped iris template in order to get more data points for our iris recognition steps. We have also employed a four-level quantization model on phase information template that is obtained by using 1D Gabor wavelet where the iris identification system has two subsequent regions of the phase space that are 50% dissimilar. The new segmentation technique and new trapezoidal template are tested for whole images of the CASIA iris dataset database.

II. THE PROPOSED APPROACHED

The most commonly used database for iris recognition is The Chinese Academy of Sciences – Institute of Automation (CASIA) which contains 108 different images of human eye [12]. There are seven images for each eye captured in two sessions. In the CASIA Database, the images are capture in the infra – red light, in which there is no reflection (Chinese Academy of Sciences, 2003). The images are saved in bitmap (.bmp) format with resolution 320x280 pixels.

A. Adding Noise

The mobility of people, the type of camera and wavelength used to capture the image, the relative light intensity in the background, the interference with the eyelids and eyelashes are all factors that may

affect negatively one or more of the procedures that are performed in iris recognition. Under the mentioned fact, we degraded image qualities by adding artificial noises to the CASIA dataset. Two types of noises we used such as Gaussian noise, and Salt-and-pepper noise.

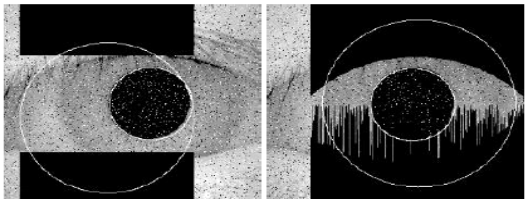


Figure 1. Pepper-and-salt noised added (S1) and (S3) iris images of same person

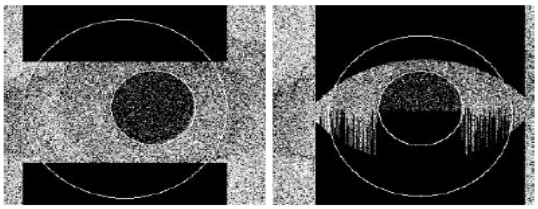


Figure 2. Gaussian noised added (S1) and (S3) iris images of same person

B. Segmentation

Segmentation is the first major step of the iris recognition and its aim is to localize the existence of the iris region in given images. To detect the pupil and iris boundaries Hough Transform algorithm is used from which we get a set of circles. In classical segmentation technique, it firstly determines the outer circular boundary of the iris and secondly searches for the pupil boundary. After doing these, it reports six different parameters: the coordinates of centers and the radii for both the iris and the pupil [13]. The approach explained above that finds the outer iris boundary first, we will call S1 segmentation (Masek Algorithm). There is another approach that is more efficient than S1 segmentation that firstly finds the pupil boundary and then the outer iris boundary [14]. In this work, Liu et al. used other optimization techniques and reported improved accuracy. Recently, Koc et al [11] used state-of-art segmentation technique which is called segmentation technique S3 and denoted as EPK_IRIS, this technique improved succeed of the segmentation step is shown in Figure 3, therefor it increased the overall accuracy of the recognition system which is shown in Figure 3.

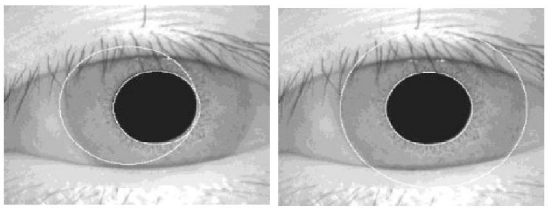


Figure 3: EPK_IRIS (left), MASEK (right)

When we add the artificial noises, namely Gaussian noise, and Salt-and-pepper noise, to the CASIA dataset, we saw that segmentation success of S3 is always better than S1 which are shown in Figure 4 and Figure 5.

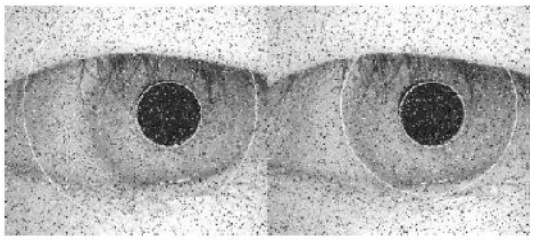


Figure 4: Segmentation with Salt & pepper Noise

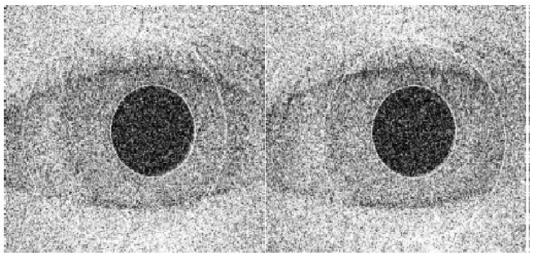


Figure 5: Segmentation with Gaussian Noise

C. Template Creation

Once the iris region is selected, in the classical rectangular template 20 values of pixel intensity information could be extracted in the radial direction (for a fixed angle) and 240-pixel intensity information extracted in the angular direction (for a fixed radius). This makes a 'pixel intensity template' with a size of 20x240. In our paper, we define a new trapezoidal shaped iris template.

The upper base of the trapezoid corresponds to the smallest circle that is closest to the pupil and the lower base of the trapezoid corresponds to the largest circle that is at the boundary between the iris and the sclera. Trapezoidal template's 20 values of pixel intensity information extracted in the radial direction (for distinct angles) and 468-pixel intensity information extracted in the angular direction (for a fixed radius). These selections create a "pixel intensity template" with a size of 20x468. When we calculate phase information and use 2 bits of data (i.e. the 11, 01, 00, 10 notation) for each phasor then the "phase information template" size is doubled and becomes 20x936.

D. Performance test

For the iris recognition techniques, achieving a high accuracy means; a maximization of the sum of TP (true positive) + TN (true negative), or a minimization of the FP (false positive) + FN (false negative). When calculating the accuracy, the true negatives (TN) has higher weight than true positives (TP) since the inter-class dual comparisons are at least two orders more that is shown in Figure 6. When calculating the EER there is no weight of the two factors (FAR and FRR) considered. This means that the accuracy and the EER are never

instantaneously at their optimal value for the same threshold value [11], hence there are confusing results reported. Generally, FAR and FRR results are inversely proportional. When working with a dataset to test the algorithms that are developed, the number of the inter-class dual comparisons is a few orders more than the number of intra-class dual comparisons. If FAR and FRR are equal to zero, then we have a perfectly working biometric system and as a result the EER is also zero.

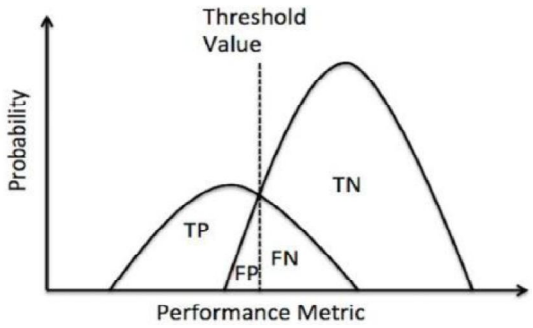


Figure 6: Performance metric probability

III. RESULTS

We have tested classical rectangular iris template with newly defined trapezoidal iris template by using classical Masek's segmentation (S1) and state-of-art EPK_IRIS segmentation (S3). We reported performance results of iris recognition system after adding two different artificial noises at different noise levels; (i) Salt-and-pepper noise, and (ii) Gaussian noise by using two segmentation types, (i) (S1) and (S3). To decide optimum threshold values between intra and inter classes, we used classical Hamming Distance metric [2].

When we calculate the accuracy of the iris recognition system, we have seen that the accuracy of the system with the EPK_IRIS segmentation (S3) gives always better results than classical Masek segmentation (S1) on both template types which are easily seen through Figure 7 to Figure 14.

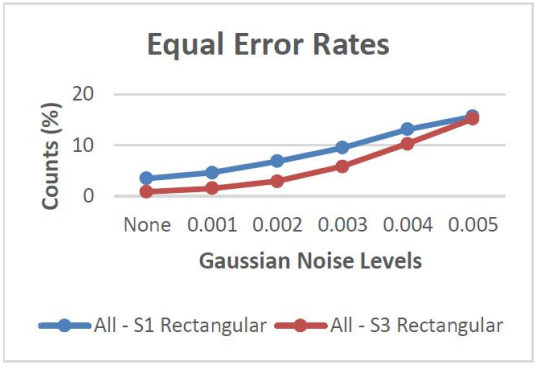


Figure 7: Performance results of Masek and EPK_IRIS segmentations when Gaussian noises added for rectangular shaped iris templates

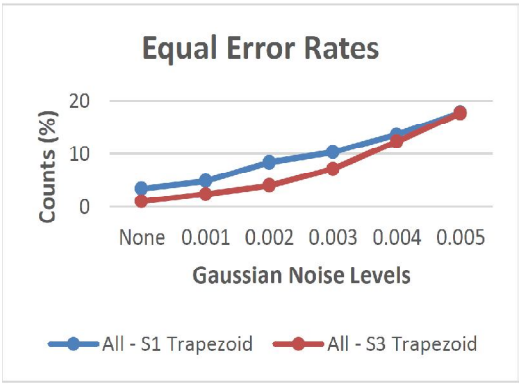


Figure 8: Performance results of Masek and EPK_IRIS segmentations when Gaussian noises added for trapezoidal shaped iris templates

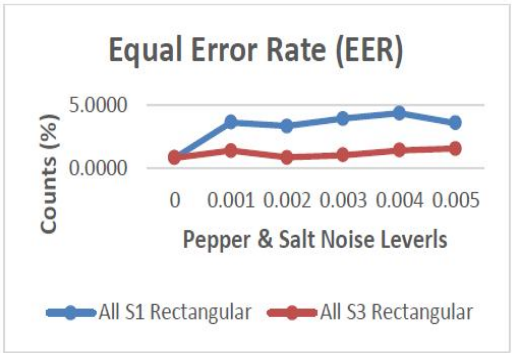


Figure 9: Performance results of Masek and EPK_IRIS segmentations when Pepper-and-Salt noises added for rectangular shaped iris templates

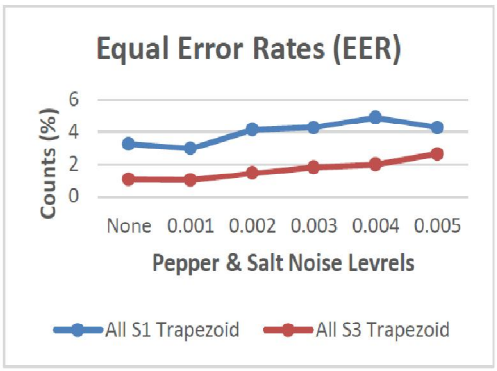


Figure 10: Performance results of Masek and EPK_IRIS segmentations when Pepper-and-Salt noises added for trapezoidal shaped iris templates

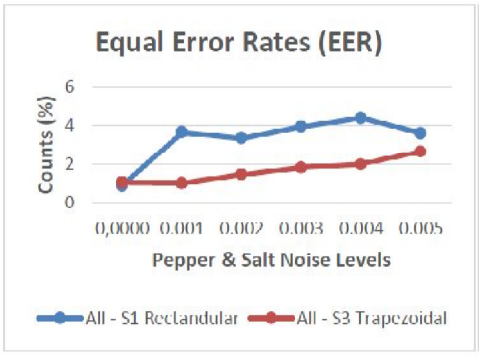


Figure 11: Performance comparisons between EPK_IRIS and Masek segmentations when Pepper-and-Salt noises added for rectangular and trapezoidal shaped iris templates

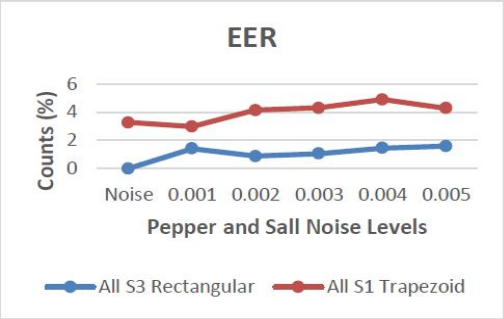


Figure 12: Performance comparisons between EPK_IRIS and Masek segmentations when Pepper-and-Salt noises added for rectangular and trapezoidal shaped iris templates

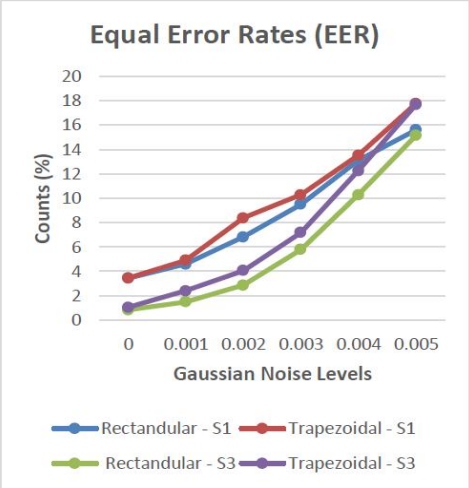


Figure 13: Performance results of Masek and EPK_IRIS segmentations when Gaussian noises added for rectangular and trapezoidal shaped iris templates

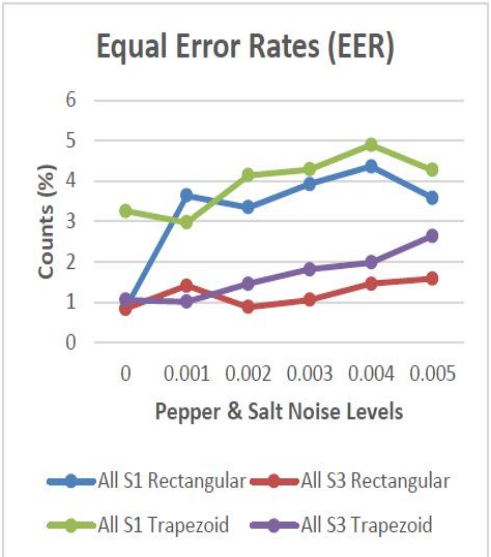


Figure 14: Performance results of Masek and EPK_IRIS segmentations when Gaussian noises added for rectangular and trapezoidal shaped iris templates

CONCLUSION

In this work we tested the proposed segmentation and the new trapezoidal iris template on CASIA iris database. Results show that the new segmentation greatly improves the segmentation under and also the overall accuracy in terms of equal error rate (EER). The new trapezoidal shaped template proposed here also perform better than the classical rectangular template. Results suggest that under different noise levels and using rectangular or trapezoidal iris templates always EPK_IRIS segmentation gives better results than MASEK segmentation in terms of equal error rate.

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