ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

Pupil Dilation Degrades Iris Template and Affects the Performance of Recognition System

Dr K R Badhiti

Assistant Professor, Dept. of C.S.E, Adikavi Nannaya University, Rajahmundry, Andhra Pradesh, India

ABSTRACT: Iris Recognition is a high-confidence biometric identification system with promising future in the security systems area. Its robustness and unobtrusiveness, as opposed to most of the currently deployed systems, make it a good candidate to replace most of the security systems around. Iris recognition systems make use of the uniqueness of the iris patterns to derive a unique mapping where it becomes possible to apply some matching algorithms to identify a person. In this paper, we propose three techniques to increase the iris recognition robustness and accuracy. First, we propose a new segmentation algorithm to handle iris images were captured on less constrained conditions. This algorithm reduces the error percentage while there are types of noise, such as iris obstructions and specular reflection. The proposed algorithm starts by determining the expected region of iris using K-means clustering algorithm, then circular Hough transform is used to localize iris boundary. After that, some proposed algorithms will be applied to detect and isolate noise regions. Second, a study of the effect of the pupil dilation on iris recognition system is performed, in order to show that the pupil dilation degrades iris template and affects the performance of recognition systems. Therefore, a limit of pupil dilation degree is determined. If the degree of pupil dilation exceeds this limit, the iris code will be affected or some of its information will be discarded. This limit can be used to avoid detrimental pupil dilation. Finally, we analyze the iris code bits to determine the consistent and inconsistent bits, and we compare between the inner and outer regions to find which region contains more inconsistent bits.

KEYWORDS: Iris Recognition; Robustness and Accuracy; K-means Clustering Algorithm; Circular Hough Transform; Pupil Dilation; Inconsistent Bits.

I. INTRODUCTION

Biometrics consists of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits. Another definition defines biometrics as the science and technology of measuring and analyzing biological data. Iris recognition is becoming one of the most important biometrics used in recognition when imaging can be done at distances of less than two meters. This importance is due to its high reliability for personal identification. Human iris has great mathematical advantage that its pattern variability among different persons is enormous [6], because iris patterns possess a high degree of randomness[3]. In addition, iris is very stable over time. The iris consists of a pigmented fibro vascular tissue, known as stroma. The stroma connects a sphincter muscle and a set of dilator muscles to open it. It is divided into two major regions: the pupillary and the ciliary zone (Iris). The pupillary zone is the inner portion of the iris whose edges form the pupillary iris border. The ciliary zone is the outer portion of the iris, which extends itself into the iris origin in the ciliary body. The region that separates the pupillary and scleric portions is designated as the collarets. This is typically the region where the sphincter and dilator muscles overlap [9].

Figure 1: Morphology of the human iris (UBIRIS Database).

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

II. LITERATURE SURVEY

Iris Recognition Methods: Although there are many proposed iris recognition systems, all of them approximately share the following main stages: iris Segmentation, iris normalization, feature extraction, and feature comparison, as shown in Figure 2. This section, explains in detail the stages of the most common methods in iris recognition system.

Daugman's Method :

Daugman's 1994 patent [11] described an operational iris recognition system in some detail. In 2004 his new paper [3] said that image acquisition should use near-infrared illumination so that the illumination could be controlled.

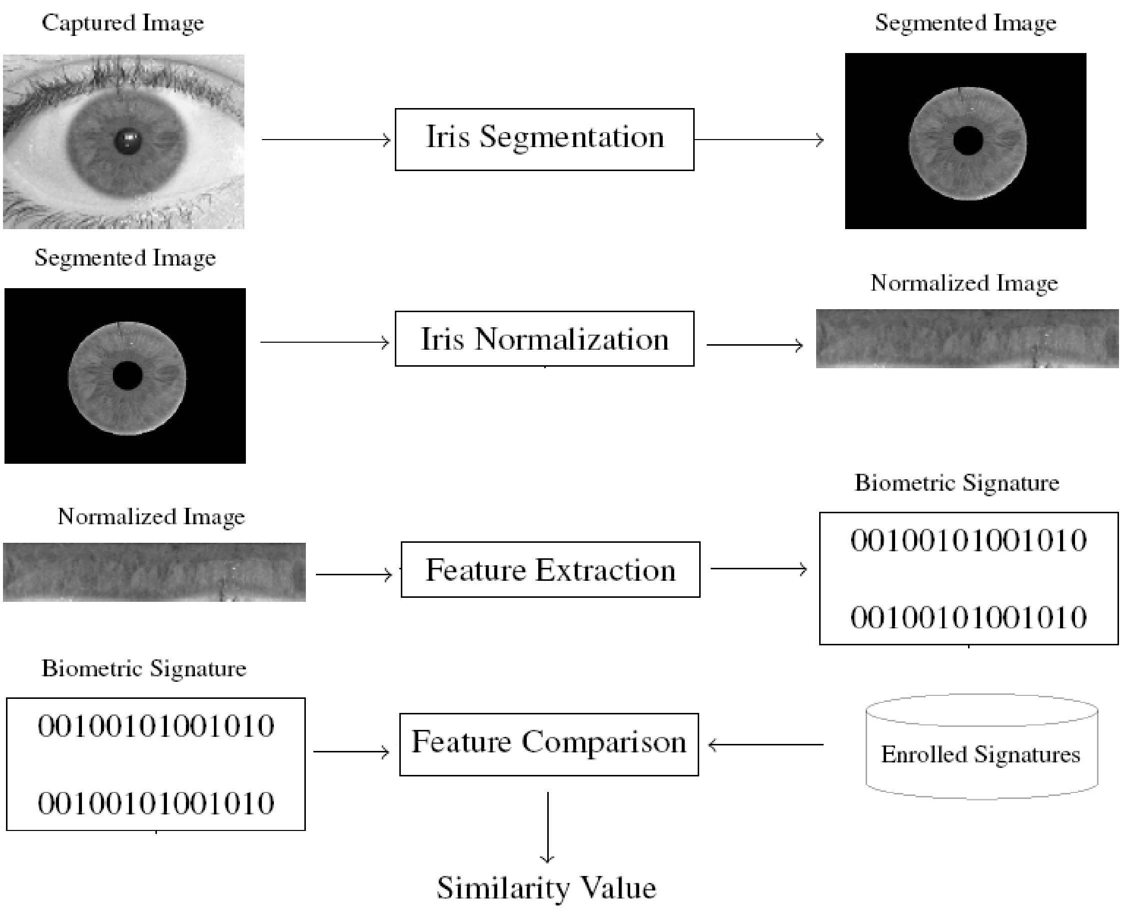


Figure 2: Main stages of the iris recognition systems

Daugman's approximated the pupil and iris boundaries of the eye as circles. So, he proposed an Integro-Differential operator for detecting the iris boundary by searching the parameter space. Daugman proposed the rubber sheet model to normalize the segmented iris [3]. To extract the features from the normalized iris Daugman applied a two dimensional texture filter called Gabor filter [11] to an image of the iris and extracted a representation of the texture, called the iris code. To compare two iris templates Daugman used Hamming distance as the similarity measure.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

Wildes' Method: Wildes used a gradient based binary edge map construction followed by circular Hough transform,applied a Laplacian of Gaussian filter at multiple scales to produce a template and compute the normalized correlation as a similarity measure after normalizing the segmented iris [2]. He used an image registration technique to compensate scaling and rotation then isotropic band-pass decomposition is proposed, derived from application of Laplacian of Gaussian filters to the image data. In the Comparison stage a procedure based on the normalized correlation between both iris signatures is used.

III. PROPOSED ALGORITHM

Proposed Iris Recognition Algorithms:

Three techniques were proposed to enhance the iris recognition system. As shown in Figure 3, the first one is a new segmentation algorithm to handle iris images were captured on less constrained conditions. This algorithm reduces the error percentage while there are types of noise exist, such as iris obstructions and specular reflection. The proposed algorithm starts by determining the expected region of iris using K-means clustering algorithm, then circular Hough transform is used to localize iris boundary, after that some algorithms are proposed to detect and isolate noise regions.

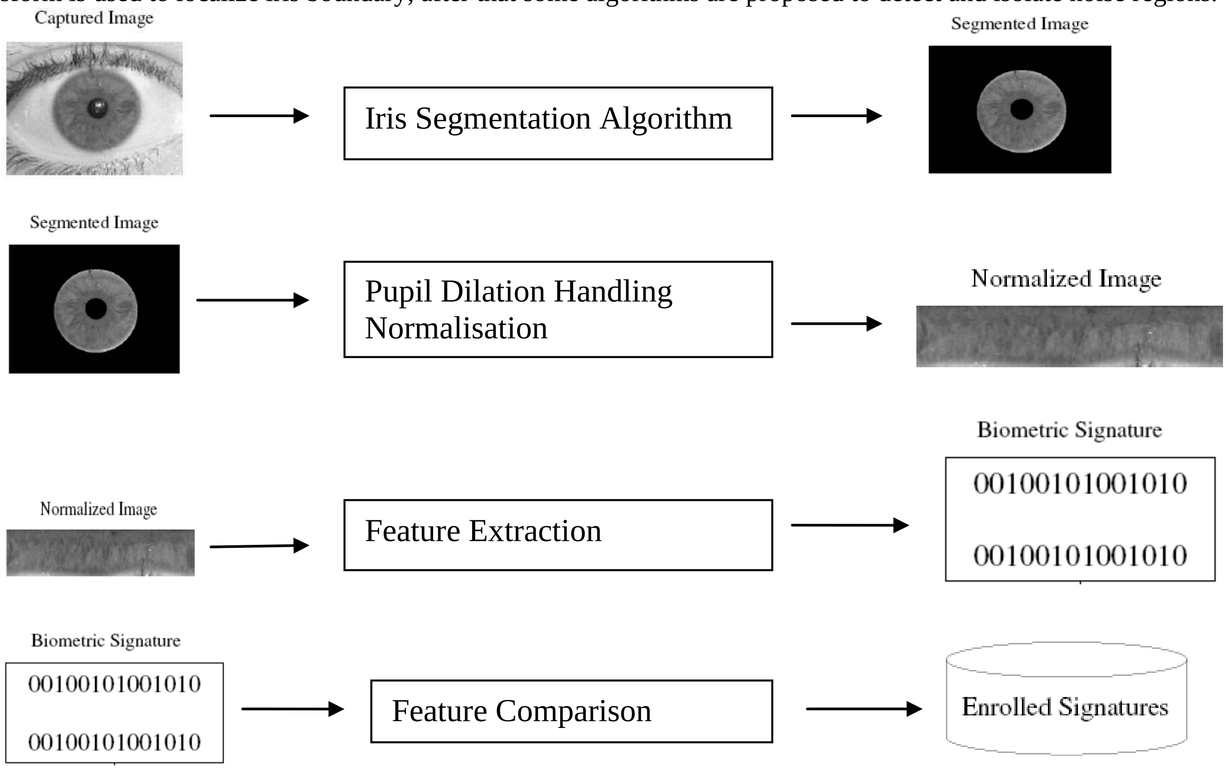


Figure 3 Block diagram of proposed enhancing iris recognition algorithms

The second technique studies the effect of pupil dilation on iris recognition system, in order to show that the high pupil dilation degrees degrade iris template and affect the performance of recognition system. After that, a limit of dilation degree is determined, which after it, the iris code will be affected or some of its information will be discarded. This limit can be used to avoid detrimental pupil dilation. Finally, analyzing the iris code bits to determine the consistent and inconsistent bits, and compare between the inner and outer regions to find which region contains more inconsistent bits to be excluded from the iris template.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

Segmentation Method:

This section concerns about one of the crucial steps in building an iris recognition system, which is iris segmentation. In this stage, we should accurately extract the iris region despite of the presence of noises such as varying pupil sizes, shadows, specular reflections and highlights. The segmentation stage is important because it is the basis of all further operations, such as normalization and encoding. Proposed segmentation algorithm significantly improves the robustness of the segmentation process even with large noisy iris regions.

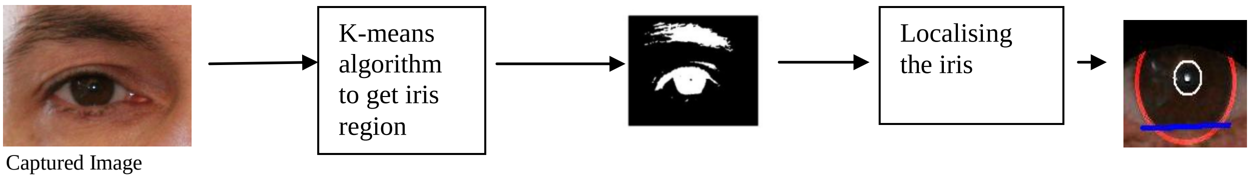


Figure 4: Localising the Iris in the Captured Image by using Different steps

K-means Clustering:

The K-means algorithm is an iterative technique that is used to partition an image into *k* clusters by assigning each point to the cluster whose center (also called centroid) is nearest. The center is the average of all the points in the cluster that is, its coordinates are the arithmetic mean for each dimension separately over all the points in the cluster.

The basic K-means algorithm we used is:
1. Compute the intensity distribution (also called the histogram) of the intensities.
2. Initialize the centroids with *k* random intensities.
3. Repeat the following steps until the cluster labels of the image do not change anymore.
4. Cluster the points based on distance of their intensities from the centroid intensities
5. Compute the new centroid for each of the clusters.

The proposed segmentation algorithm starts by determining the expected region of iris using the K-means clustering algorithm. The output image is used by vertical Canny edge detection to produce edge-maps. The circular Hough transform is applied on the edge image to determine the estimated iris center and radius [3]. We use K-means clustering and vertical edge map to reduce the time of searching for circular Hough transform. Therefore, the circular Hough transform will be applied on the binary edge image which comes from applying the edge detection on masked region, which result from K-means[11].

Pupil Dilation:

The pupil dilation degrades iris template and affect the performance of recognition system. To show this, the following steps are followed:

1: Gather dataset of iris' images that contains many irises for the same class which have widely variations in pupil dilation degrees.
2: Segment irises in the selected dataset and encode each iris in it to produce its iris code.
3: Compare each iris' template in the dataset with all other iris' templates in the dataset.
   a) compare irises in the same class to generate intra-class comparisons distribution.
   b) compare irises in different classes to generate inter-class comparisons distribution.
4: Calculate the FMR and FNMR for this dataset.
5: Exclude irises which have a dilation degree more than 0.5 from the dataset and repeat steps from 1 to 4.
6: Compare the results.

Compare the error rates for two datasets; the first dataset contains all the degrees of pupil dilation. The second dataset contains only irises of small pupil dilation degrees. If the pupil dilation affects the performance, the error rate of the second dataset must be less than the first dataset error rate.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

Determining the pupil dilation limit algorithm:
1: Gather dataset of iris images that contains many irises for the same class, which have wide variations in pupil dilation degrees.
2: Segment irises in the selected dataset and encode each iris in it to produce its iris' code.
3: Compare each iris template in the dataset with all other iris templates in the dataset.
 a compare irises in the same class to generate intra-class comparisons distribution.
 b compare irises in different classes to generate inter-class comparisons distribution.
4: Calculate the FMR and FNMR for this dataset.
5: Exclude irises which have a dilation degree more than a certain limit X from the dataset, where
 the first value of X equals the highest pupil dilation degree in the dataset.
6: Decrease the value of X gradually and repeat the steps from 1 to 5.
7: Get the limit value X that minimizes the error rates.

Iris Code:
1 Gather dataset of iris images have that high detailed texture.
2 Segment irises in the selected dataset and encode each iris in it to produce its iris code.
3 Compare the templates of irises for the same person to determine which bits are consistent or inconsistent. Let X be the percent of bit retention (if X = 70% means that this bit remains zero or one in 70% of iris images for the same person).
 If any bit keeps its value for a percent more than X, it is labeled as consistent.
 If any bit keeps its value for a percent less than X, it is labeled as inconsistent
The value of X can be selected to be suitable for the capturing device and the selected dataset. After determining the consistent and inconsistent bits in our dataset, we can use the result in several ways. Here, we use the consistent and inconsistent bits to study the regions where these bits exist in.

Determining the best regions in iris code:

1: Gather dataset of iris images which have high detailed texture.
2: Segment irises in the selected dataset and encode each iris in it to produce its iris code.
3: Divide the iris code to four parts, each part with 5x480 bits
4: Mask each part separately and execute matching test and compute the FNMR for each one.
5: Compare the results

IV. RESULTS

PUBLIC IRIS DATABASES:

The fair comparison between recognition methods needs similar input data to compare and evaluate their results. Therefore, standard iris' databases assume high relevance, and become indispensable in the development process. There are many iris' image databases available freely on the Internet such as CASIA, UBIRIS, MMU, ICE, WVU and UPOL.

Results of Segmentation:
After applying the iris segmentation algorithm on UBIRIS, the segmented images are shown below. After that, compute the accuracy (the segmentation is accurate when the two circle of iris and pupil fall exactly into the iris and pupil borders) of the resulted images.

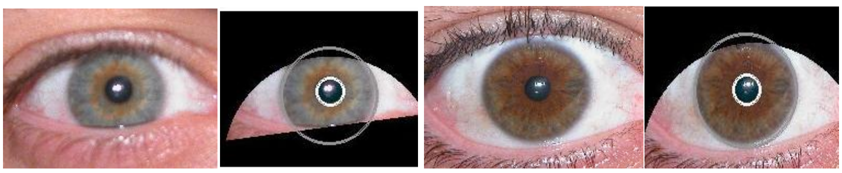


Figure 5 Examples of correct segmented irises

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

To evaluate the performance of the proposed segmentation method in the whole recognition system,implement the other three stages (normalization, encoding, comparisons). Some functions from Masek‘s iris recognition algorithm are used[4,5] . The implemented system is used to generate the iris' template code for every iris. To draw the match and non-match distributions for this database, each iris image in the database is compared with the other all irises in the database. For the UBIRIS v1 Iris Database session1, the total number of comparisons equals 1,448,410 where the total number of intra-class comparisons equals 2410 and that of inter-class comparisons equals 1,446,000. During the comparison stage, the HD is used as the metric of dissimilarity between two considered iris' codes.

Results of Pupil Dilation:

Pupil dilation degree is computed by obtaining the radius of the pupil and the radius of the iris. So, firstly it is the need to localize and segment each iris in dataset then the radius of iris and pupil is obtained. All the dataset' irises are true segmented because it is selected carefully, and if any iris has an inaccuracy in its segmentation,exclude it from the dataset in the selection stage as said before to make the taken dataset has only one problem or source of error it‘s the pupil dilation.

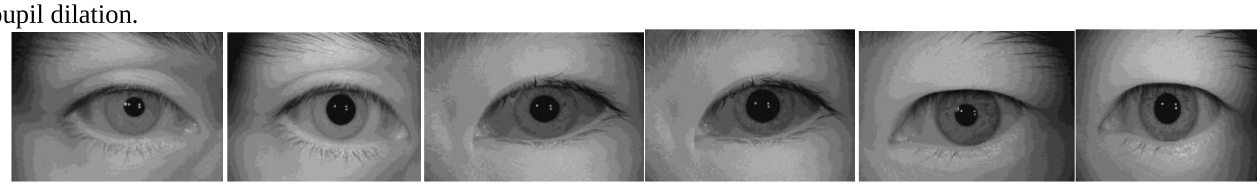
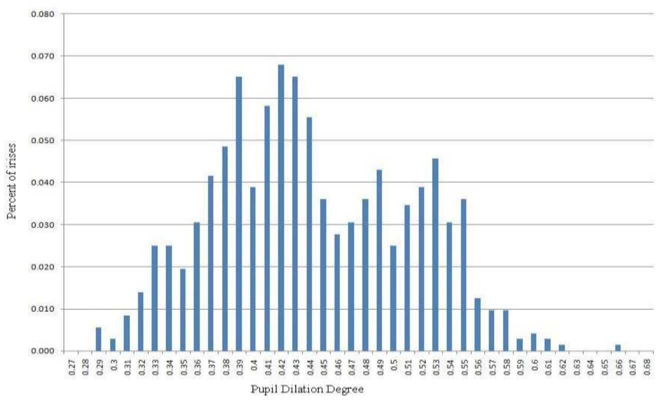


Figure 6 the big difference of pupil size



Pupil dilation ratios

To measure dilation, process measures the degree of dilation by dividing the pupil radius on the iris' radius. Since the pupil radius is always less than the iris' radius, this dilation ratio must fall between 0 and 1. In the selected 721 images, all dilation ratios were between 0.28 and 0.66. The distribution of dilation ratios is shown above. It is observed that the datasets have widely variations in pupil dilation degrees, which will be necessary in evaluating the effect of dilation in a good and fair experiments.

The Effect of Pupil Dilation on Performance:

To show that the pupil dilation affects the performance of iris recognition system, all irises in our dataset is first segmented using circular Hough transform to detecting the iris and pupil boundaries [12]. This involves first employing Canny edge detection to generate an edge map. Gradients were biased in the vertical direction for the outer iris/sclera boundary, as suggested by Wildes et al. [2,3,4]. In cases the segmentation software detect occlusion by eyelids, parts of the iris region are masked . This can limit the effect of eyelids and eyelashes on the results.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

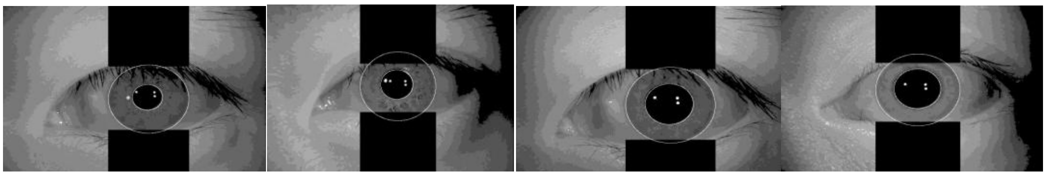


Figure 7 Samples of segmented and masked noise irises from the selected dataset

After that, the segmented irises are normalized using Daugman approach. In the feature encoding step, we convolve the normalized iris patterns with 1D Log-Gabor wavelets to generate 2x20x240 bit iris template for each iris [5, 6]. Divide the irises into two groups, irises with pupil dilation degrees less than 0.5, and irises with pupil dilation degrees more than or equal 0.5. Then, compare each iris template in the dataset with the other iris' templates in two cases. When use all images, and when excludes irises in the second group (dilation degree more than 0.5). In the first experiment, the compared iris images equal 721. The total number of comparisons equals 259,731 where the total number of intra-class comparisons equals 6270 and that of the inter-class comparisons equals to 253,461. In the comparison stage, we use the HD as the metric of dissimilarity between two considered iris' codes [7,8]. In the second experiment, the compared iris images equal 555, after excluding 166 images which have pupil dilation degrees more than 0.5. Below table shows the result of each experiment. It is clearly observed that when irises with high pupil degree excludes from the dataset, the FMR and FNMR are reduced and the percent of true match and true non-match are increased. This means that irises with high pupil dilation degrees cause more errors in iris' templates.

Performance value	**All irises in our dataset**	**Irises with pupil dilation degree less than 0.5**
False Match Rate	0.027%	0.004%
False Non Match Rate	1.39%	0.69%
True Match Rate	99.973%	99.996%
True Non Match Rate	98.61%	99.31%

Comparison of results when using all irises and when using irises with pupil dilation degree less than 0.5.

The FNMR decreases when we use non-dilated pupil from 1.39% to 0.69%. At the same time, the true match rate is increased to 99.996% which is a very good value. This means that pupil dilation affects the identification and recognition processes by degrading some iris' bits in iris' code.

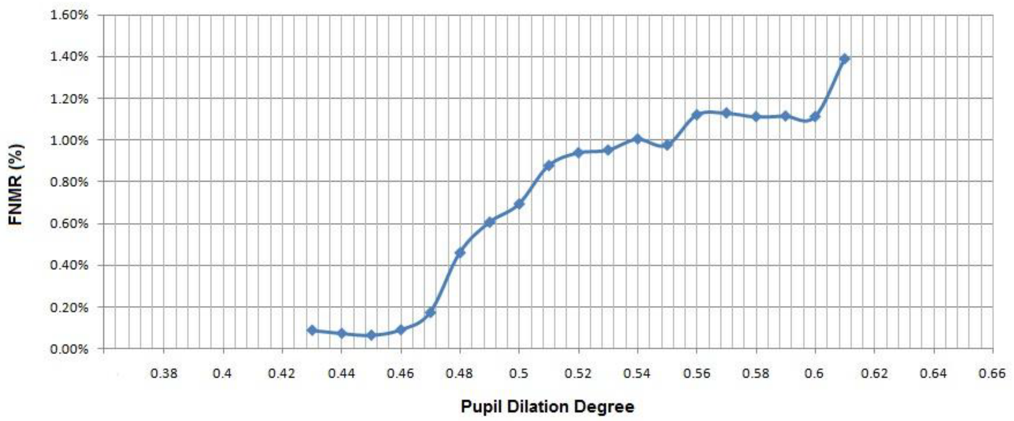
ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

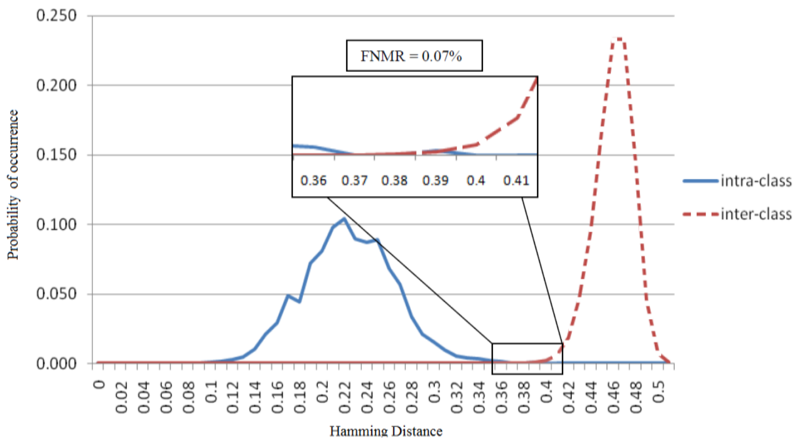
(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

The Limit of Pupil Dilation:



The minima in the graph occurs when pupil dilation degree equals 0.45, then the FNMR equals 0.07% and the TNMR = 99.93%. Before and after 0.45, the FNMR increase. The FNMR has the highest value, when all images in the
The FNMR when gradually delete irises with high pupil dilation degree.When we begin excluding templates with pupil dilation equal 0.44 and 0.43, the FNMR begins increasing again. We notice that when excluding this group of templates, the error remains as it is, but the true non-match rate is decreased. This means that the remaining error is not caused by the pupil dilation. As a result, we recommend that to obtain a strong secure iris recognition system, the degree of dilation for any pupil must be less than 0.45.It notes that the FNMR error is reduced to 0.07.dataset is used in analysis without excluding any dilated pupil template. It is noticed that the error value decreases as it exclude more dilated pupil templates from the dataset, until it reach the pupil dilation degree of 0.45. When excluding templates with pupil dilation equal 0.44 and 0.43, the FNMR begins increasing again.



The match and non-match distributions for dataset when images with pupil dilation degree <= 0.45 are used.

V. Conclusion and Future Work

In the other hand, there are some new research ideas needs to be tested and analyzed. The following points view these ideas.

- Enhancing the encoding stage to be suitable to iris images captured in non-ideal conditions.
- Finding the best encoding methods that can handle different types of errors such as pupil dilation.
- Studying the effect of pupil dilation on the iris code using the concepts of consistent and inconsistent bits.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 11, November 2015

REFERENCES

1. A. Jain, R. Bolle, and S. Pankanti, ―Biometrics: Personal Identification in a Networked Society,‖ Norwell, MA: Kluwer, 1999.
2. D. Zhang, ―Automated Biometrics: Technologies and Systems,‖ Norwell, MA: Kluwer, 2000.
3. J. Daugman, ―Statistical richness of visual phase information: update on recognizing persons by iris patterns
4. J. Daugman, ―Demodulation by complex-valued wavelets for stochastic pattern recognition,‖ *Int. J.Wavelets, Multi-Res. and Info. Processing*, vol. 1, no. 1, pp. 1–17, 2003
5. R. Wildes, ―Iris recognition: an emerging biometric technology,‖ *Proc. IEEE*, vol. 85, pp. 1348–1363, Sept. 1997.
6. Daugman, ―How iris recognition works,‖ *IEEE Transactions on Circuits and Systems for Video Technology*, 21–30 2004
7. L. Flom and A. Safir, U.S. Patent 4 641 394, 1987. ―Iris Recognition system‖ .
8. J. Daugman, U.S. Patent 5 291 560, 1994. ―Biometric personal identification system based on iris analysis‖.
9. J. Daugman, ―High confidence visual recognition of persons by a test of statistical independence,‖ *IEEE Trans. Pattern Analy. Machine Intell.*, vol. 15, pp. 1148–1161, Nov. 1993.
10. http://biometrics.idealtest.org/dbDetailForUser.do?id=4.
11. J. Daugman, ―Demodulation by complex-valued wavelets for stochastic pattern recognition,‖ *Int. J.Wavelets, Multi-Res. and Info. Processing*, vol. 1, no. 1, pp. 1–17, 2003.
12. W. Boles and B. Boashash, ―A human identification technique using images of the iris and wavelet transform,‖ *IEEE Trans. Signal Processing*, vol. 46, pp. 1185–1188, Apr. 1998.