Iris Recognition under the Influence of Diabetes

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ESR 6. AMBER Project, Ph.D Student

Title of Project

- **Making Mobile Biometrics More Reliable**
- *Supervisor: Professor Pacut*

Overview

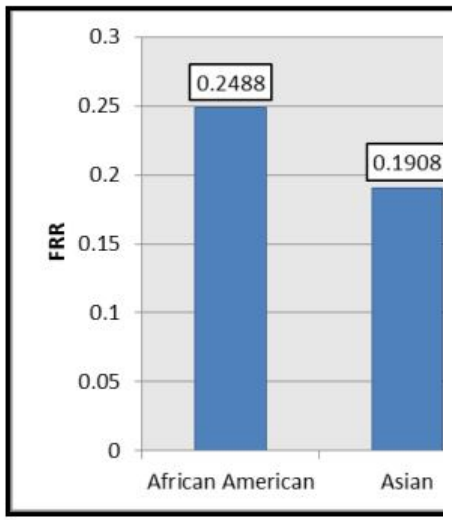
- Iris recognition is one of the most reliable modalities for identification purpose.
- Even for identical twins, the iris pattern is completely different
- The iris detailed structures of the two eyes of one person are completely discriminable from each other.
- The abnormalities in the iris tissue pattern can challenge the reliability of system.

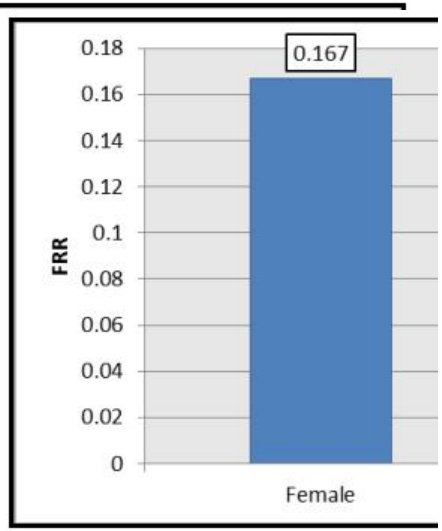
Introduction

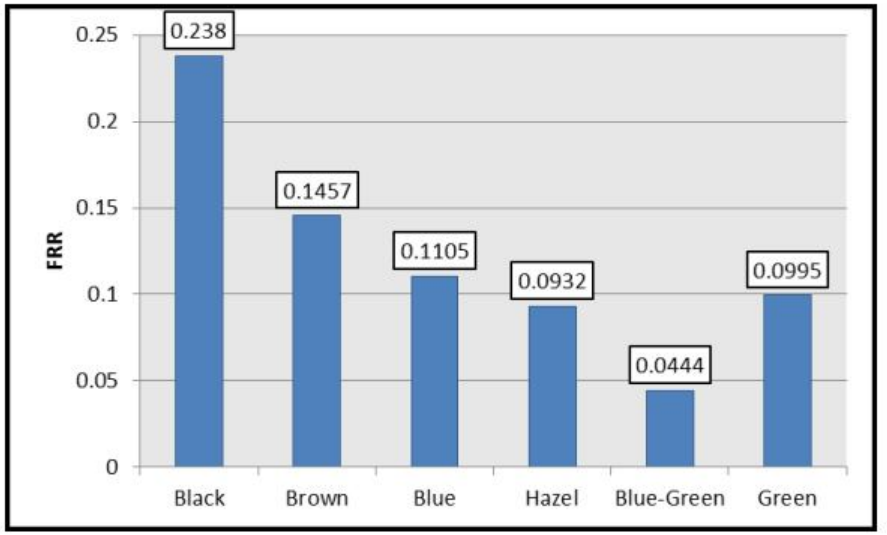
- Diabetes is a risk factor for many well-known diseases and it is a growing epidemic especially among elderly people.
- This social issue can be the main reason for eye diseases includes diabetic retinopathy, etc.
- Howard and Etter [3] hypothesized that factors: ethnicity, gender and even eye color can play a significant role in the expected false rejection rate.

Introduction

- They concluded that Asian and African American individuals with brown eyes have a distinct propensity for being incorrectly not identified by iris recognition systems.







Related Works

- Strong academic evidence suggests that diabetes can be diagnosed by examining the iris texture.
- Samant and Agarwal [8], provided an automated tool with machine learning techniques to access the correlation between distortion of iris tissues and diabetes mellitus.
- They have also proposed a diagnostic tool along with the mainstream diagnosis methods for discrimination of healthy patients and those who are suffered from diabetes.
- The results show best classification accuracy of 89.63% calculated from RF classifier.

Related Works

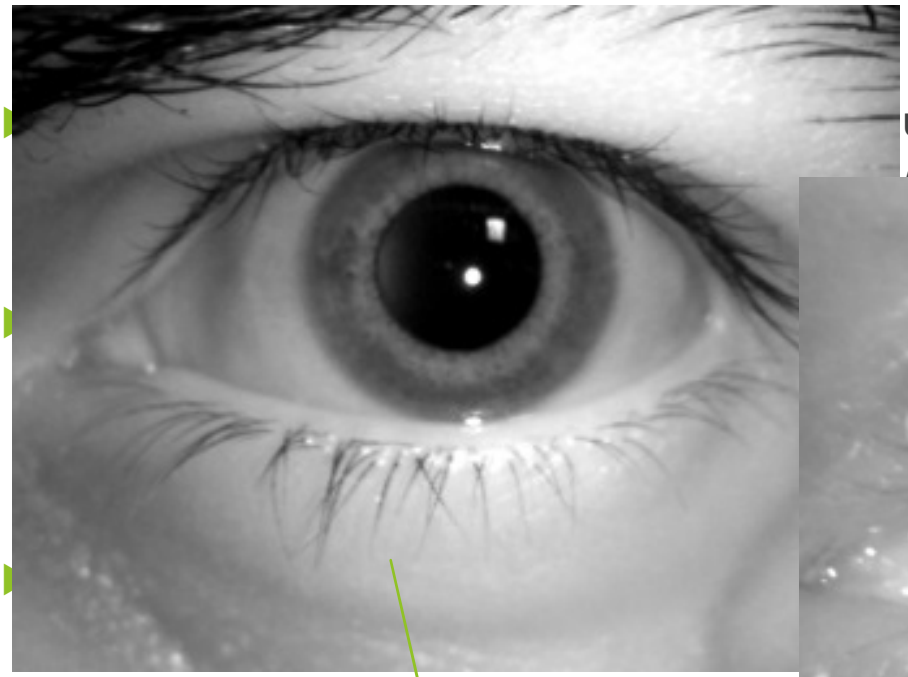
- In order to answer this question: "how iris recognition methods perform in the presence of ophthalmic disorders?,"
- Trokielewicz et al. [17] studied the effect of eye diseases on the reliability of iris recognition system using ill affected iris images from 92 participant (184 eyes), for four different shape of disorder.
- They have also reported [18] that because of the mentioned problems for diseased eyes, iris segmentation phase is the most sensitive part of recognition whole process.
- database comprises 2996 iris images of 230 distinct eyes (including 184 illness-affected eyes).

Previous studies have also shown that cataract surgeries can affect the performance of iris recognition system [19-22].

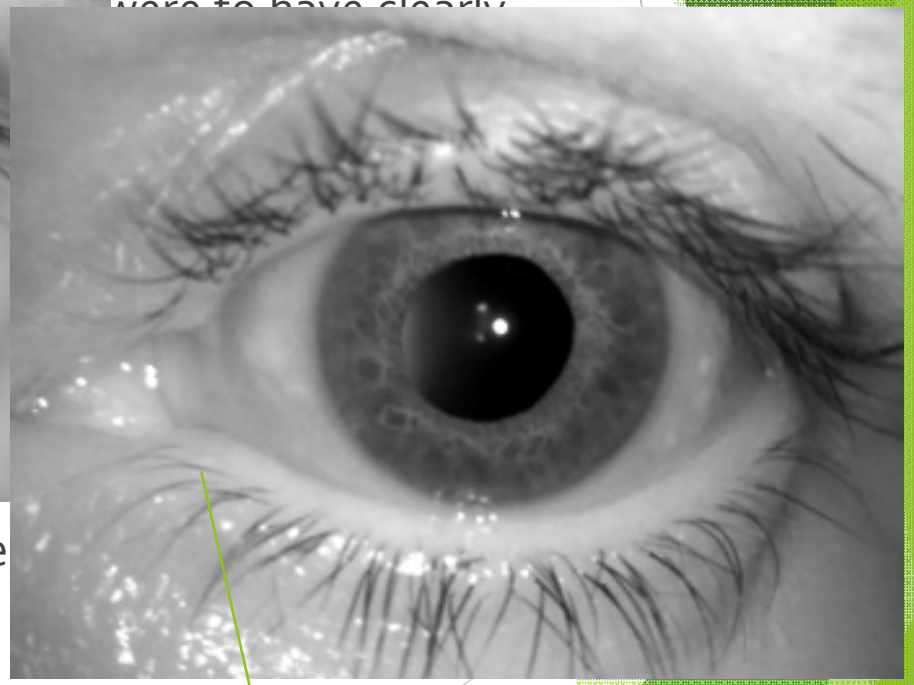
New Database

Condition	Age Group (%)	Gender (%)	Total number of irides	Total number of pictures
Healthy	Less than 20 years old: 21%	Female: 62%	162 irides	546
	Between 20 and 40 years old: 61%			
	Between 40 and 60 years old: 12%	Male: 38%		
	More than 60 years old: 6%			
Diabetic	Less than 20 years old: 1%	Female: 80 %	181 irides	772
	Between 20 and 40 years old: 17.5%			
	Between 40 and 60 years old: 46.5%	Male: 20 %		
	More than 60 years old: 35%			

New Database



- up but different age



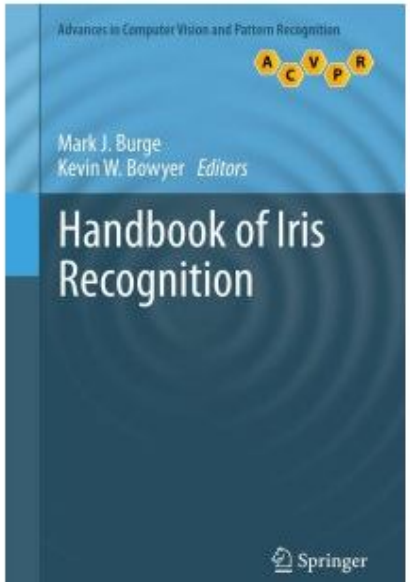
- The pictures are grayscale and the re
  640*480 pixels.

Healthy

Diabetic

Methodology

USIT -- University of Salzburg Iris-Toolkit v2.4.1



USIT - University of Salzburg Iris Toolkit v2 *is a Windows/Linux software package for iris recognition, made publicly available together with the book chapter:*

C. Rathgeb, **A. Uhl**, **P. Wild**, *and* **H. Hofbauer**. *"Design Decisions for an Iris Recognition SDK," in K. Bowyer and M. J. Burge, editors, Handbook of iris recognition, second edition, Advances in Computer Vision and Pattern Recognition, Springer, 2016.*

The software package includes algorithms for:

- *Iris Preprocessing*
- *Feature Extraction*
- *Feature Comparison*

USIT is based on easy-to-use command line tools (input and output relies on files). In order to download USIT follow the link on the **bottom**.

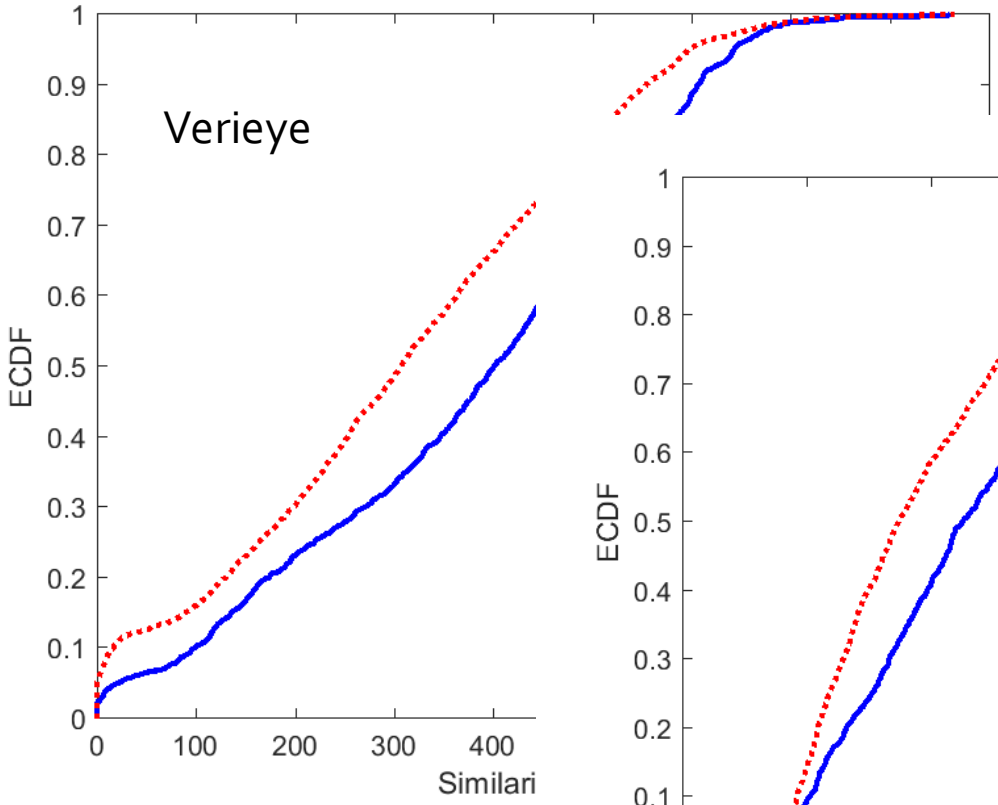
Methodology

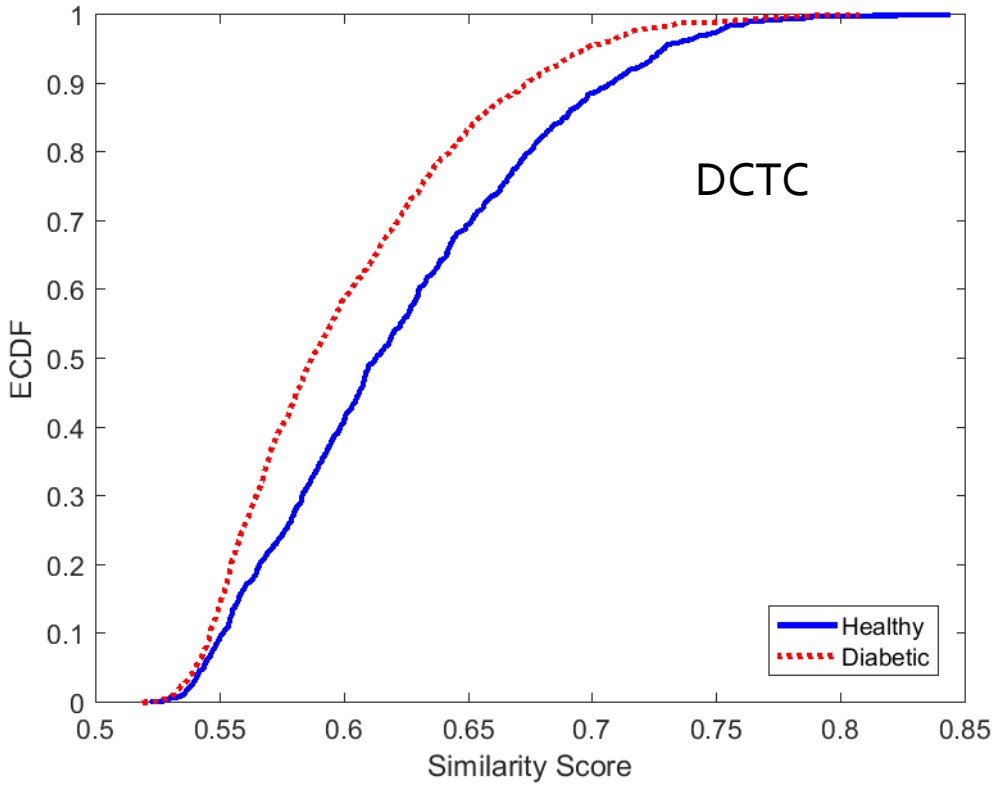
- For validation of the obtai
used.
- The selected image is com
score is outputted for eacl
- The maximum score is 28
- Verieye outputs a score of
as a match.
- For segmentation, VeriEye
accurately detect contours
circles.
- The enrollment and match
high matching performance/accuracy.

Results and Discussions

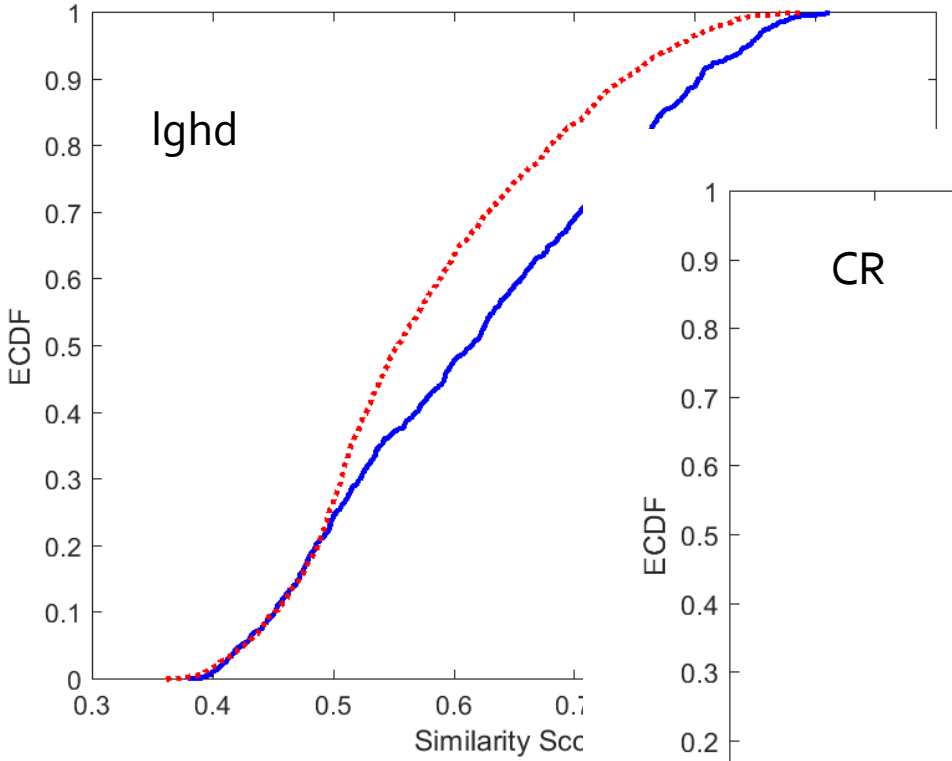
- The obtained comparison scores between samples will be presented and discussed.
- According to number of possible comparison scores, up to 900 K results have been achieved.
- Two datasets: those comparison scores obtained by comparing diabetic iris samples and those matching results achieved by comparison of iris pattern images taken from healthy irides.
- As it can be illustrated in next Figure, the empirical cumulative distribution functions of genuine scores obtained by a- Verieye b- DCT c- 1d-log gabor and d- CR codes show statistically significant differences between graphs.

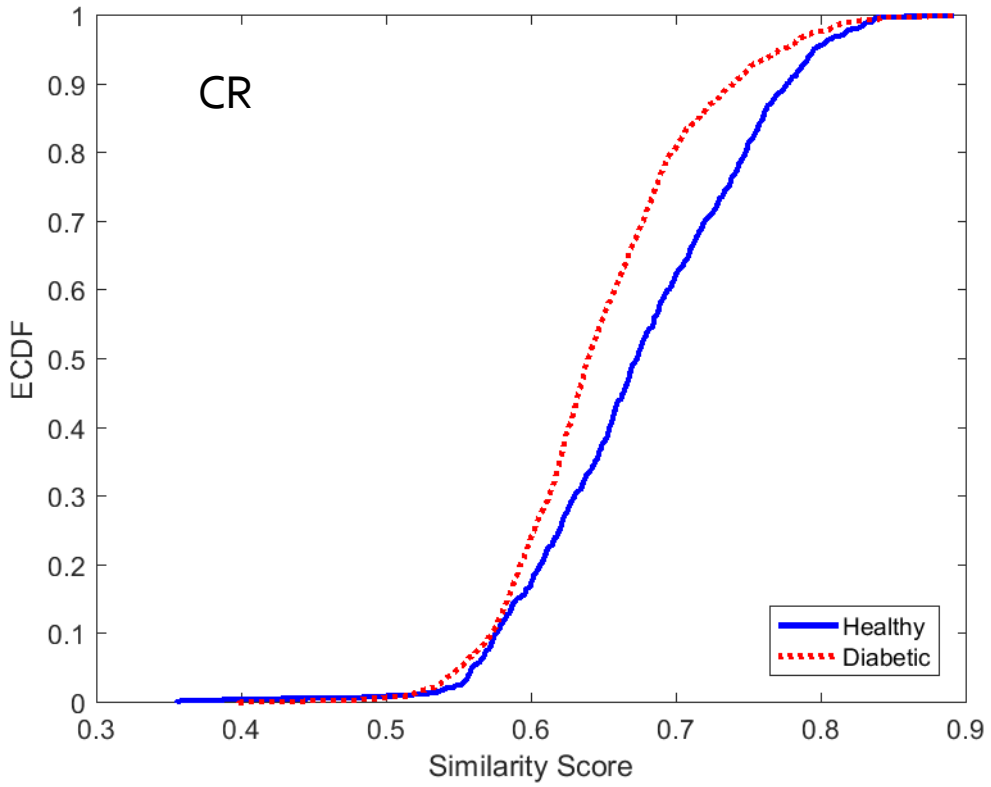
Results and Discussions





Results and Discussions

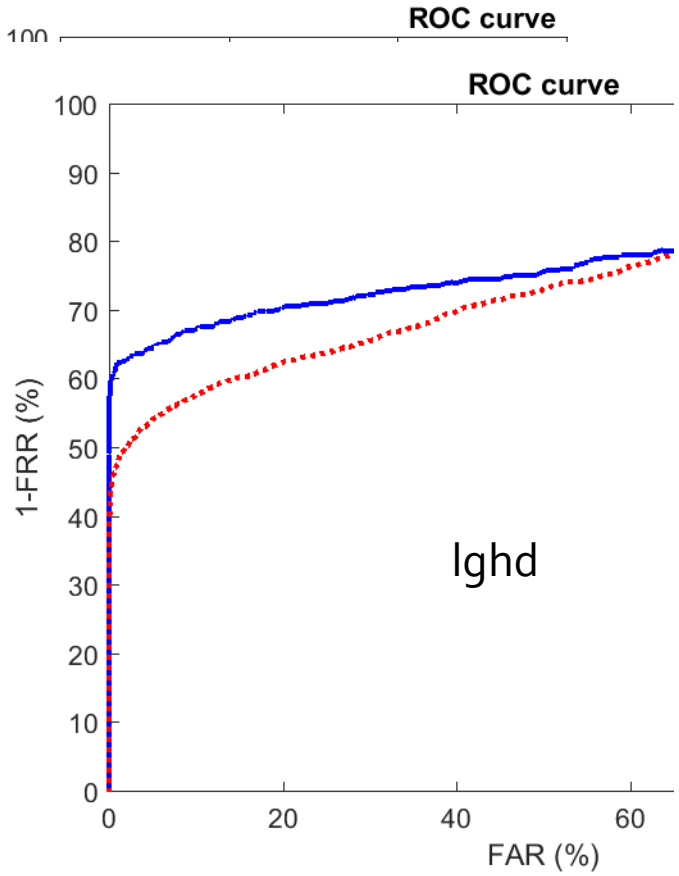


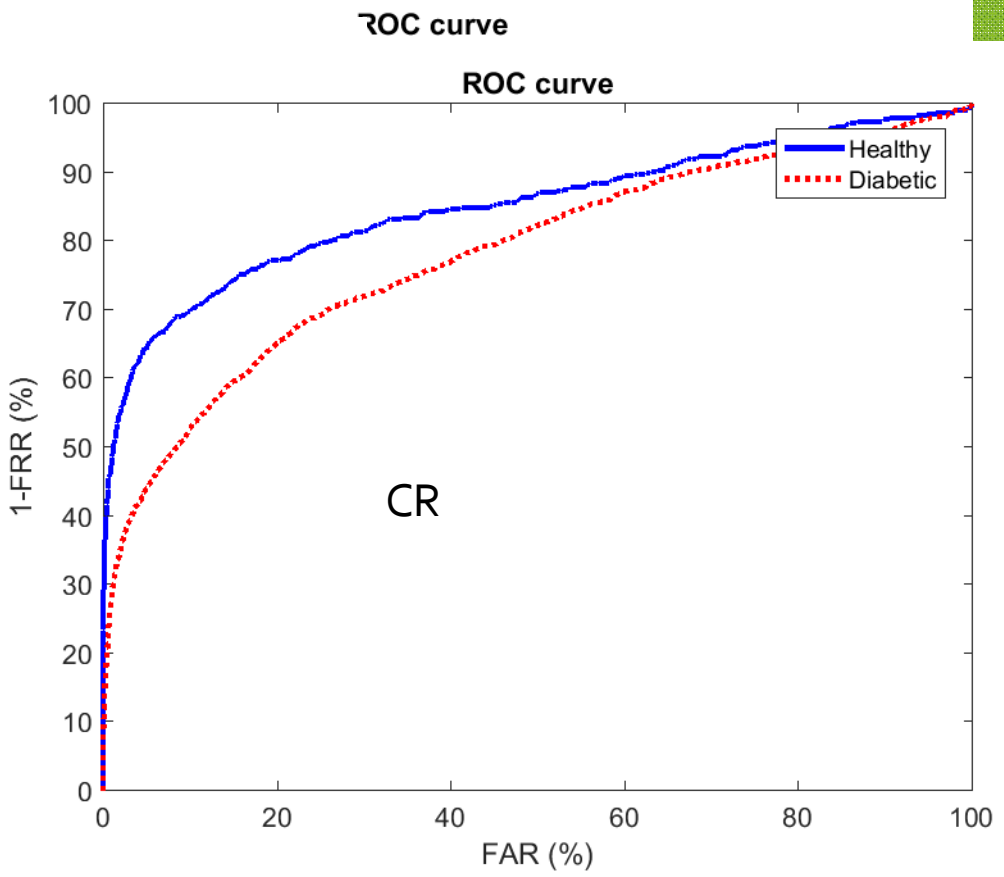


Results and Discussions

- The ROC curves for healthy and diabetic groups have been presented in next Figure.
- According to the Figure, the healthy eyes are easier to be recognized in comparison with non-healthy eyes.
- It is also worth mentioning that the Verieye has best performance while the 1d log Gabor is worst descriptor for feature extraction based on the obtained results.
- Table (slide n.17) presents the AUC for different ROC curves which have been presented in next Figure.

Results and Discussions





Results and Discussions

- In ideal case, when we can enhance the accuracy of system to one hundred percent, (when true acceptance rate equals with one at false rejection rate = 0), the AUC would be 100%.

$$\frac{\text{The Coverage under ROC curve-Emprical}}{\text{The Coverage under ROC curve-Ideal}} \times 100$$

Methodology	Healthy AUC	Diabetic AUC
Verieye	0.9828	0.9555
DCTC	0.9658	0.9027
1D-LogGabor	0.8272	0.7721
CR	0.8927	0.8203

Results and Discussions

- The results show that if the gallery and probe images are taken from healthy eyes, every recognition system yields the best performance.
- But for identification of users under influence of diabetes the reduction in performance is observed.
- So, user identification tends to be harder under the influence of diabetes and the accuracy of iris recognition system for healthy irides is higher.
- First null hypothesis which states that: "the mean values of distributions are same" and second null hypothesis which claims that: "the obtained samples are drawn from same distributions"
- According to chosen confidence threshold (0.01) and obtained p-values the both null hypothesizes can be rejected

Maybe…

- The biological age of individuals can obviously make changes in the biometric data.
- It must be also noted that, due to the physiology of pupil dilation mechanisms differences, (pupil dilation responsiveness decreasing with age) for users from different age groups, the difference in mean age of the chosen groups must be considered as an additional error source.
- As the users are coming from different age groups, so maybe this factor can be considered as one of the influential parameters.

Conclusions

- This work was concerned about the reliability test of iris recognition system under influence of diabetes.
- A new database has been collected and offered in this manuscript.
- We have used four different matchers, in order to obtain the similarity scores between the captured samples.
- Although there is no obvious impairment on the non-healthy irides,
- but according to the results achieved by all four matchers (3 open source codes and one commercial closed one), the accuracy of system is higher when we want to recognize healthy people using their iris texture images.
- The Best performance has been observed by using Verieye and the methodology proposed by Monro et al. (USITv.2).

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IMPACT FACTOR 2017: 1.096
5-year IMPACT FACTOR: 1.492

CiteScore 2017: 0.48

SCImago Journal Rank (SJR) 2017: 0.202
Source Normalized Impact per Paper (SNIP) 2017: 0.356


Questions?

Differences of Discrete Cosine Transform:

- Due to Differences of Discrete Cosine Transform's much lower complexity, it can be considered as a computationally intensive replacement for the Karhunen Loeve Transform (KLT). DCT is a real valued transform and it calculates the truncated Chebyshev series processing minimax properties.

One dimensional log – Gabor feature extraction

- The algorithm proposed by Masek et al. [26] examines 1D – intensity signals applying a dyadic wavelet transform and a log-Gabor filter, respectively.

Algorithm of Ratgheb et al.

- This feature extraction method is based on comparisons between gray scale values. The features can be extracted by examining the local intensity variations in the iris texture. This technique also includes a post iris texture image processing stage in order to eliminate the small peaks of pixel paths by determining threshold. The Ratgheb et al. 's descriptor needs no complex calculation.

- **Iris Segmentation: Weighted Adaptive Hough and Ellipsopolar Transform [24]:**

- In this manuscript, for iris segmentation Weighted Adaptive Hough and Ellipsopolar Transform (WAHET) methodology has been used.
- Weighted Adaptive Hough and Ellipsopolar Transform technique is a two-stage iris segmentation technique;
  - Finding center point: the center of multiple approximately concentric rings at iteratively refined resolution can be determined by removing the detected reflection mask, detecting the edge, and finally by applying the weighted adaptive Hough transform.
  - Extracting the region of interest: the center point must be used for this purpose. Firstly initial boundary must be detected and after first iteration, Ellipsolar transform will be applied for Inner and outer boundary detection. After this stage the extracted iris texture will be normalized using Daugman's rubber sheet model.