High Performance Low Complexity DCT-based Iris Recognition

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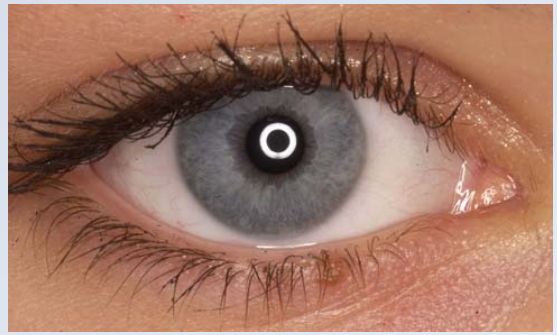
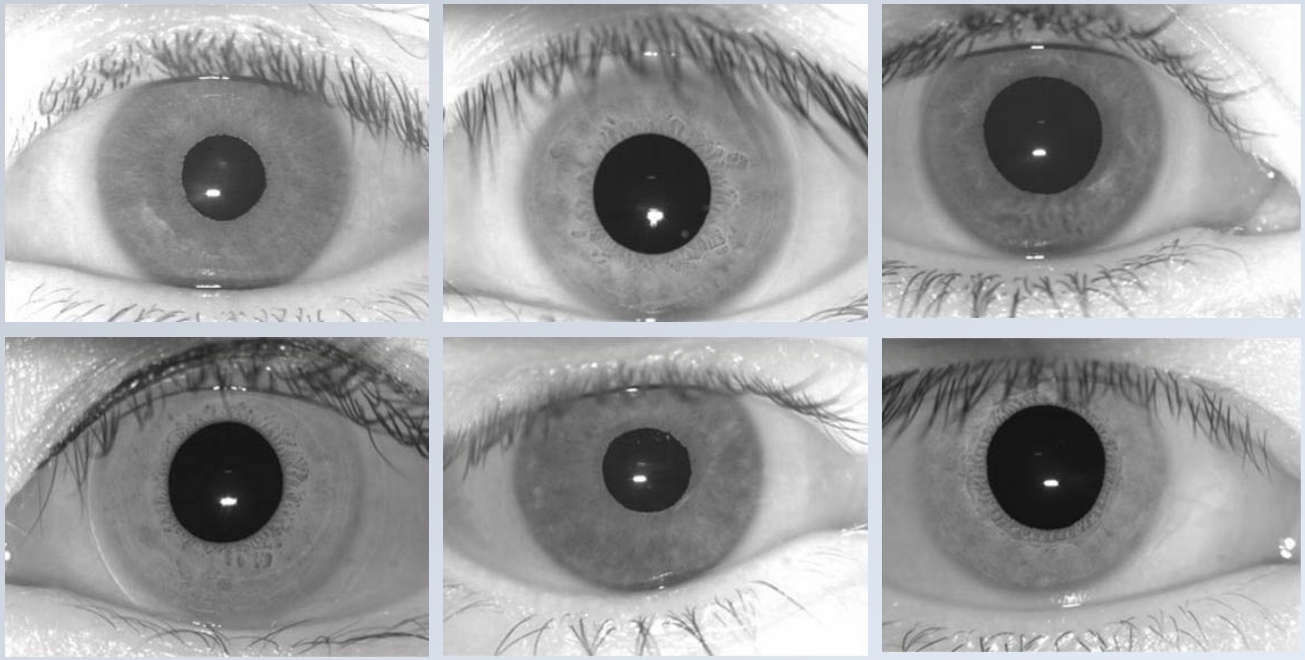
Outline

- Data Collection
- Iris Recognition System
- Feature Extraction & Weighting
- Classifier Design
- Proposed Metric
- Results
- Ongoing & Future Work



Bath Iris Image Database



Currently 16,000 Images
from 400 Subjects (800 Eyes)

Mid-2006 Target 32,000 Images
from 800 Subjects (1600 Eyes)

http://www.bath.ac.uk/elec-eng/pages/sipg/irisweb

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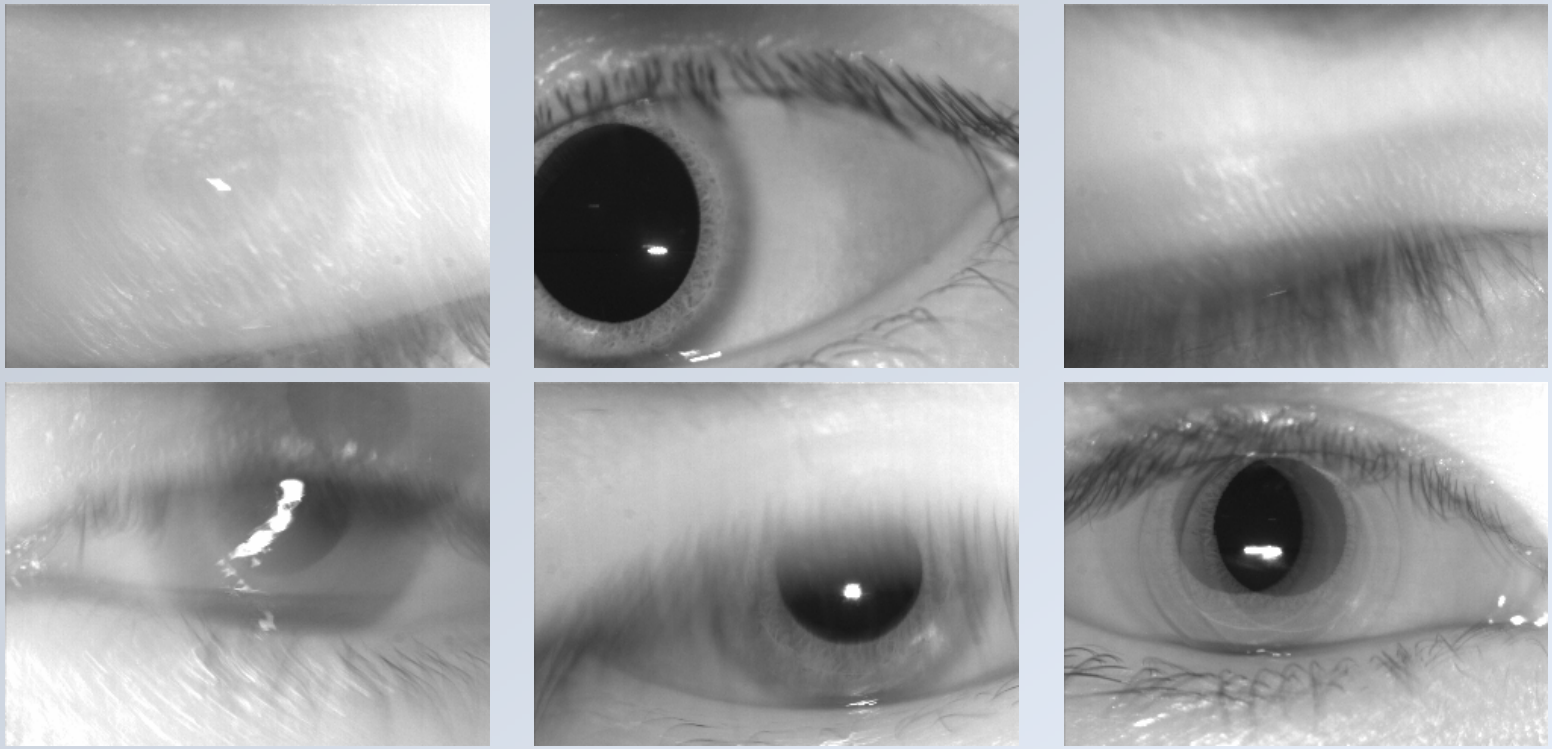
Non Ideal Images



Blinking, Out-of-focus, Motion Blur, Out of Line-of-sight

Iris Recognition System

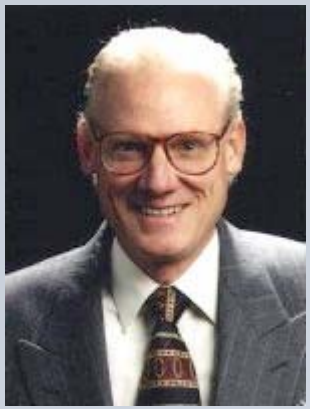
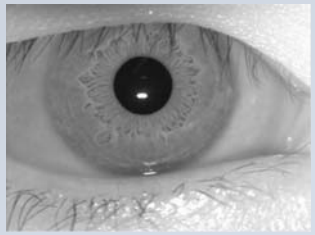


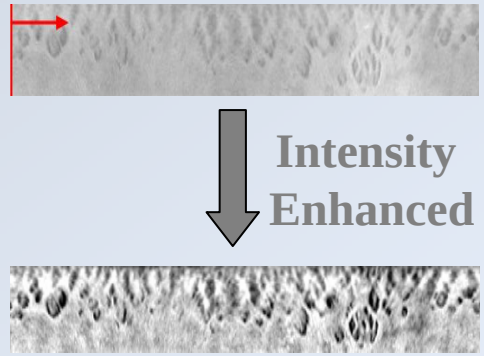
Image Acquisition



Eye Image

Localization

Normalization



Intensity Enhanced

Feature Extraction

Iris Code

Classifier

Match

Decision

Enrolled Database

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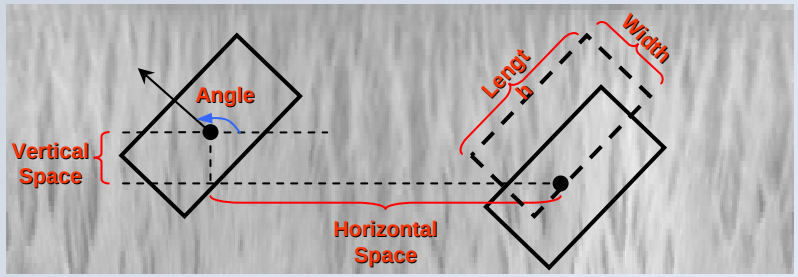
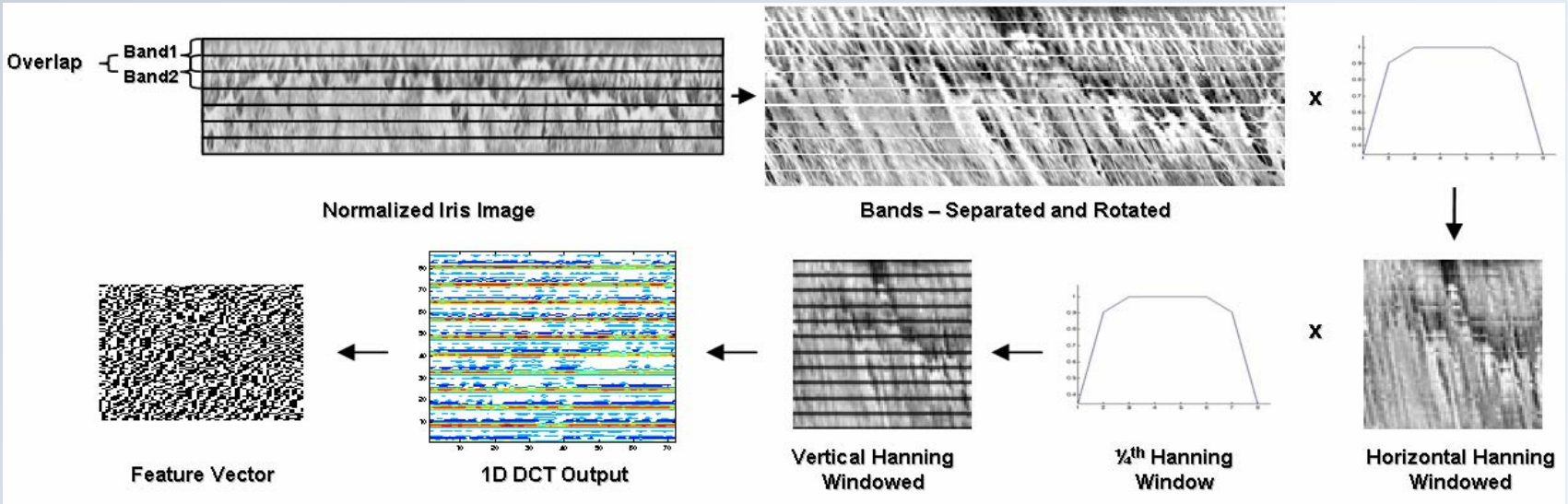
Feature Extraction

- **Image divided in diagonal 8 x 12 patches** *[BMVA 04, ICIP 05]*
- **50% overlap in both directions**
- **Windowed average over width**
- **Windowed 1D DCT of length 12 over length**
- **Adjacent DCTs differenced**
- **Zero Crossings form Feature Vector**





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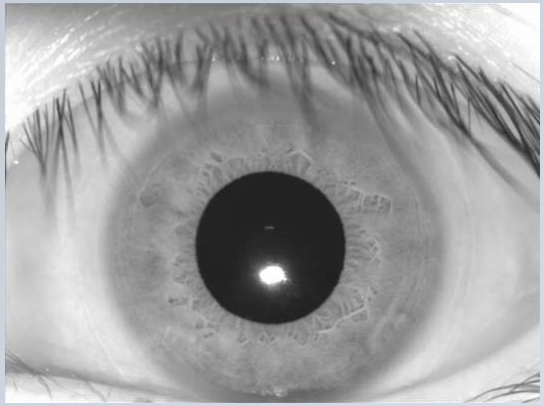
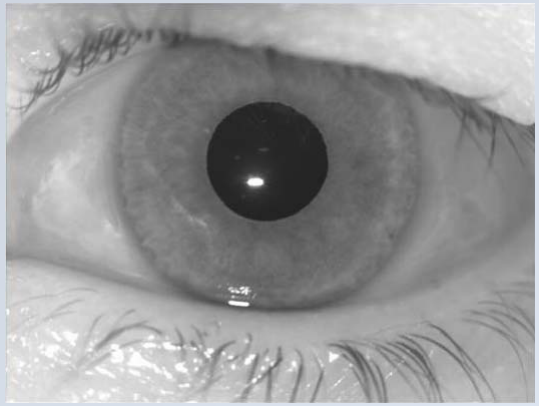
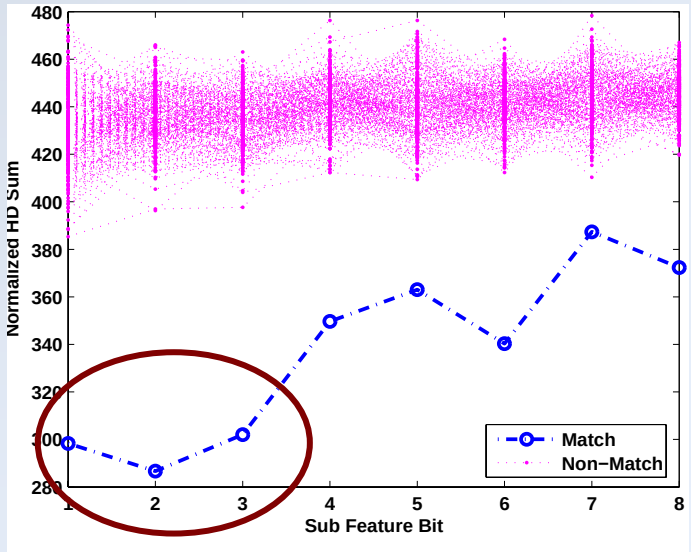
Weighting





- **Blue and Brown Iris Structures differ.**
- **Positional weightings effective within ethnic groups but ineffective across groups.**
- **DCT Coefficient weighting is effective in choosing the most discriminating bits and reducing the Feature Vector Size.**
- **Most effective sub-feature bits 1, 2, 3.**
- **Final Feature Size = *2343 bits (300 bytes).***



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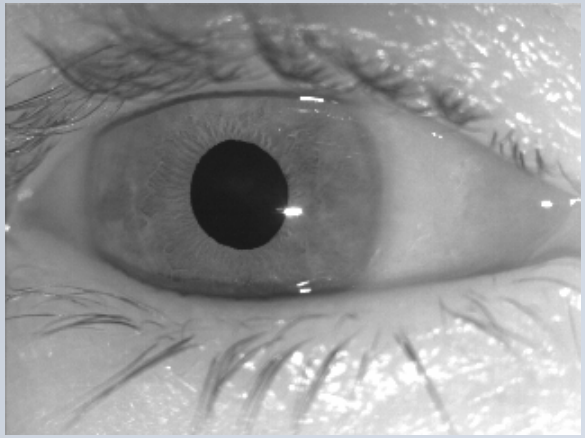
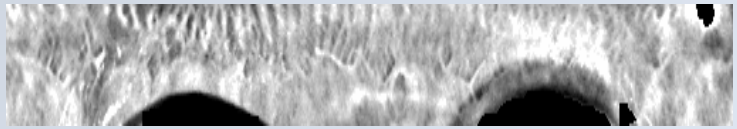
Masking



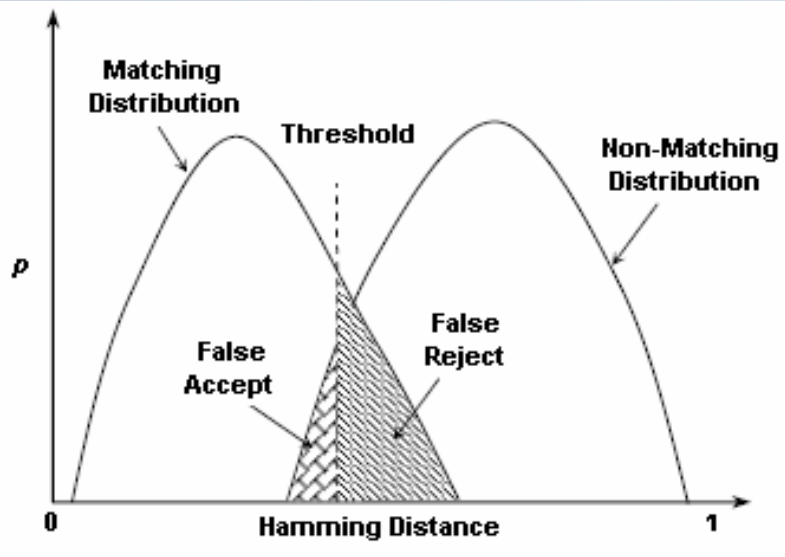


- Artifacts in iris images lead to erroneous code formation.
- Caused by specular reflections, hard contact lens, eyelids, eyelashes, etc.
- Non-iris regions masked to 0 graylevel in normalized image.
- Masked regions omitted during image equalization and coding.

Product-of-Sum Distance Classifier

$$Dist = \frac{1}{K}\prod_{i=1}^{M}\left(\frac{\sum_{j=1}^{N}\left(Feature\,1_{ij} \oplus Feature\,2_{ij}\right)}{\sum_{j=1}^{N}\left(Mask\,1_{ij} \cap Mask\,2_{ij}\right)}\right)$$

The Product of Sum of Hamming Distances (HD) between subfeature bits gives a metric with good separation of Matching and Non-Matching classes.

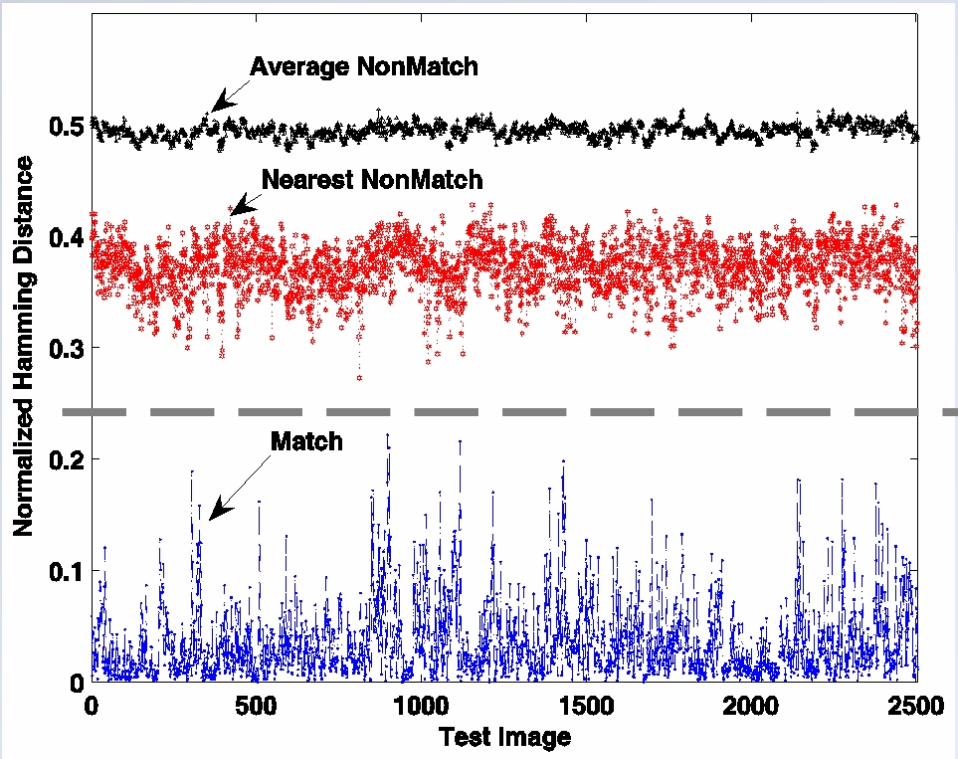


- **Parameter Optimization by minimizing Equal Error Rate (EER).**
- **Theoretical EER predicted by measuring areas of equal overlapped regions.**
- **Matching and Nearest Non-Matching Distances modelled using best fit distribution curves.**

Proposed Metric

A widely used metric for system performance - separation between Normalized Hamming Distance of Matching and **Average** of Non-Matching Irises.

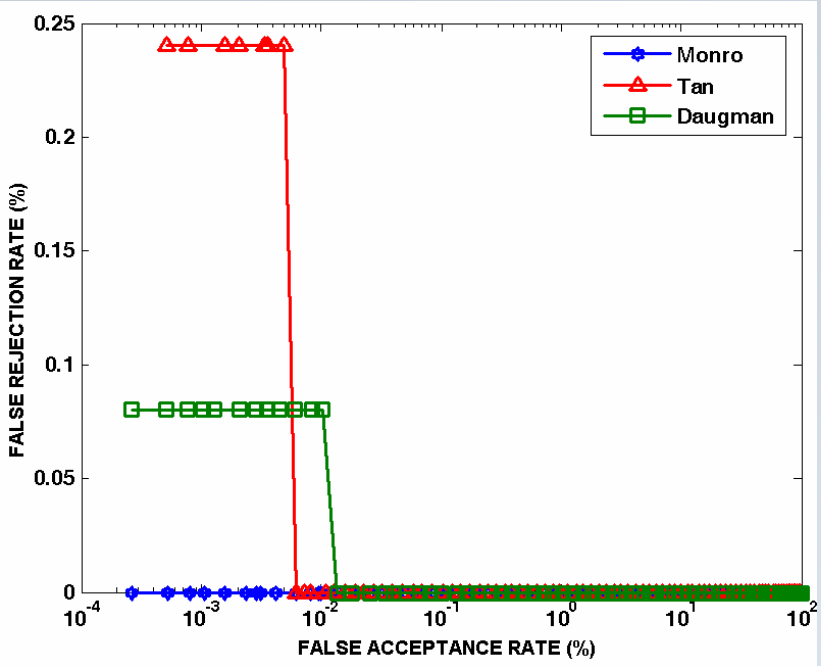
Proposal - Compare the separation between Normalized Hamming Distance of Matching with **Nearest** Non-Matching Irises.

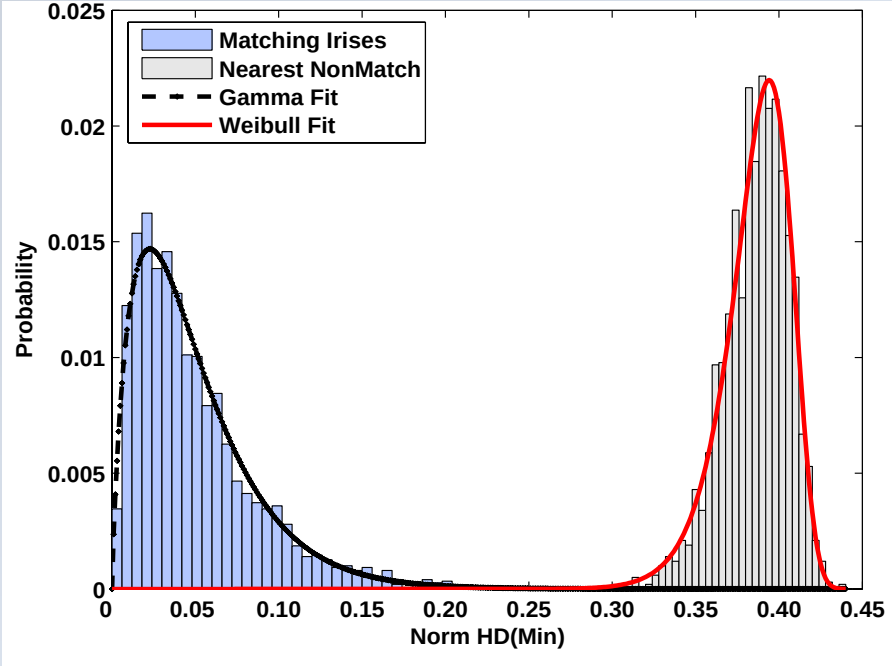


Test Datasets

Dataset	Number of Classes	Enrol Images per class	Test Images per Class	Total
CASIA	308	3	Rest	2156
Bath	150	3	Rest	2955

Results





Receiver Operating Characteristic Curves

EER = 2.6 x 10^{-4} and Falling

Method	Feature Extraction (ms)	Matching (ms)	Total (ms)
Daugman	422	31	453
Tan	125	68	193
Monro	***45***	***31***	***86***

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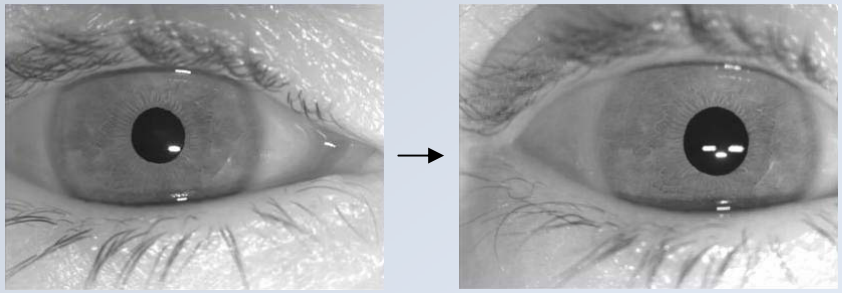
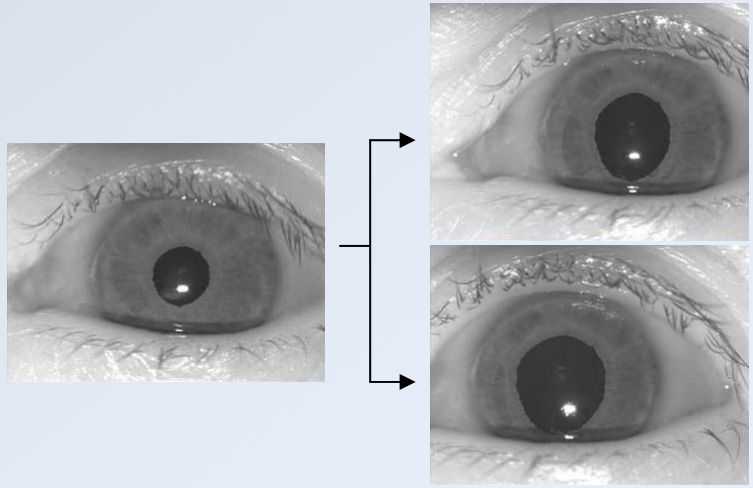
Ongoing & Future Work

- More Iris Image Collection
- Iris Quality Metrics
- Novel Localization methods
- Fast Searching and Matching
- Rotation Invariance
- Alternative Iris Transforms
- Iris Variation Simulation
- Liveness Detection
- Effect of Medical Conditions
- Spoofing Countermeasures





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Questions ?

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