High Performance Low Complexity DCT-based Iris Recognition

Donald M Monro, Soumyadip Rakshit and Dexin Zhang

Electronic and Electrical Engineering, University of Bath
Bath BA2 7AY, United Kingdom
S.Rakshit@bath.ac.uk
Http://dmsun4.bath.ac.uk

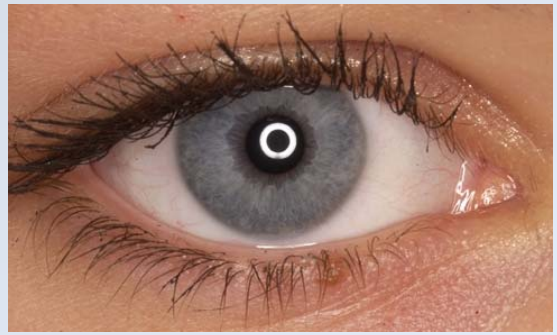
NIST FRGC ICE Workshop 23 March 2006

Smart Sensors Ltd
High performance iris recognition and matching

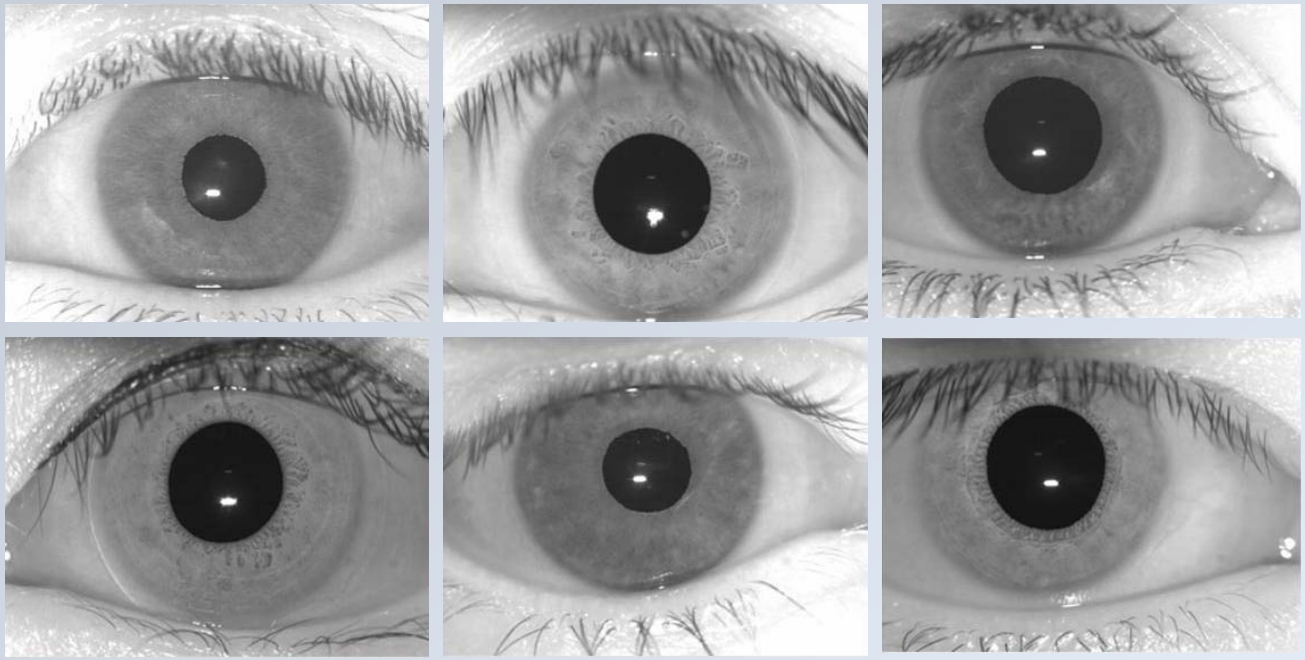
UNIVERSITY OF BATH

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)

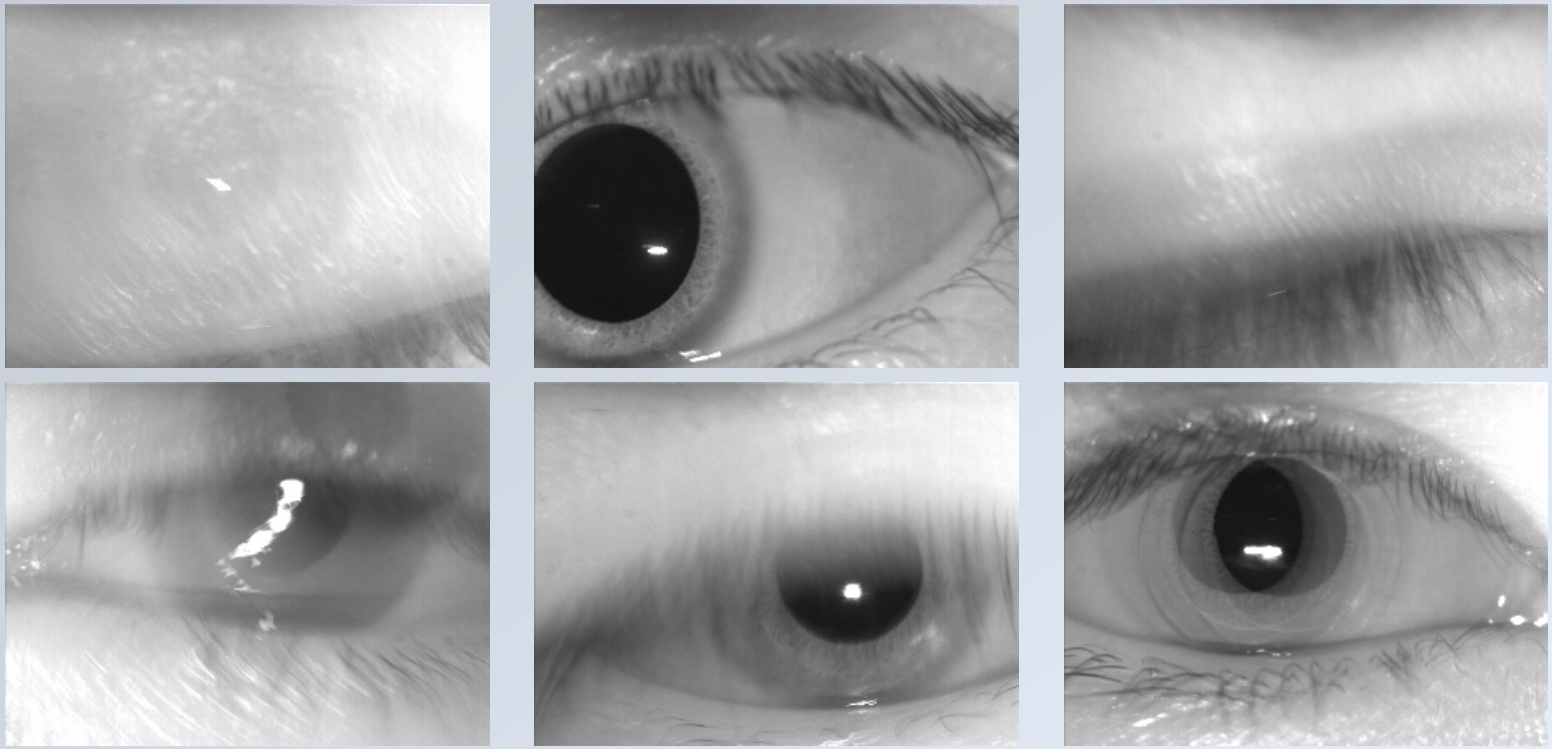
Mid-2006 Target 32,000 Images
from 800 Subjects (1600 Eyes)

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

Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

Non Ideal Images



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

Iris Recognition System

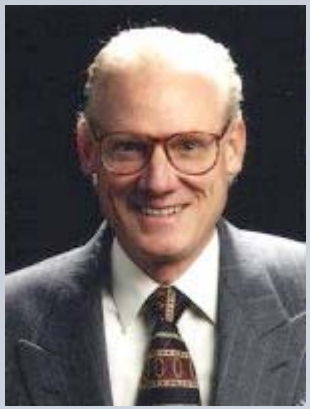
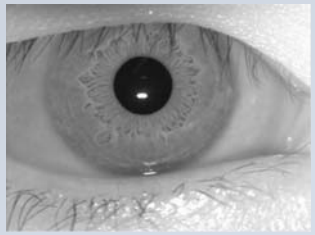


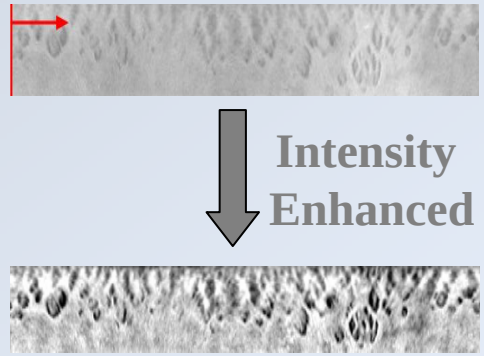
Image Acquisition



Eye Image

Localization

Normalization



Intensity Enhanced

Feature Extraction

Iris Code

Classifier

Match

Decision

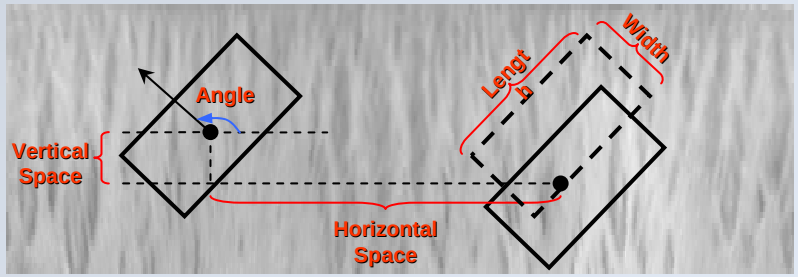
Enrolled Database

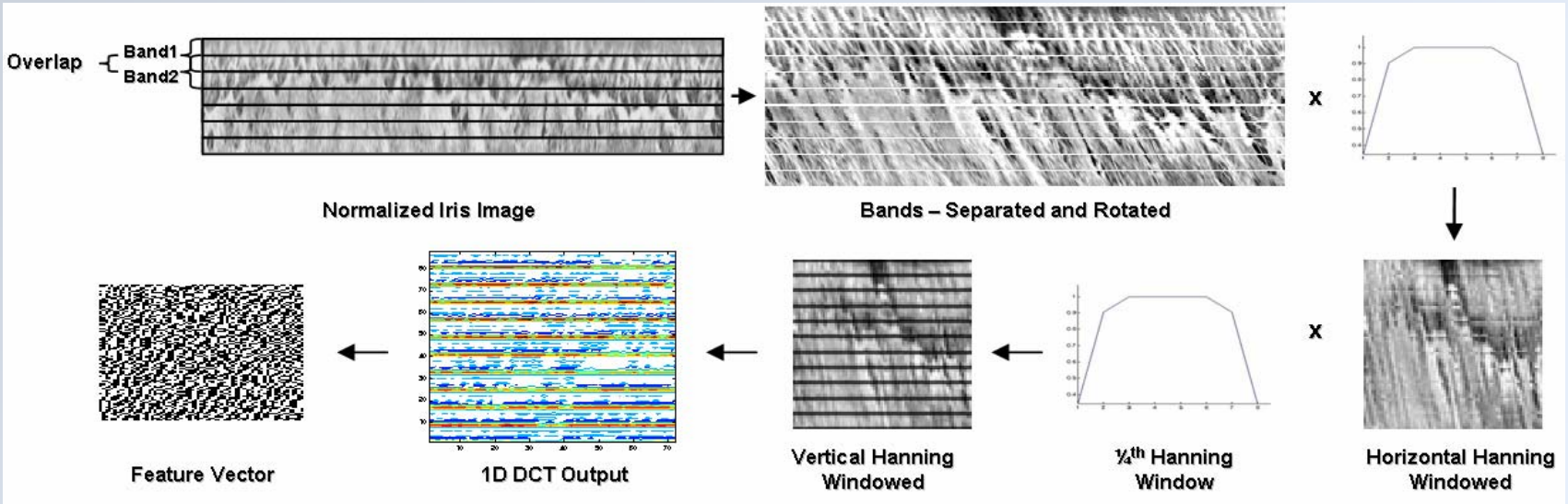
Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

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**

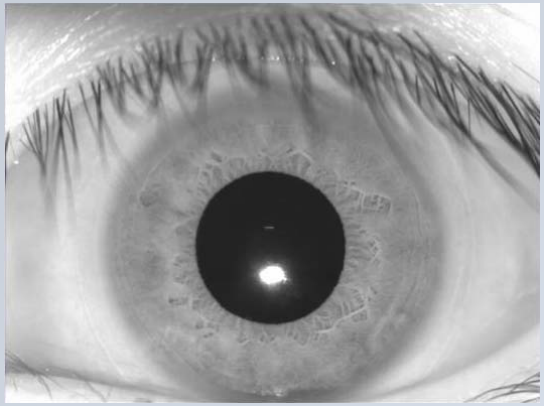


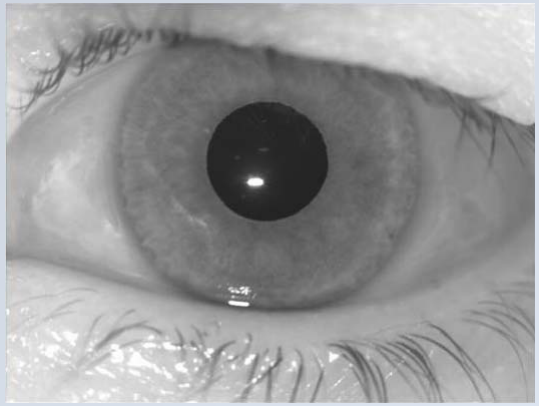


Smart Sensors Ltd
High performance iris recognition and matching

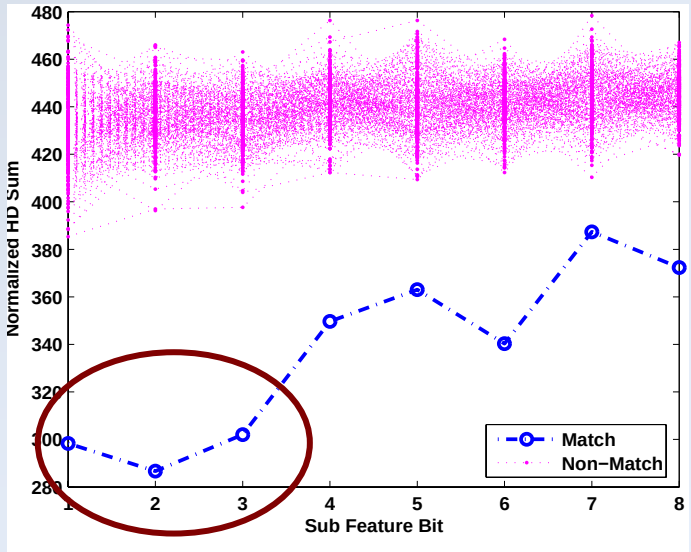
UNIVERSITY OF BATH

Weighting





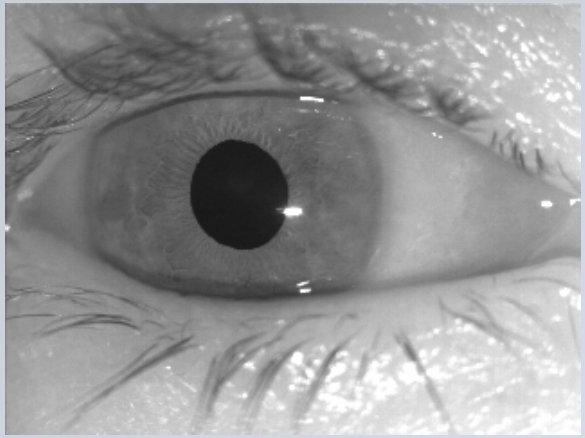
- **Blue and Brown Iris Structures differ.**
- **Positional weightings effective within ethnic groups but ineffective across groups.**
- **DCT Coefficient weighting is effective in choosing the most discriminating bits and reducing the Feature Vector Size.**
- **Most effective sub-feature bits 1, 2,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

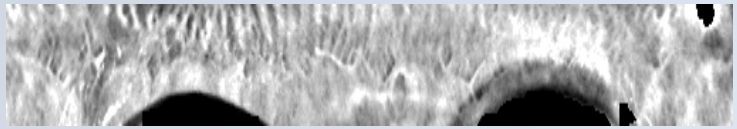


Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

Masking



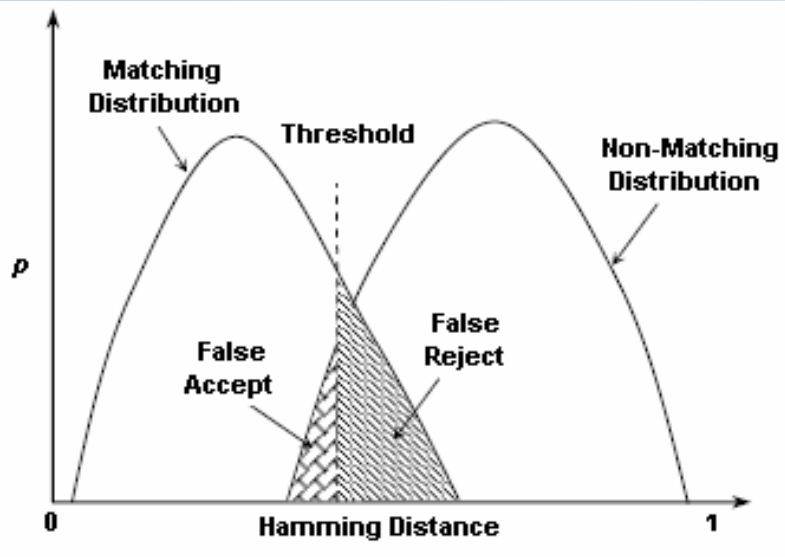


- Artifacts in iris images lead to erroneous code formation.
- Caused by specular reflections, hard contact lens, eyelids, eyelashes, etc.
- Non-iris regions masked to 0 graylevel in normalized image.
- Masked regions omitted during image equalization and coding.

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.

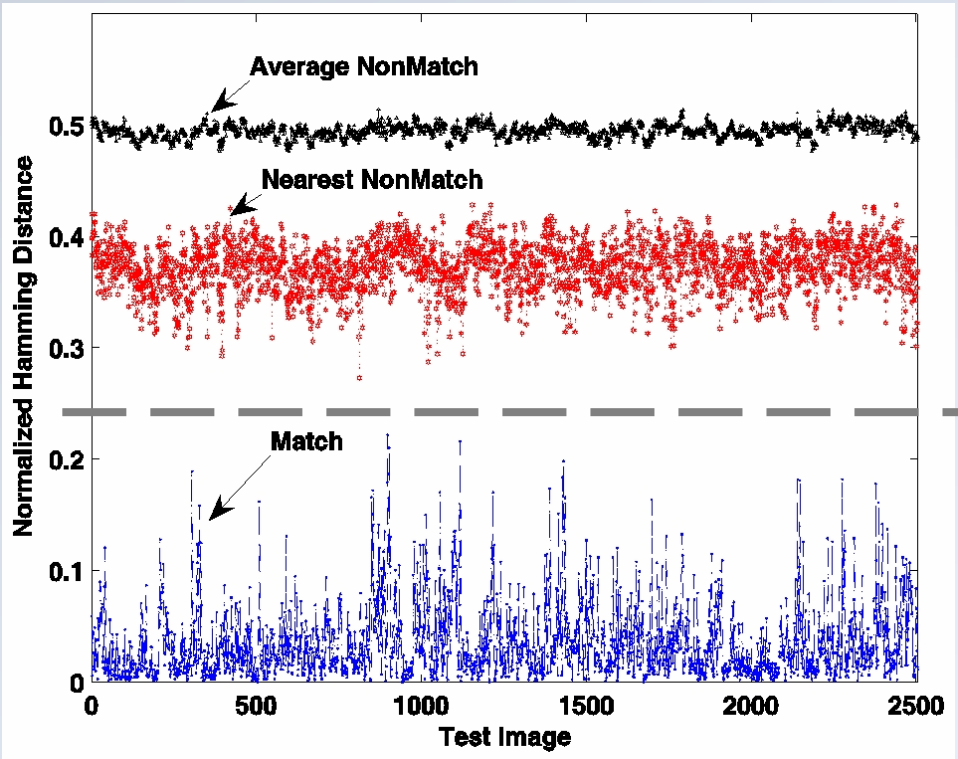


- **Parameter Optimization by minimizing Equal Error Rate (EER).**
- **Theoretical EER predicted by measuring areas of equal overlapped regions.**
- **Matching and Nearest Non-Matching Distances modelled using best fit distribution curves.**

Proposed Metric

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

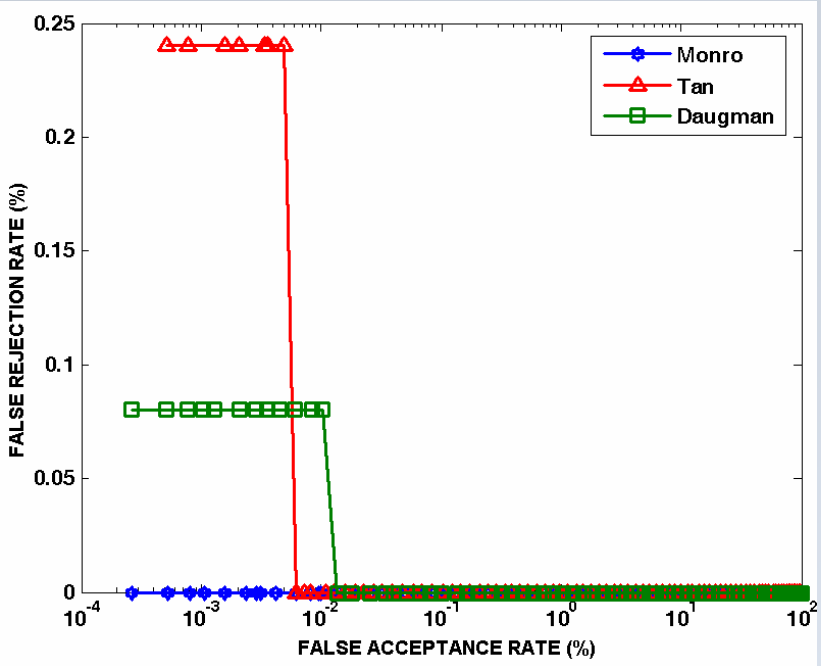
Proposal - Compare the separation between Normalized Hamming Distance of Matching with **Nearest** Non-Matching Irises.

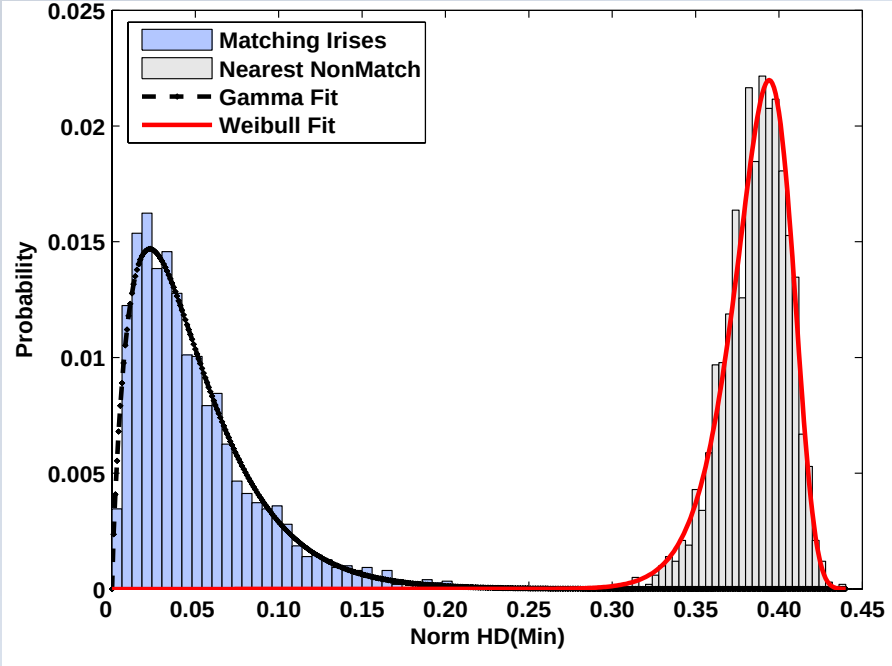


Test Datasets

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

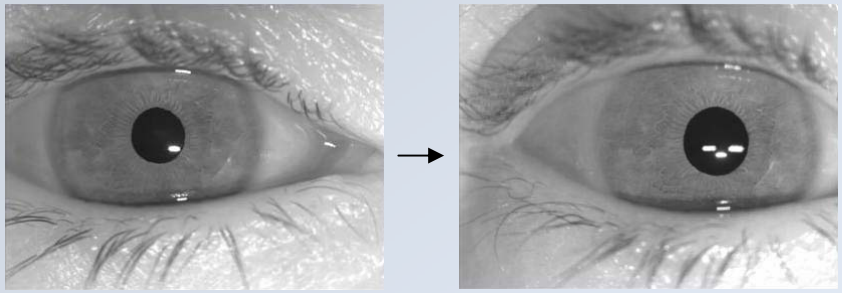
Method	Feature Extraction (ms)	Matching (ms)	Total (ms)
Daugman	422	31	453
Tan	125	68	193
Monro	*45*	*31*	*86*

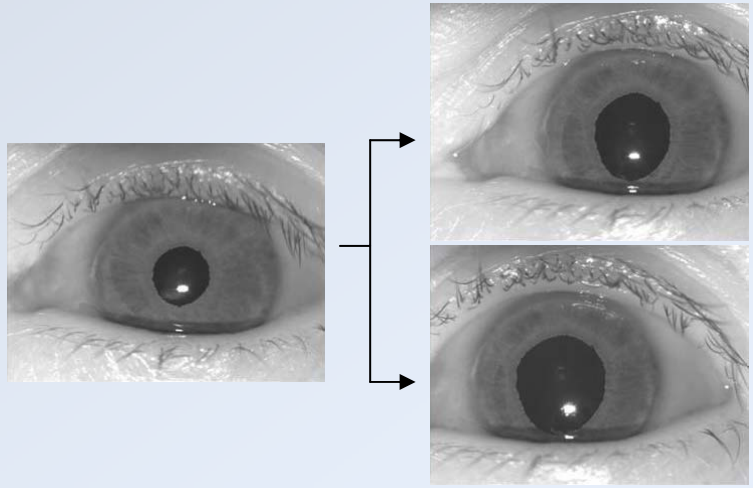
Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

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





Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

Acknowledgements

Professor Tieniu Tan
National Laboratory of Pattern Recognition (NLPR)
Chinese Academy of Sciences Institute of Automation (CASIA)

Industrial Sponsors: Smart Sensors Ltd. (UK)

Donald M Monro, Soumyadip Rakshit and Dexin Zhang

Electronic and Electrical Engineering, University of Bath
Bath BA2 7AY, United Kingdom
S.Rakshit@bath.ac.uk
Http://dmsun4.bath.ac.uk

NIST FRGC ICE Workshop 23 March 2006

Smart Sensors Ltd
High performance iris recognition and matching

UNIVERSITY OF BATH

Questions ?