

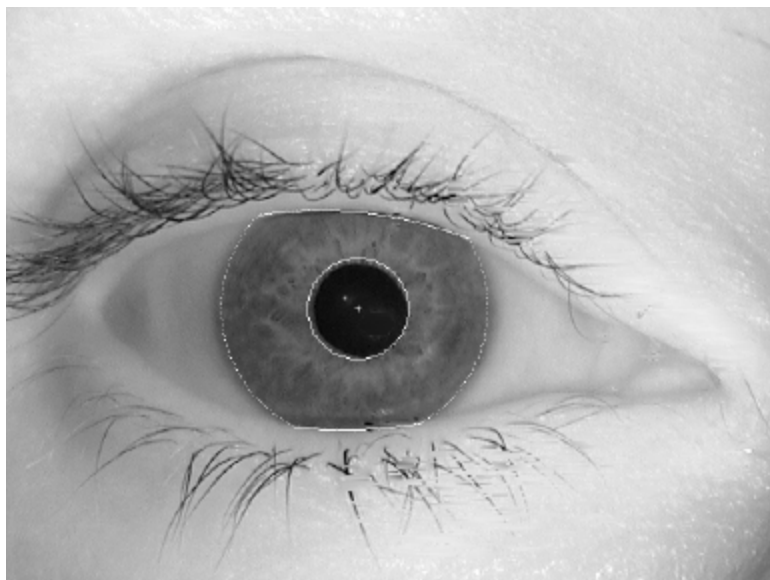
IrisCode[®] Template Compression and Its Effects on Authentication Performance

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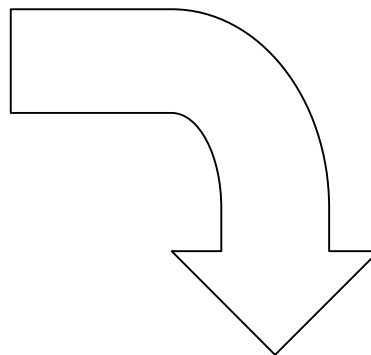
Motivation

- Standard iricode template size: 512 bytes
- Size requirement for storage on 2-D barcode, with other biometric and biographic information: 230 bytes
- Investigated lossy compression through subsampling to guarantee fixed template size

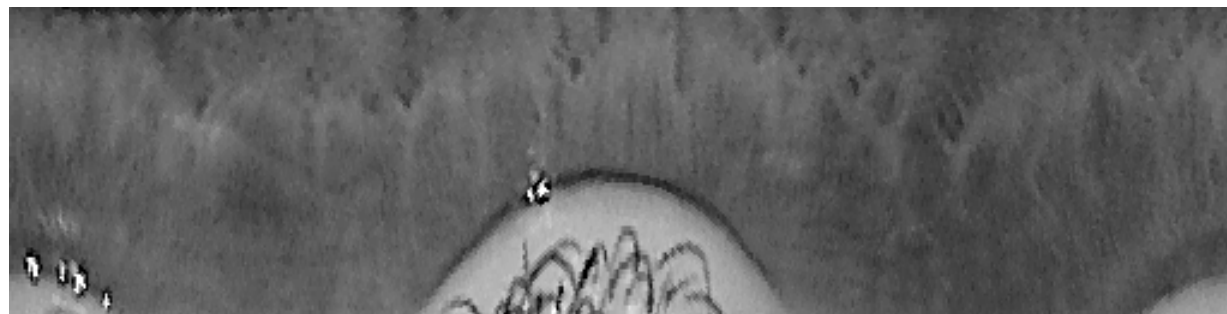
From Image to IrisCode



Iris image



Polar image



IrisCode Template Structure

- Polar image divided into R concentric rings with T angular sampling locations
- Filter pair applied at each sampling location
- Filter responses quantized into $\{0, 1\}$
- Assembled into bit string



Template Subsampling Schemes

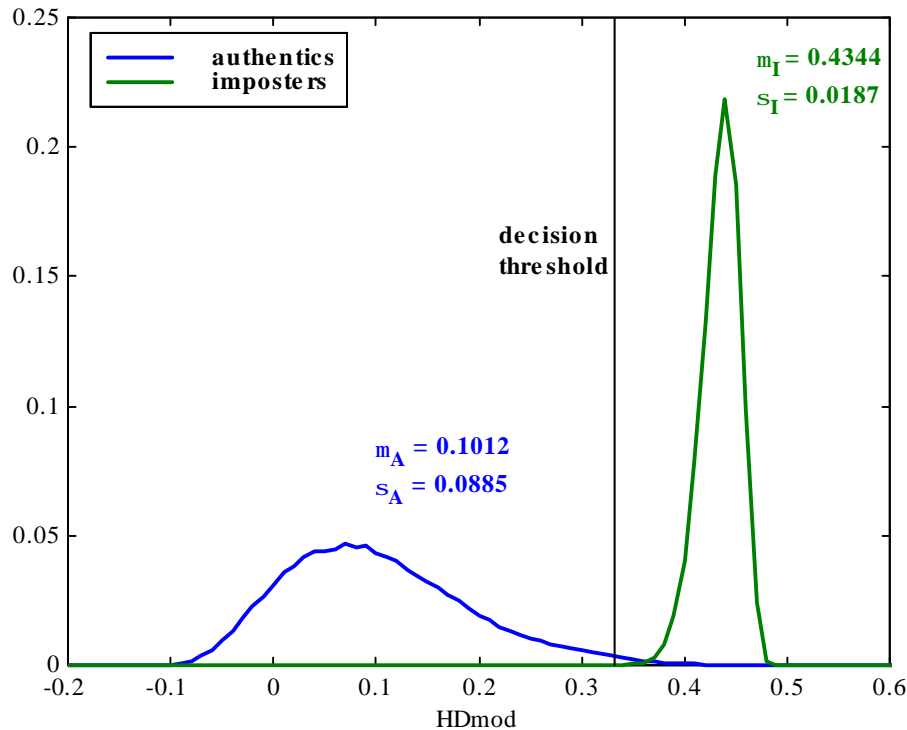
1. Angular: every n -th angle
2. Radial: every n -th ring
3. Single filter, subsampled angularly
4. Both filters, subsampled at different rates

Iris Image Test Set

- Images collected from Afghan refugees at UNHCR repatriation center Takhta Baig in Peshawar, Pakistan
- 4 images each of 9670 different right eyes
- 38,680 iris images total



Decision Environment



Imposters: can be modeled accurately by binomial distribution

Authentics: no good model available; use empirical histogram

Performance Metrics

1. Degrees of freedom
2. Decidability index
3. Equal error rate
4. False nonmatch rate at fixed false match rate

Degrees of Freedom

- Based on imposter distribution only
- Defined as number of trials n of equivalent binomial distribution:

$$p_k^{(n)} = \binom{n}{k} \cdot p^k \cdot (1-p)^{n-k}$$

$$n = \mathbf{m} \cdot (1 - \mathbf{m}) / \mathbf{S}^2$$

Degrees of Freedom: Problems

- Measures only the discrimination power of the iris encoding between different irides
- Does not consider how closely the encoding maps identical irides
- Does not distinguish between signal and noise in the encoding

Decidability Index

- Defined as normalized distance between means of authentic and imposter distributions:

$$d' = \frac{|\mathbf{m}_A - \mathbf{m}_I|}{\sqrt{(\mathbf{s}_A^2 + \mathbf{s}_I^2)/2}}$$

- Problem: works best for Gaussian-type distributions; misled by heavy tails or multiple modes

Equal Error Rate

- Defined as error where false match rate and false nonmatch rate are equal:

$$EER = FNMR(x) = FMR(x)$$

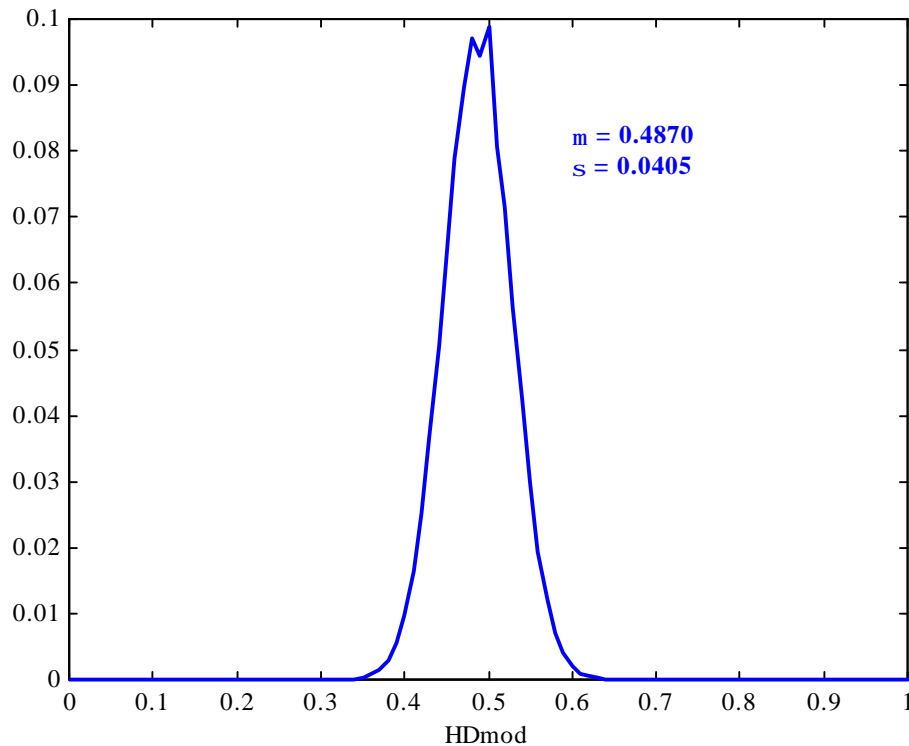
- Problem: empirical authentic distribution often contains no observations in the EER range

False Nonmatch Rate

- Defined as false nonmatch rate at fixed false match rate
- Uses standard iris recognition FMR of 1 in 1.2 million (0.0000833%)
- Can be computed from modeled imposter and empirical authentic distribution

False Nonmatch Rate: Step 1

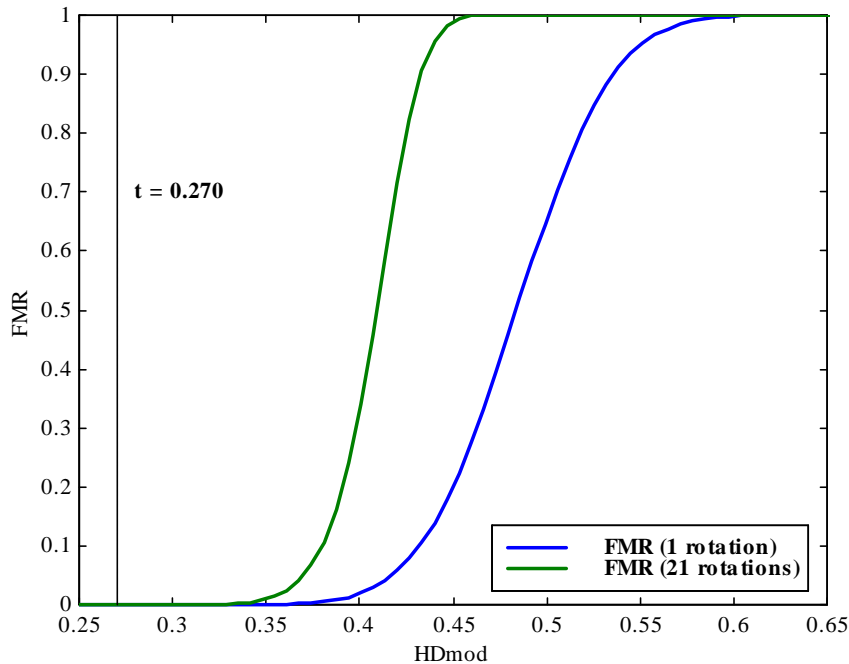
Determine degrees of freedom n from single-rotation imposter distribution. Example:



$$n = \mathbf{m} \cdot (1 - \mathbf{m}) / \mathbf{s}^2 \approx 152$$

False Nonmatch Rate: Step 2

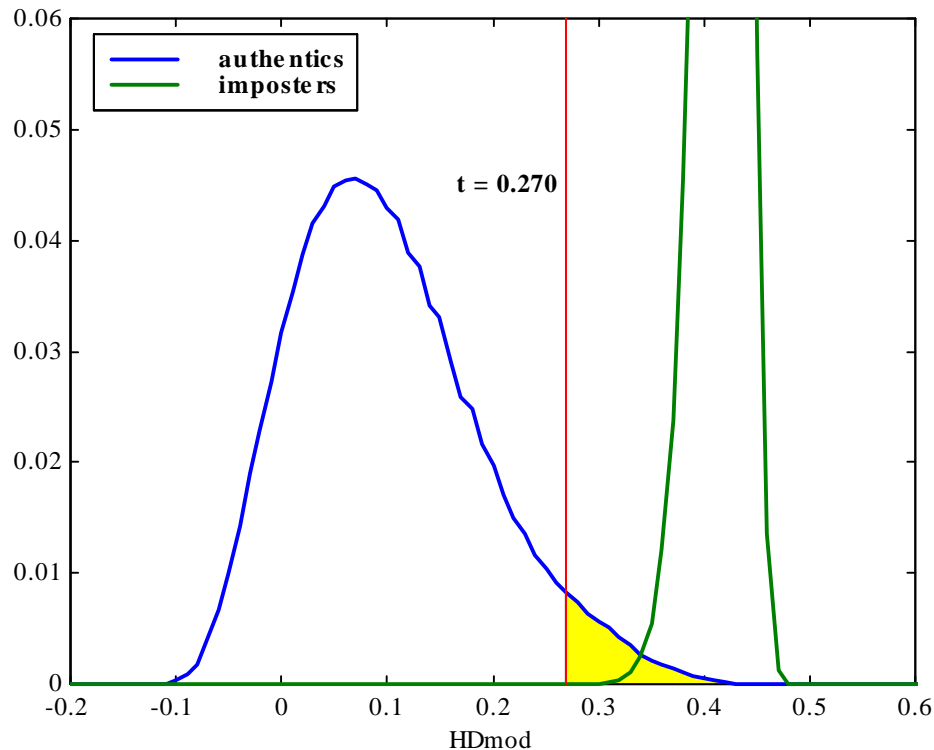
Find threshold t with target FMR by numerically inverting cumulative distribution function for n degrees of freedom and 21 rotations:



$$t = 0.270$$

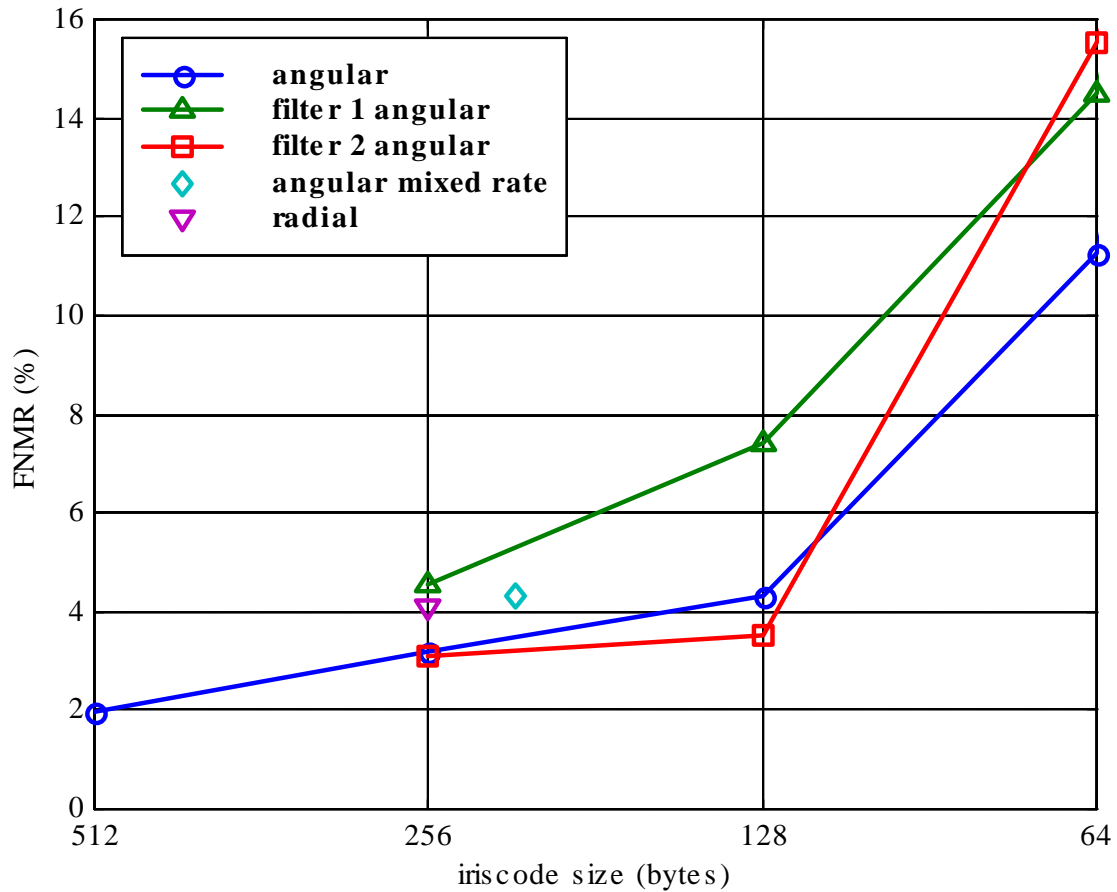
False Nonmatch Rate: Step 3

Integrate over authentic distribution to the right of decision threshold t to obtain false nonmatch rate:



$$FNMR = 4.3\%$$

Results: False Nonmatch Rate



Conclusions

- Template size reduction to 256 bytes, either by 2x subsampling or by omission of filter 1, leads to tolerable increase in FNMR (from 2% to 3%) for presented test set
- For another test set, subsampling schemes above did not degrade performance at all
- Achieve final reduction to 230 bytes with standard lossless compression algorithm