EEE-6561 Fundamentals of Biometric Identification

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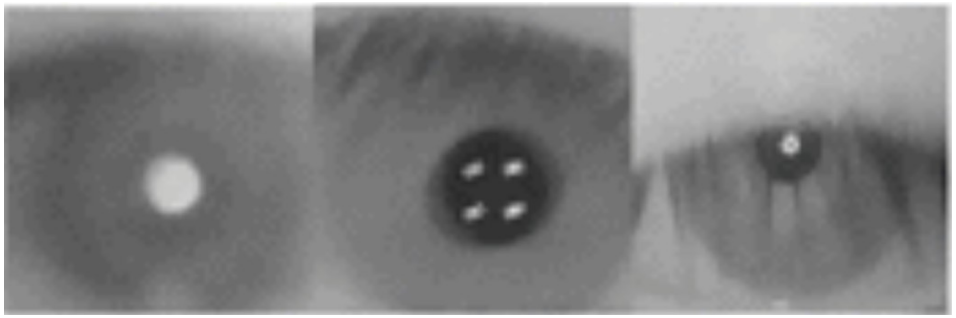
Lecture #4 Biometric System Evaluation and Design

Damon L. Woodard, Ph.D.
Dept. of Electrical and Computer Engineering
dwoodard@ece.ufl.edu

Failure to Acquire (FTA)

Falsely rejected biometric samples

Problem at acquisition time:



Wei et al., “Robust and Fast Assessment of Iris Image Quality,” ICB 2006

Failure to Enroll

Falsely rejected biometric samples at enrollment time

Image Credit: Eli Sprecher, American Journal of Human Genetics

Identification System Errors

Identification System Error Rates

- False positive identification rate and False negative identification rate
- False positive identification rate: The expected proportion of identification transactions by users not enrolled in the system, where an identity is returned, is known as the *false positive identification rate* (FPIR)
  - This is analogous to the false match case in biometric verification
  - The FPIR depends both on the size of the enrollment database (*N*) and the threshold (η).

False Negative Identification Rate (FNIR)

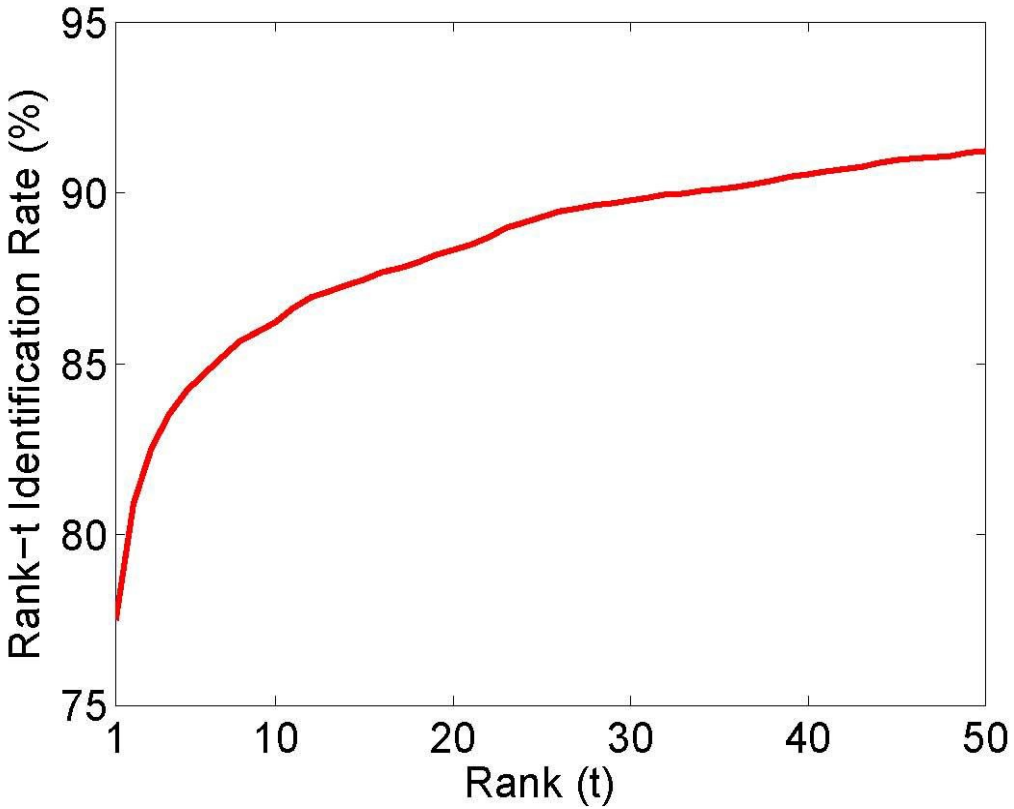
- False negative identification rate: The expected proportion of identification transactions by users enrolled in the system in which the user's correct identity is not returned is called the *false negative identification rate* (FNIR)
- FNIR depends on the size of the enrollment database (*N*), the threshold (η) used for the match scores, and the number of identities ***t*** returned by the identification system

True Positive Identification Rate

- True positive identification rate (TPIR): The expected proportion of identification transactions by users enrolled in the system, where the user's correct identity is among the ***t*** identities returned by the system.
  - FNIR = 1 - TPIR
- If the biometric system outputs the identities of the top ***t*** matches, the corresponding TPIR is also known as the rank-*t* identification rate, which we refer to as R_t
- In particular, the value of TPIR for ***t*** = 1 is called the *rank-one accuracy*

CMC Curve

The rank-*t* identification rate for different values of *t* can be summarized using the Cumulative Match Characteristic (CMC) curve, which plots R_t against $\boldsymbol{t}$ for $\boldsymbol{t} = 1, 2, \cdots, N$, where N is the number of enrolled users.



Some Relations

- FNIR = FNMR = FRR

  The probability that the input is falsely declared as a non-match against the user's template is the same as in verification mode

- FPIR = $1 - (1 - \mathrm{FMR})^N$

  –A false positive identification occurs when the input falsely matches one or more templates in the database. FPIR is then computed as one minus the probability that no false match is made with any of the database templates

  –If the FMR is very small ($\ll (1/N)$), FPIR can be approximated as FPIR $\approx N \times$ FMR

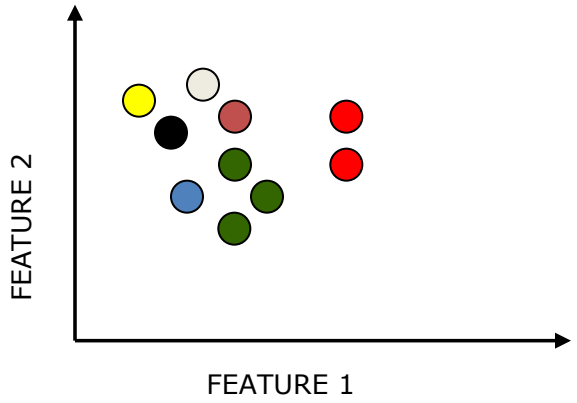
Biometric System Design

Challenges in Biometric Systems Design

- Individuality of biometric characteristics
- Large number of classes (e.g., millions of faces)
- Intra-class variability and inter-class similarity
- Segmentation
- Noisy and distorted images
- Population coverage & scalability
- System requirements (error rate, speed, cost)
- Attacks on the biometric system

Large Number of Patterns

- Most pattern recognition applications deal with a small number of “classes” and a large number of “exemplars” per class
- Biometrics, on the other hand, has to reckon with a large number of “classes” and a small number of “exemplars” per class



False Rejects and False Accepts

Variability observed in the face image of a single person due to change in pose, expression, lighting and glasses

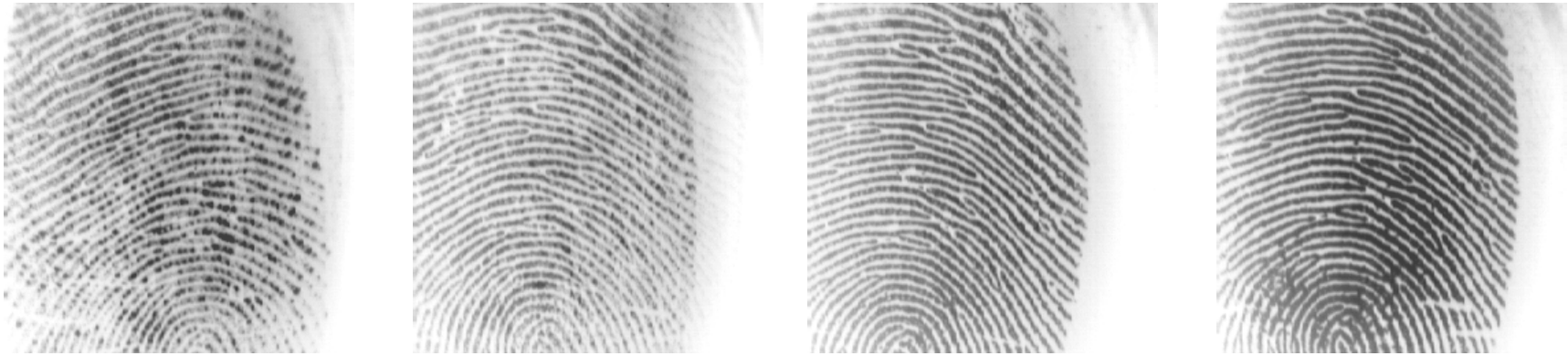
Faces that look similar

*R.-L. Hsu, ``Face Detection and Modeling for Recognition'', Ph.D. Thesis, 2002

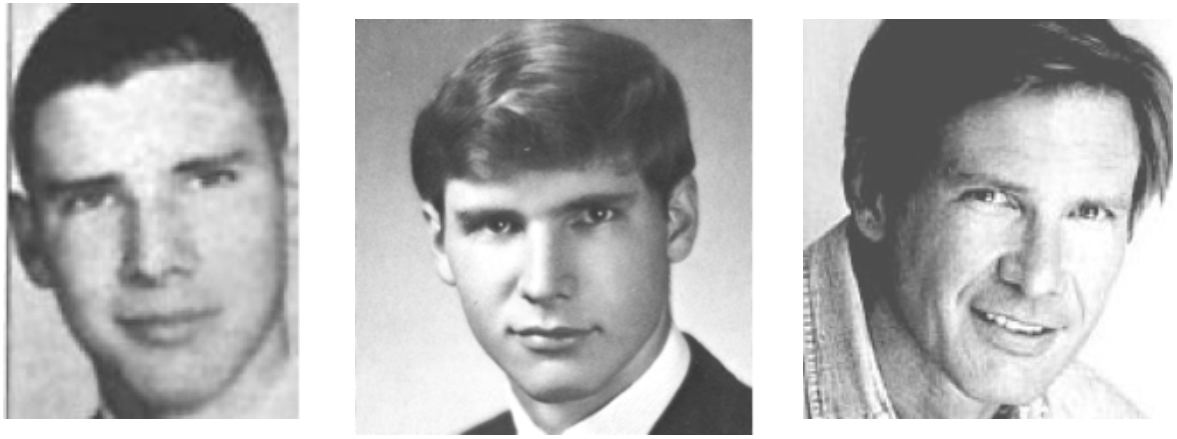
Temporal Variations

Uludag, Ross, Jain, "Biometric Template Selection and Update: A Case Study in Fingerprints", Pattern Recognition, 2004.

Time duration: 6 months



Time duration: several years



Questions?

Slide Credits

Material used from Introduction to Biometrics text authors Arun Ross and Anil Jain as well as Walter Scheirer