Biometric Authentication Technologies: Hype Meets the Test Results

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Hype

Main Entry: **hy·per·bo·le**
Pronunciation: hI-'p&r-b&-(")lE
Function: *noun*
Etymology: Latin, from Greek *hyperbolE* excess, hyperbole, hyperbola, from *hyperballein* to exceed, from *hyper-* + *ballein* to throw

Date: 15th century
: extravagant exaggeration (as "mile-high ice-cream cones")

Vendor Hype

- “A face - at a distance, in a crowd, at a glance. Blink and you might miss it. Facial recognition technology is the only biometric capable of identifying known people at a distance”.
- “Currently, facial recognition has a range limited to approximately 10 feet.”

Vendor Hype

- “Facial surveillance can yield instant results, verifying the identity of a suspect instantly and checking through millions of records for possible matches quickly, automatically and reliably. Our automated systems are used airports, casinos, public buildings, town centers and shopping malls around the world to enhance the effectiveness of CCTV systems.”

Academic Hype

"The biometrics industry is mythical. Publicly-available, independent evaluation of technologies and products is extremely rare. Three available reports show that most of the technologies and products don't work. Technologies, products and suppliers continue to appear and disappear at a rapid rate. Pilots almost never proceed to the next stage. Anecdotally, installations are so ineffectual that they're a great embarrassment to everyone concerned"

Publicly Available Independent Evals

- www.cesg.gov.uk/technology/biometrics
- www.frvt.org
- http://bias.csr.unibo.it/fvc2002
- www.engr.sjsu.edu/biometrics/nbtccw.pdf

Industry Stability

- International Biometric Industry Association
  - www.ibia.org
- 4 of 30 (non-AFIS) companies listed in 1988 “Biometrics Industry Sourcebook” are still in business

“A large, diverse market”

- Credit systems
- Industrial and military security systems
- Personal locks

Speed, Decentralization, Ultravalidity, Convenience

--Hughes Research Laboratory Report #190, March 1961

“Truly reliable personal identification”

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- ID cards are lost, loaned, or stolen
- an indisputable, unchangeable and nontransferable characteristic of the person himself
- Far more reliable than even picture badges
- lower per-portal cost than guards
- Response time is 2 seconds

"Truly reliable personal identification"

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- Applications:
  - Airport maintenance and freight areas
  - Information storage areas
  - Hospital closed areas, drug storage areas
  - Apartment houses, office buildings, coed dorms
  - Prison areas
  - Computer terminal entry and access to information

    -- Calspan marketing brochure (1974)

Conclusion

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- The hype is factually correct, but leaves an impression that may not be accurate

A Scientific Approach

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- "the phenomena of nature are regarded as one continuous series of causes and effects; and the ultimate object …is to trace out that series.." –T.H. Huxley (1879)
- Beyond correlation to mechanism
  - Understand
  - Predict
  - Control

A Modern Definition Of Biometric Authentication

The automatic identification or identity verification of living, human individuals based on behavioral and physiological characteristics

-- B. Miller (1988)

Available Devices

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- Fingerprint
- Palm Print
- Hand Geometry
- Finger Geometry
- Iris Scan
- Vein
- Facial Imaging
- Speaker Verification
- Dynamic Signature Analysis
- Keystroke Analysis

Current Testing

- Technical Performance
  - Technology
  - Scenario
  - Operational
- Vulnerability
- Security (Common Criteria)

We Aren't Testing (yet)

- Business Case
  - Costs
  - Savings
- User attitudes
- Public perception
- Privacy safeguards

Developing Technical Perfomance Metrics

"Best Practices for Testing and Reporting Biometric Device Performance" – U.K. Biometrics Working Group

www.cesg.gov.uk/technology/biometrics

5 Technical Performance Metrics

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- Failure-to-enroll rate
- Failure-to-acquire rate
- False positive
  - False match
- False negative
  - False non-match
- Throughput

Application Classes

- Positive

  To prove I’m known

  To prevent multiple users of a single identity

- Negative

  To prove I’m not known

  To prevent multiple identities of a single user

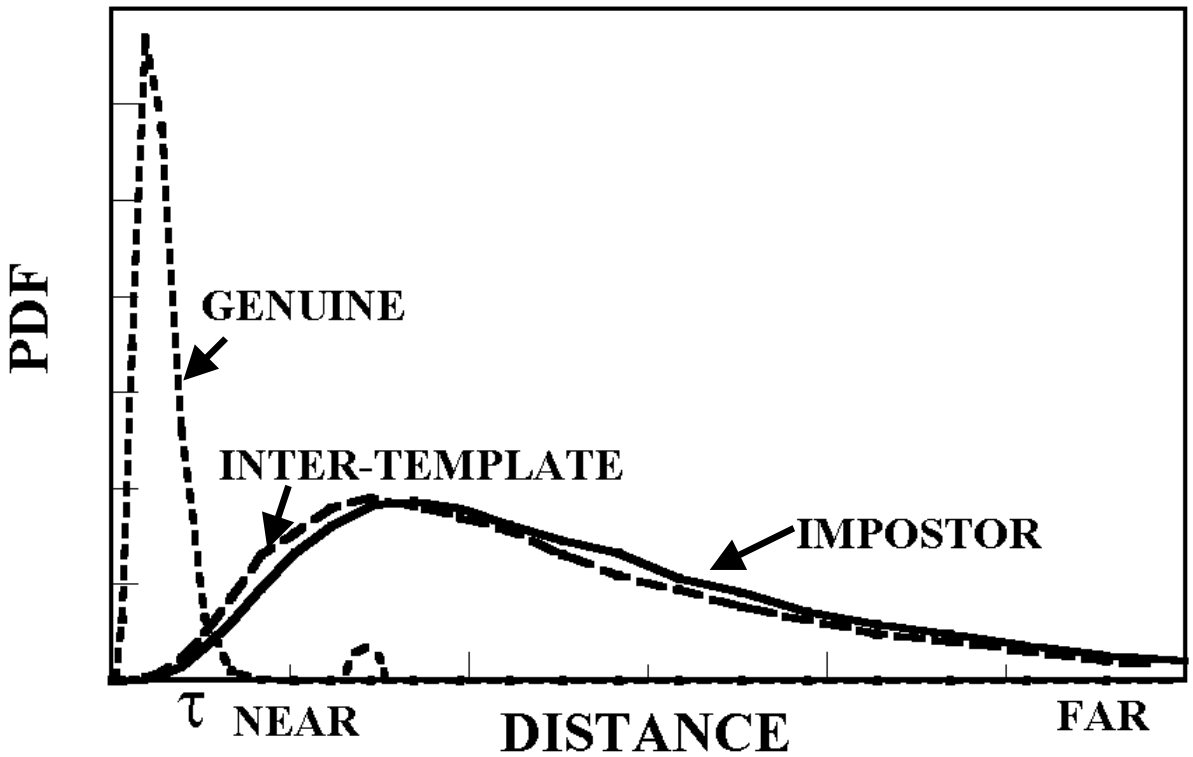
Acceptance and Rejection

- False acceptance
  - To wrongly verify an untrue claim regarding identity
- False rejection
  - To fail to verify a true claim regarding identity

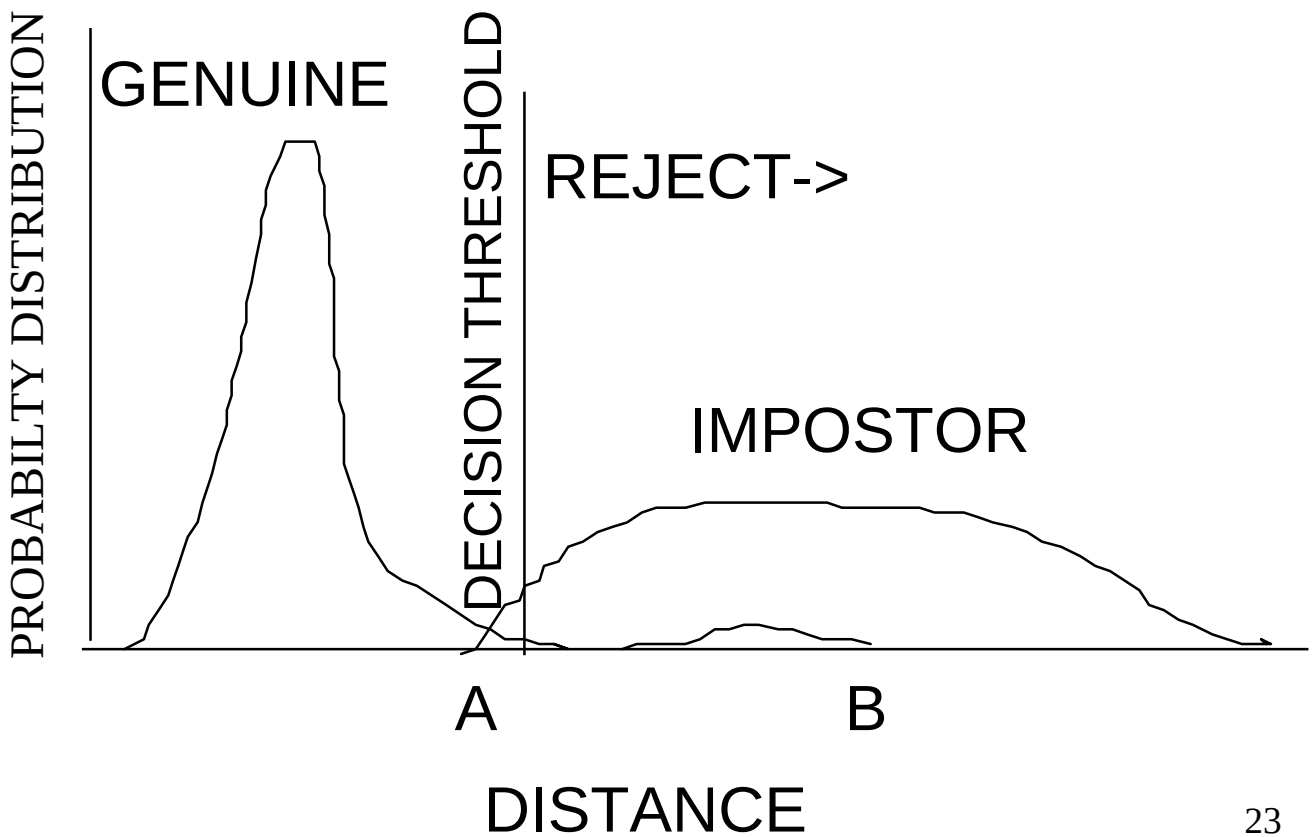
Performance Metrics

- Independent of Application Class
- Account for all causes of failure
  - False positive/false negative
  - Failure-to-enroll
  - Failure-to-acquire

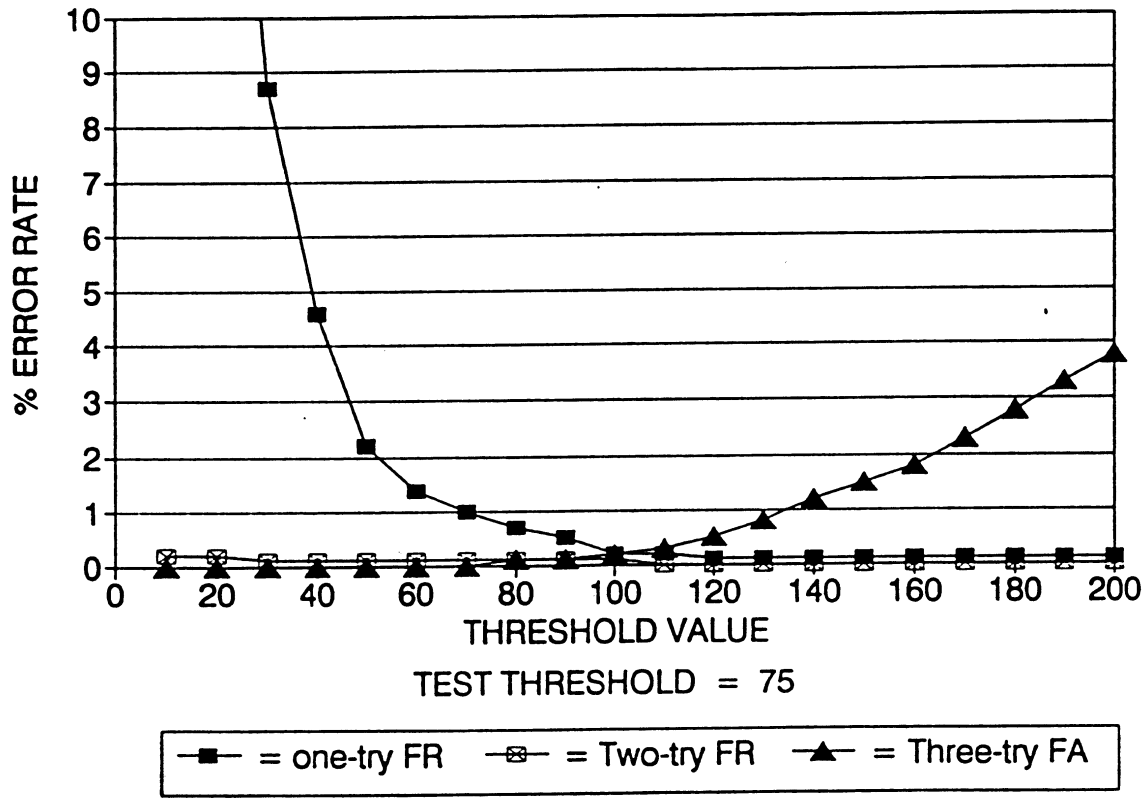
False Pos/Neg Distributions



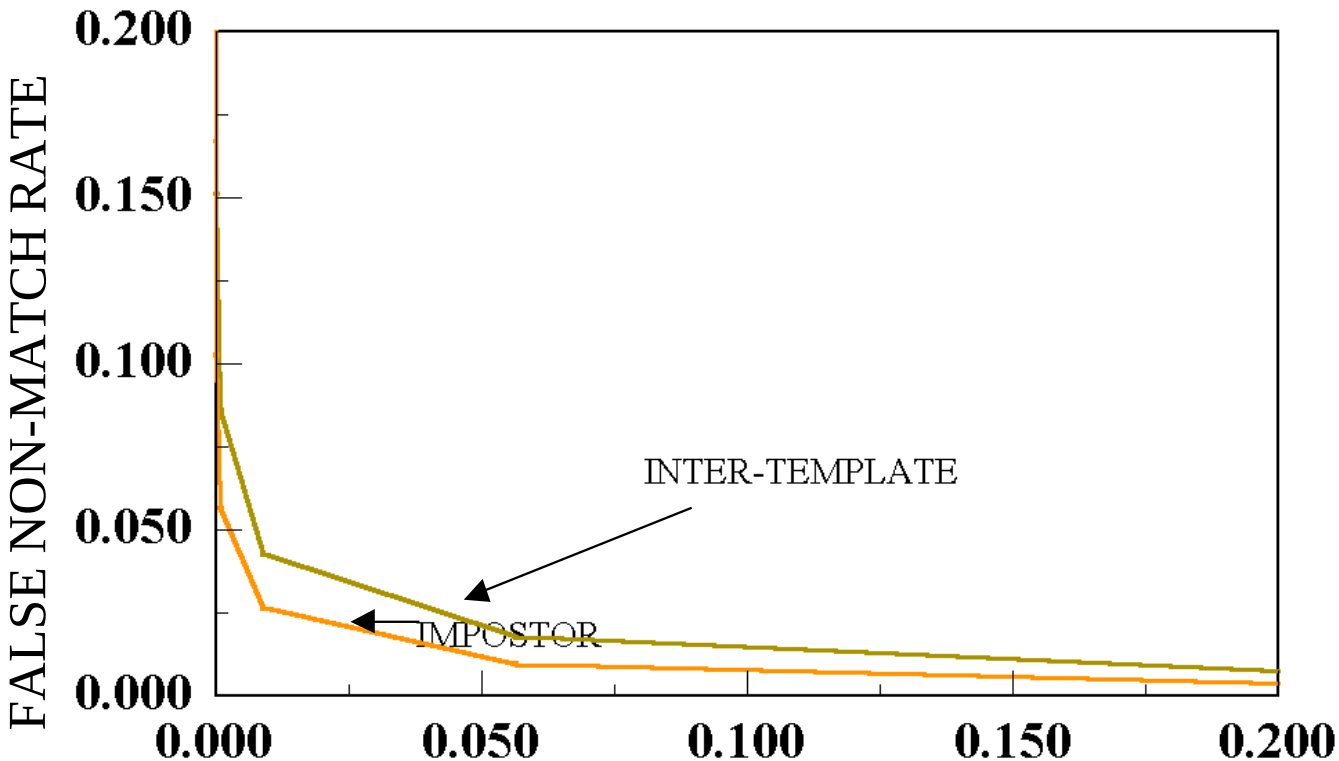
Thresholds


PROBABILTY DISTRIBUTION
GENUINE
DECISION THRESHOLD
REJECT->
IMPOSTOR
A
B
DISTANCE

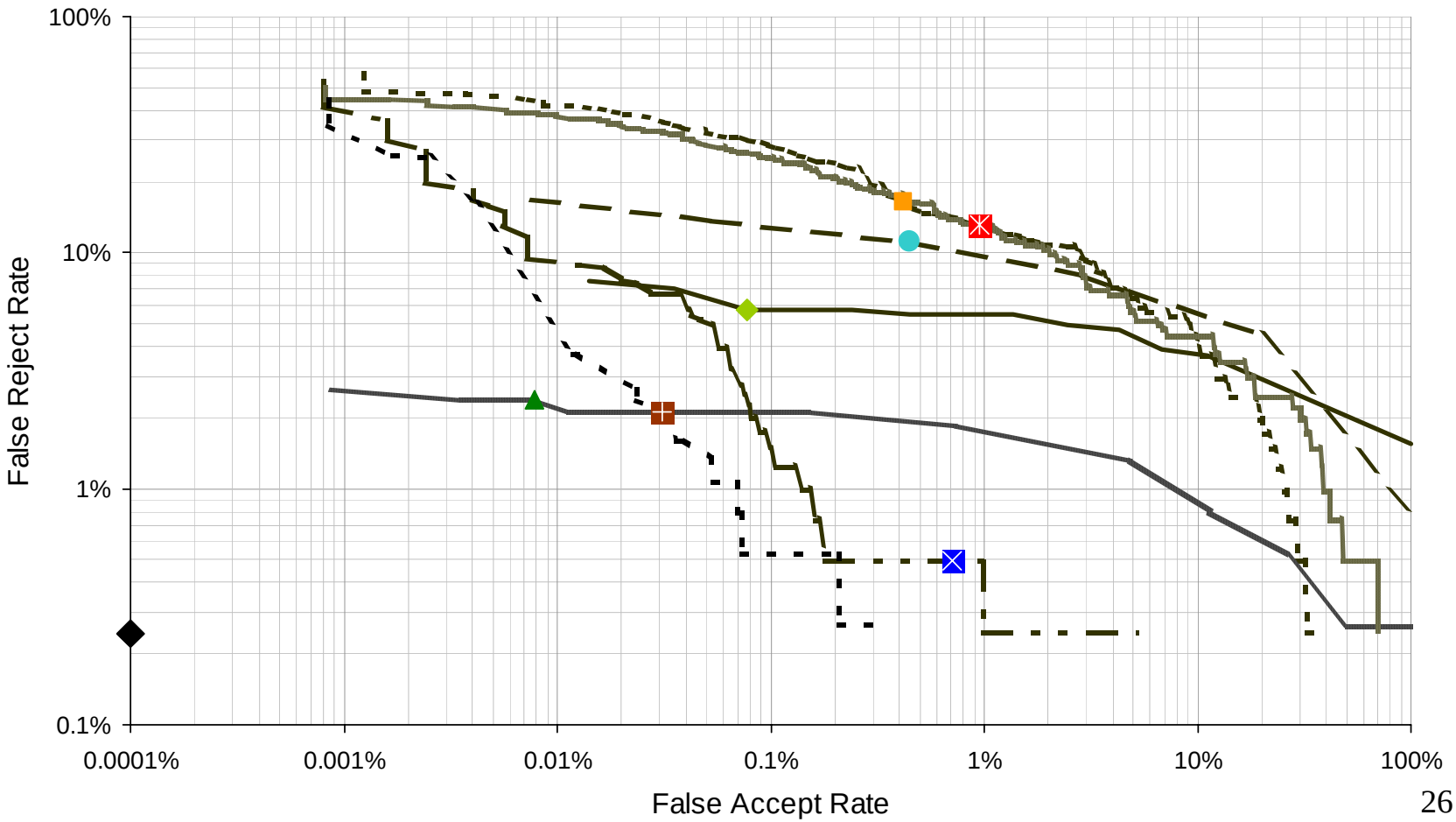
Cumulative Error Distribution



Receiver Operating Characteristic Curves



Decision Error Trade-off Curve



Decision Policy

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- Translate scores to decision
- False match, false non-match and failure-to-acquire/enroll rates become false rejection and false acceptance
- Positive and negative ID
- “Three-strikes-you’re out”
- Multiple measures

System Error Rates

- False positive = f(FMR, N, P,M)
- False negative = f(FNMR, N, M, BinError)
  - N number templates in searched database
  - P penetration rate
  - M number of submitted samples

Metrics are Misleading

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- We are **not** measuring the performance of the technology
- Performance of people with the technology
  - Strongly environmentally sensitive
  - Strongly attitude sensitive
- Inability to predict performance in one environment from tests in another

Conditions Impacting Technical Performance

- Public/Private
- Open/Closed
- Attended/Unattended
- Habituated/Non-habituated
- Overt/Covert
- Standard/Non-standard Environment

NPL TEST

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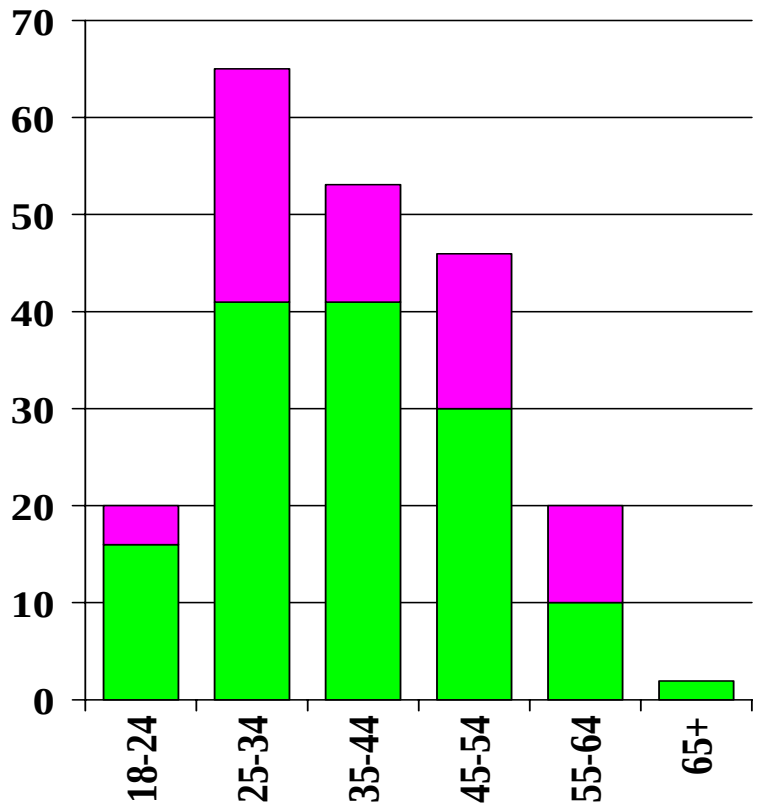
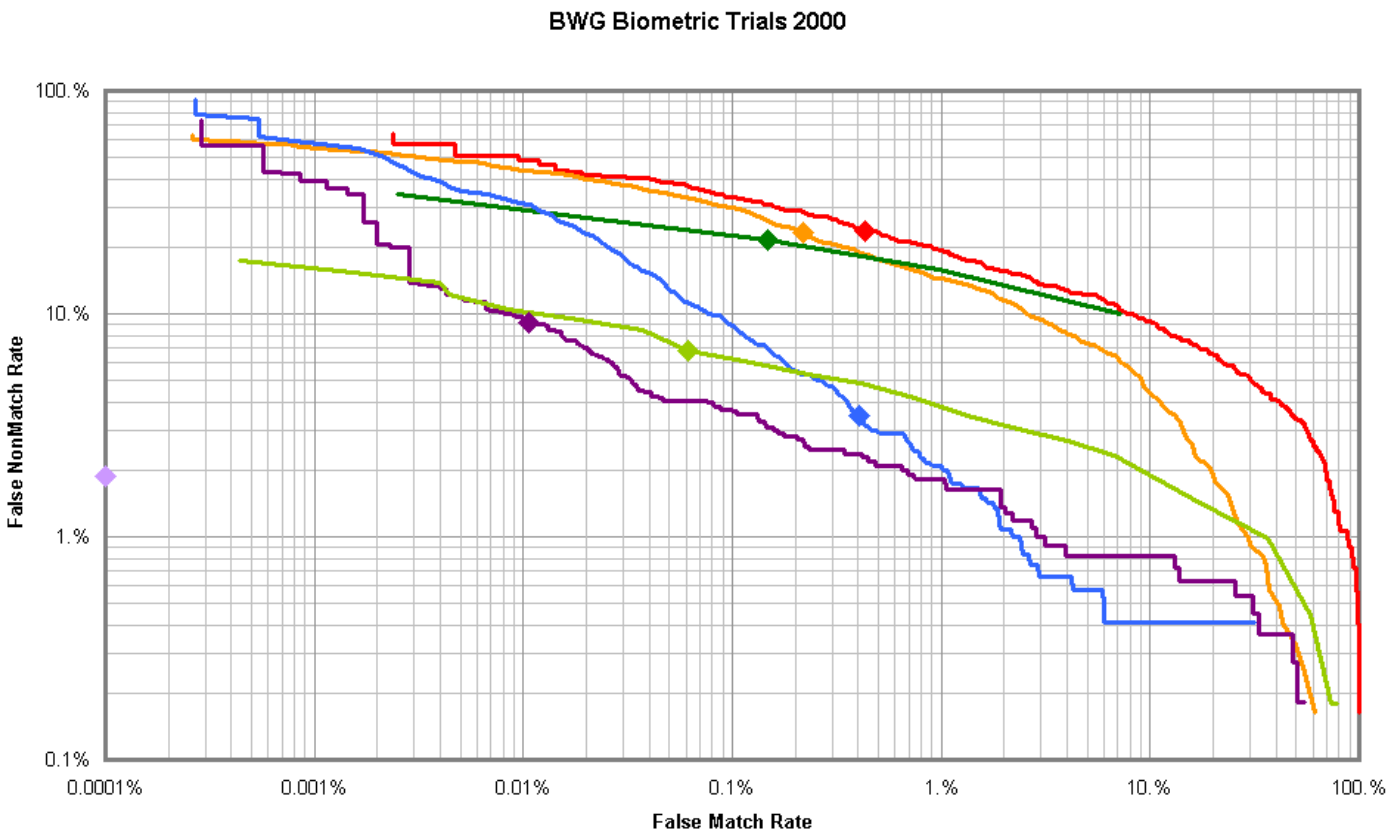
- Scenario
  - Access Control
- Office environment
  - Improved/Controlled (if easy) to vendor recommendation
- 200 volunteers
  - Age & male/female breakdown as shown
- Enrolment & 9 attempts
  - over 3 months
- Seven systems tested



CESG/NPL Test Program Results



“Best of Three” DET

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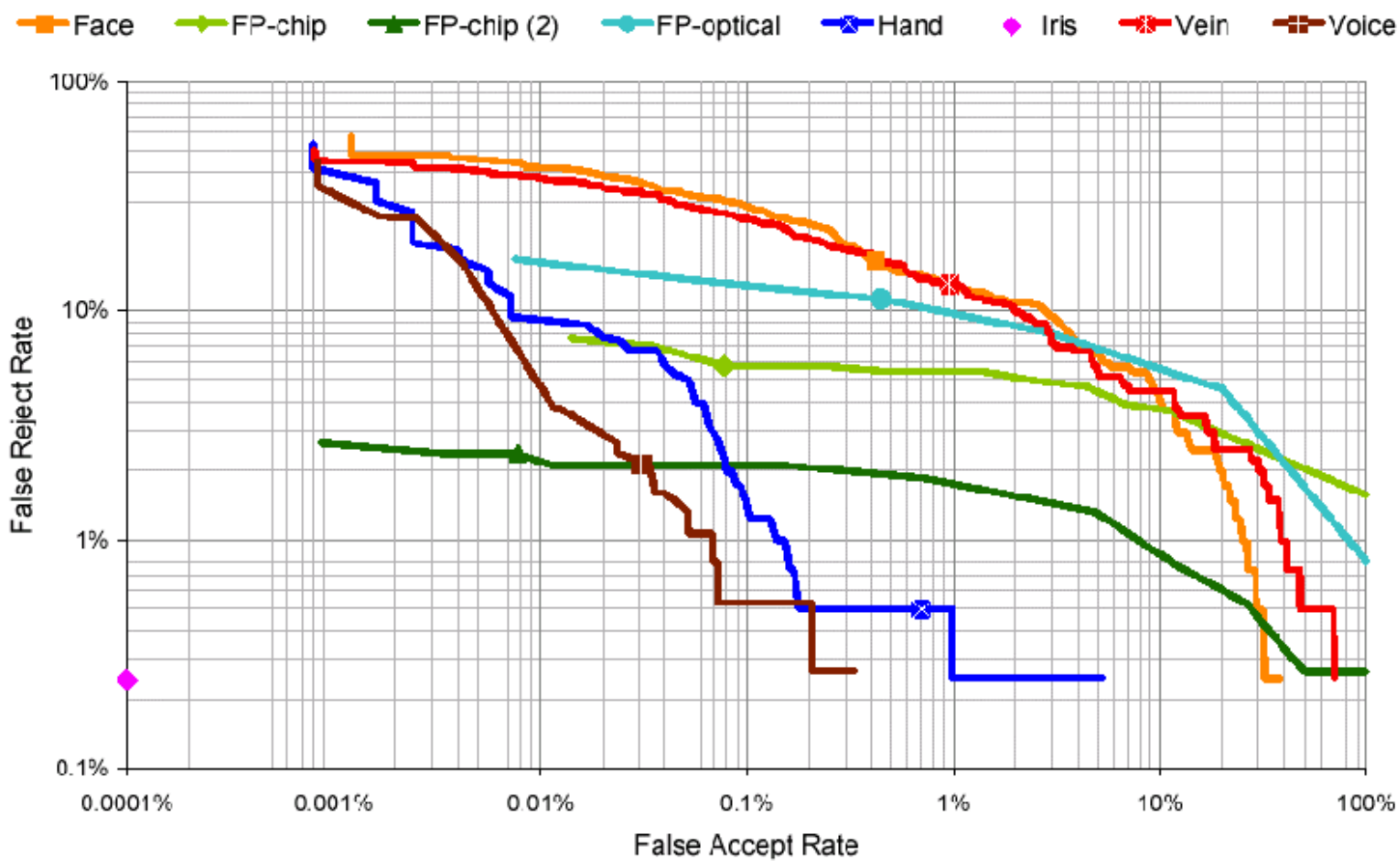

Figure 6. Detection error trade-off: Best of 3 attempts

Transaction Time

Device	Transaction Time			PIN?
	Mean	Median	Min	
• Face	15	14	10	No
• FP- optical	9	8	2	No
• FP - chip	19	15	9	No
• Hand	10	8	4	Yes
• Iris	12	10	4	Yes
• Vein	18	16	11	Yes
• Voice	12	11	10	N

FVC 2000

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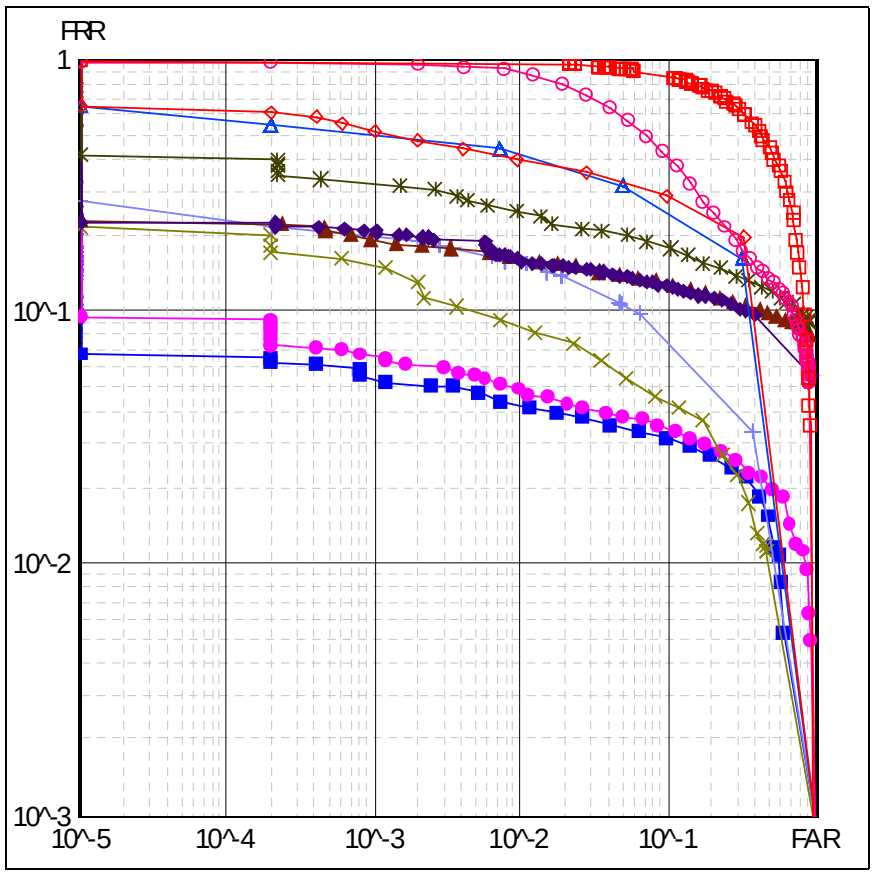
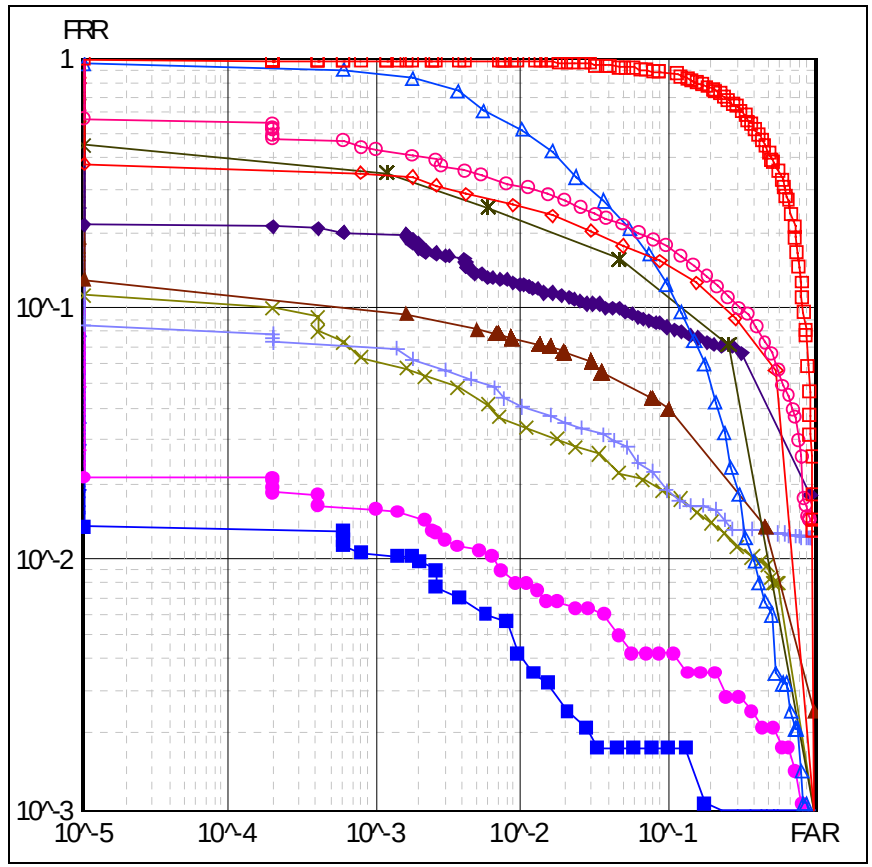




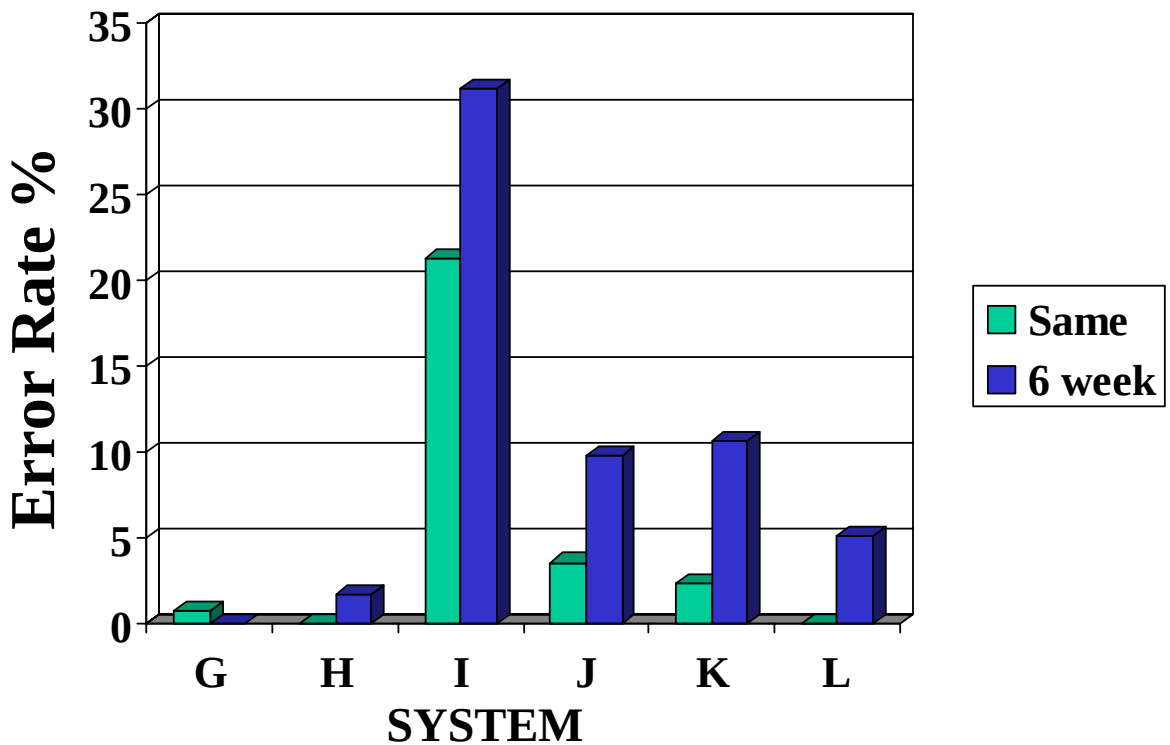
IBG FP Elderly Failure-to-Enroll Rate

System	Control FTE	Elderly FTE
A	1.75%	20.63%
B	0.0%	0.0%
C	1.75%	7.94%

IBG FP False Non-Match Rate Testing

Low Threshold

Same day/6 week Testing



Human Face Recognition

Pike, Kemp and Brace, “Psychology of Human Face Recognition”, IEE Conference on Visual Biometrics, 2 March 2000, Savoy Place, London

Same Day FAA = 34% FRR = 7%

Facial Recognition Vendor Test 2000

- DoD Counterdrug Technology Program Office, DARPA, Crane NSWC, Dahlgren NSWC

Lighting Variation

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- Mug shot - overhead

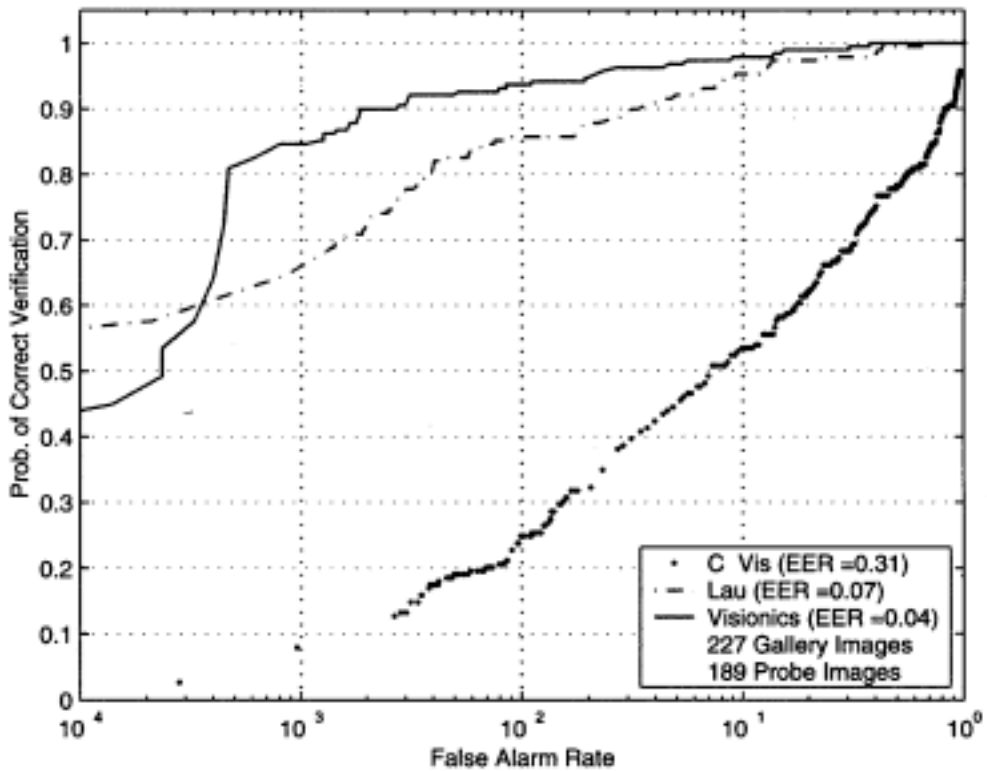

Figure M–43: *Verification Scores—Illumination I1*

Expression Change

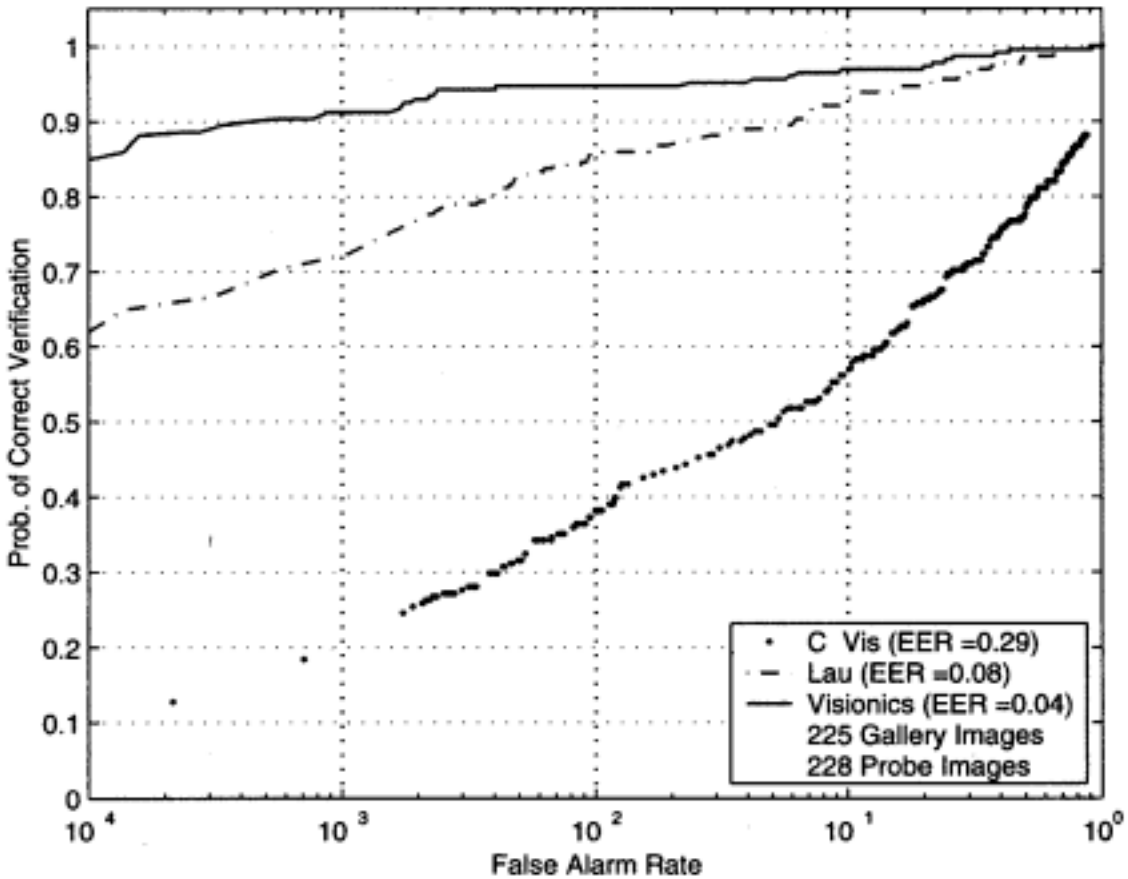

Figure M–41: *Verification Scores—Expression E1*

Pose Variation

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- Outdoors
- Mug shot - 45º
- Same session

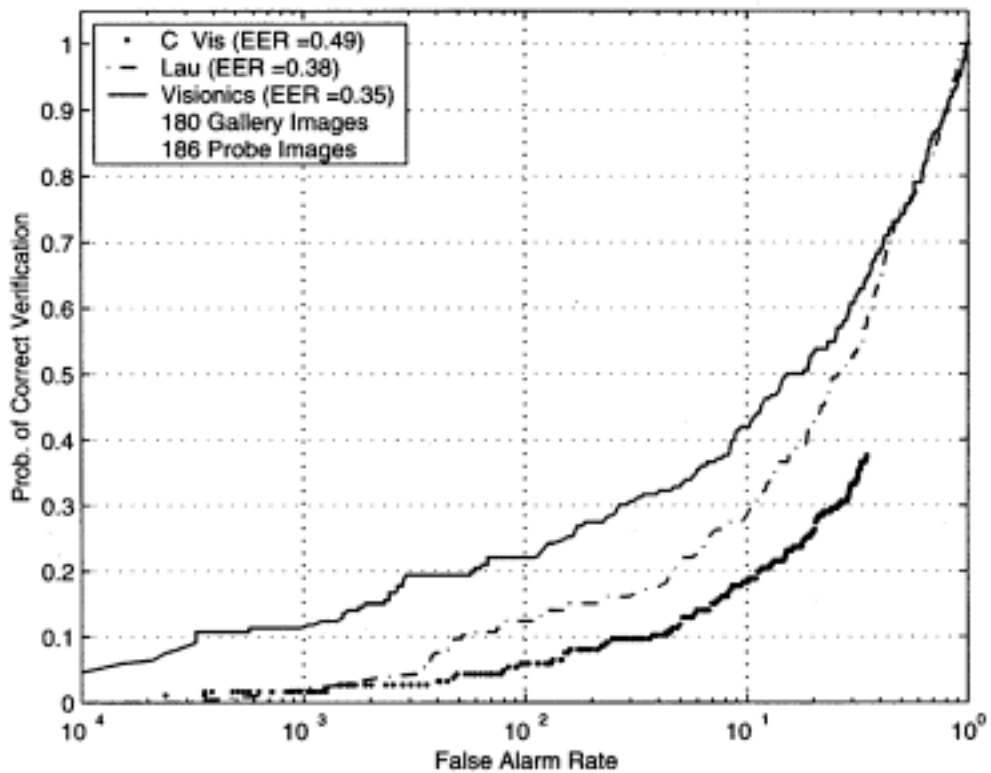

Figure M–48: *Verification Scores—Pose P5*

One Year Aging

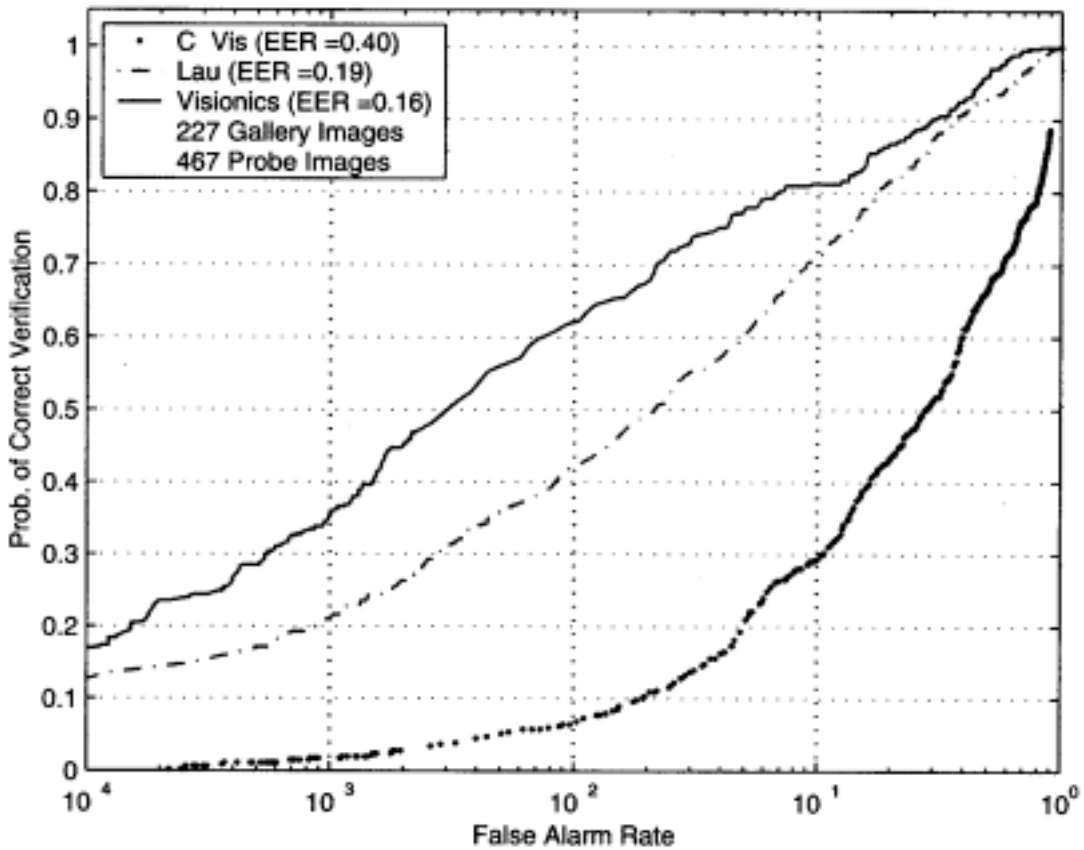

Figure M–54: *Verification Scores—Temporal T4*

DERA-BAA Test

- Heathrow Airport, Terminal 3
- Down escalator
- Single file
- Camera at 25 feet
- Clock and flashing light

Heathrow Airport (1999)

DERA Conclusions

- “Face recognition can act as an aid to surveillance and database searches
- But the full benefit gained would depend on the extent to which the installation were optimized to capture images and the staffing levels in operation

Recommended Operating Conditions

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- Passengers looking directly into cameras
- Diffuse, frontal lighting
- An interocular distance of at least 50 pixels for face images
- High quality search or watch list images of targets
- Surveillance watch lists restricted in number to reflect system performance”

Army Research Lab Face and Iris Test

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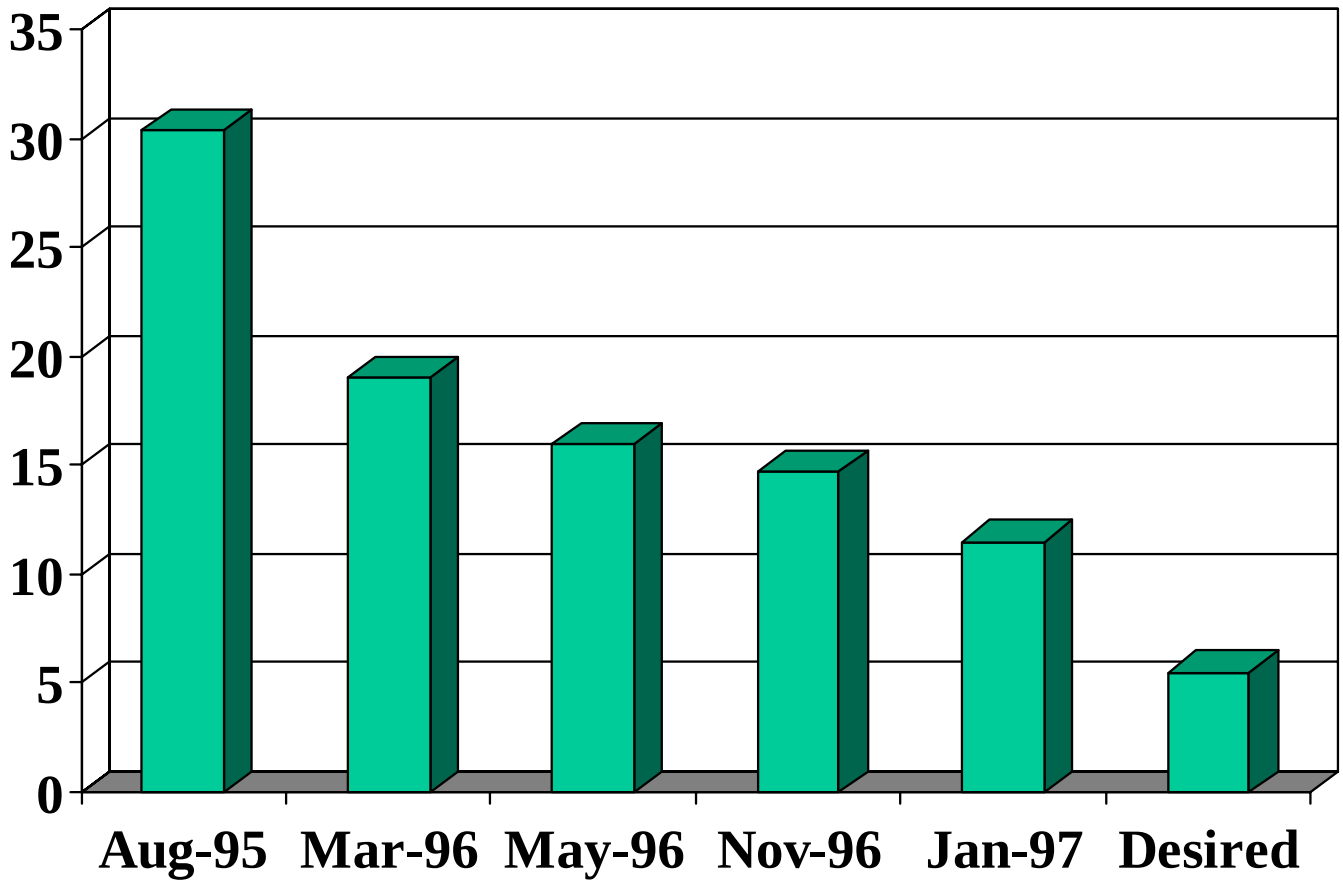
- Iris
  - FRR
    - one eye: 6%
    - Either eye: 1-2%
  - 15 sec acquisition time
  - 2 potential false matches

www.itl.nist.gov/div895/isis/bc2001/FINAL_BCFEB02/

Disney Access Time Improvement



Warren and Brandeis (Harvard Law Review,1890)

The right to life has evolved to mean "the right to enjoy life **- the right to be let alone**; the right to liberty secures the right to extensive civil privileges; and the term 'property' has grown to comprise every form of possession -- intangible as well as tangible".

Warren and Brandeis (Harvard Law Review,1890)

- "The principle which protects personal writings and all other personal productions, not against theft and physical appropriation, but against publication in any form, is in reality not the principle of private property but that of an inviolate personality"

Privacy in the Information Age

- The right to privacy is the right of an individual to decide for himself or herself when and on what terms his or her attributes should be revealed.

-- based on Alan Westin, Privacy and Freedom, (Atheneum, Boston, 1967)

Fundamental Principles of Biometric Measures

- Hard to obtain and cannot be continuously tracked;
- Private, but not secret;
- Can be stolen, but supervised use of stolen measure requires mechanical assistance;
- Cannot be revoked;
- Contain limited additional information
- Can be used (with difficulty) to link records
- Weak identifier compared to SSN, phone or CC #
- Weak identifiers ^{N} = strong identification
- = mother's maiden name?
- considered by NAS Committee on "Authentication Technologies and their Implications for Privacy"

BIOMETRIC DEVICES CANNOT DETERMINE:

- Name
- Age
- Race
- Birth place
- Health
- Citizenship
- Gender*
- Income


GOLD S
City of Inverness
Thumbprint Signature Scheme
Why Give Your Thumbprint Signature?
• Cheque & credit card fraud costs you £100 a year.
• Criminals steal your identity to get your money.
• A thumbprint signature is beyond any fraudster, protecting your money and identity.
• There is NO SECRET DATA BASE.
MONDA
TUESDA
WEDNE
THURSI
FRIDAY
SATURI
SUNDA