Biometric Identification:
*Operation, Applications, Issues*

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Newsflash!

- eight fingerprints and face required to get new US Visa
- New ICAO passport standard requires biometric data in document
- UK will issue biometric based ID card
Newsflash - Canada

☐ Canadian passport office did large project to analyze face recognition technologies in 2003

☐ Department of Transport is piloting Iris recognition for airports

☐ CCRA had “biometrics forum” Nov. 2003

☐ Alberta implemented a face recognition based driver’s licence

☐ Ontario considers iris recognition based driver’s license
What are Biometrics

Automatic identification of an individual based on behavioural or physiological characteristics
What are Biometrics

Automatic identification of an individual based on behavioural or physiological characteristics

Computer based ie. fast

Forensics is the science of humans identifying humans
What are Biometrics

Automatic
identification
of an
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physiological
characteristics

Two types:
1. Verification
2. Identification
What are Biometrics

Automatic identification of an individual based on behavioural or physiological characteristics

Biometrics is only about identity of individual. Other technologies manage security
What are Biometrics

Automatic identification of an individual based on **behavioural** or physiological characteristics

**Behavioural biometrics:**
- Gait
- Voice
- Typing dynamics
- Signature
What are Biometrics

Automatic identification of an individual based on behavioural or physiological characteristics

Physiological Biometrics
- Fingerprint
- Face
- Iris
- Retina
- Hand Geometry
- Dental shape
- DNA
...
Brief History

- 1980’s: Automated fingerprint for FBI AFIS
- Early 1990’s: National ID use
  - INSPASS/CANPASS system
- Mid 1990’s: Biometrics became cheap
  - Fingerprint scanners <$1000 in 1997
- Mid 1990’s-2001: Commercial focus
  - Biometrics business have not (yet) seen significant uptake
Biometrics Processing

- Biometric “Enrolled Image” → Feature Extraction → Template → Biometric Compare → Match Score → Threshold → Decision
- Biometric “Live Image” → Feature Extraction → Template → Biometric Compare

0.5 kB → A scalar

Many kB
Biometrics Verification

Question:
Are you who you say you are?

Test:
- Subject shows ID with claimed identity
- Compare live image to enrolled image for claimed identity => Calculate match score
- Compare match score to threshold. Make decision
Biometrics Verification

Also called:
- 1:1 comparison

Applications:
- Verification of passport holder
- Bank card / credit card verification at point of sale
- Time and attendance
Verification **Testing**

Two possible errors

- False Match (rate is FMR).
  - Also False Accept (FAR)
- False Non-Match (rate is FNMR)
  - Also False Reject (FRR)

Aside: FAR, FRR are *application* measurements. They don’t necessarily refer to pure biometric events
Biometrics Interpretation

Face Recognition results on NIST Mugshot DB

I don’t have access to the 2003 version of the software; it’s reportedly better.

Equal Error Rate
Biometrics Identification

Questions:
  Are you not who you say you are not?
  Are you a person we’re looking for?

Test:
- Subject does not present ID
- Compare live image to enrolled image for all records in DB => Calculate match score
- Sort match score for all records. Display top candidates.
Biometrics **Identification**

**Also called:**
- 1:N comparison
- Watch list comparison

**Applications:**
- Biometric only access control
- Detect duplicate application for government benefits
- Watch list comparison
Identification Testing

Identification is a much more difficult problem. Typically preprocessing is used to “bin” records rather than compare all.

Basic Measure:
- Cumulative Match Curve (CMC).

We will find target if we check all records

![Graph showing the probability of finding a target versus the number of records checked.](image-url)
Biometrics **Verification**

Many successful implementations:

- Required processing is low
- Distributed architecture
  - Template can be carried on ID card
- Cheating is more difficult
  - Need to look like another person, rather than different from yourself
- A well designed system offers incentives to users
Biometrics Verification

Some problems with verification

- Enrollment:
  - Need to “train” users for equipment.
  - Enrolled image is most important, but users are least trained
  - Template ageing => need to re-enroll.
Biometrics Verification

Some problems with verification

- Choice of threshold:
  - High FMR irritates valid users
  - High FNMR compromises security
  - How to weigh costs?

- Staff fatigue:
  - If FMR is 1:1000, and “bad people” are 1:10,000
  - good:bad people =10:1 at security
Biometrics **Identification**

No current large scale successes:

- Required processing is high
- Centralized architecture
- Cheating is easier
  - Need to look unlike yourself
  - Dependent on accurate central DB data
  - How to enroll the “bad guys”?
- How to offer incentives to valid users?
Identification **issues**

- **Adequacy of data:**
  - US VISIT: Are 8 fingerprints enough to distinguish 6 billion people?
  - How to ensure adequate quality data?

- **Staff fatigue:**
  - “bad people” are 1:10,000
  - If FMR is 1:10 billion, and DB size is 100 million
  - good:bad people =100:1 at security
Technologies: Fingerprint

- Numerous algorithm and capture devices
- Standardized storage formats, APIs
- Well regarded independent tests
- Independent research community
- Successful implementations
  - Only truly mature biometric technology
  - Many people (2-5%) don’t have fingerprints
  - Criminal implications
Technologies: Face Recognition

- Numerous algorithm and capture devices
- Well regarded independent tests
- Independent research community
- Ease of enrolment (even unwilling)
- Well accepted by people
- However, error rates are high
Technologies: Iris recognition

- Numerous algorithm and capture devices
- Standardized storage formats, APIs
- Well regarded independent tests
- Independent research community
- Successful implementations

- Error rates in the 1:billion
- Possible distance data capture
- I suspect it may not work as well as claimed

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Other technologies

- Lots of other biometrics:
  - Voice
  - Gait
  - 3D face recognition
  - Typing dynamics
  - ...

- Many have lots of potential
- However, it takes 10 years for a technology to become mature
Issues that need research

- Better performing algorithms
  - Better feature detection
  - Better feature extraction

- Combination biometrics
  - What’s the best way to use results from different vendors and different algorithms
  - What’s the best way to use other information (eg. biographical)
Issues that need research

- Proper studies of performance
  - Operational assessment
  - Large database tests
  - Template ageing
  - How does it compare to human performance?

- Privacy and security analysis
  - Biometric processing and data storage is complicated. What are the weak points?
Security issues

Fraudulent Enrollment

Biometric "Enrolled Image" → Feature Extraction → Template DB → Extract image from template

Database integrity

Template → Biometric Compare → Match Score

Confusing value

Threshold → Decision

Replay Attack

Biometric "Live Image" → Feature Extraction → Template

Lookalike Change Appearance

Confuse Algorithm (tilt head, Squash finger)

Fatigued operator
Security issues: continued

- Biometrics only provide identity
- These systems are also vulnerable to all of the traditional security threats
- Advantage is that people don’t need to remember passwords
- However, even though there are good crypto solutions to replay, I predict this will become a serious issue.
Privacy issues

- There are widespread privacy concerns about biometrics.
- This is not really a biometrics issue. Governments have proved themselves irresponsible with personal data. Now people are stonewalling.
- Have you ever checked your credit record? Mine is about 25% inaccurate.
Epilogue: Our future?

Operator: "Thank you for calling Pizza Hut."

Customer: “Two All-Meat Special..."

Operator: "Thank you, Mr. Sheehan. Your voice print verifies with your National ID Number: 6102049998"

Customer: (Sighs) "Oh, well, I'd like to order a couple of your All-Meat Special pizzas..."

Operator: "I don't think that's a good idea, sir."

Customer: "Whaddya mean?"

Operator: "Sir, your medical records indicate that you've got very high blood pressure and cholesterol. Your Health Care provider won't allow such an unhealthy choice."

Customer: "Darn. What do you recommend, then?"
Epilogue:

Operator: "You might try our low-fat Soybean Yogurt Pizza. I'm sure you'll like it"

Customer: "What makes you think I'd like something like that?"

Operator: "Well, you checked out 'Gourmet Soybean Recipes' from your local library last week, sir."

Customer: “OK, lemme give you my credit card number."

Operator: "I'm sorry sir, but I'm afraid you'll have to pay in cash. Your credit card balance is over its limit."

Customer: "@#$%/$@$?#!"

Operator: "I'd advise watching your language, sir. You've already got a July 2006 conviction for cussing ... "