Understanding Biometrics

3. Types of Biometrics

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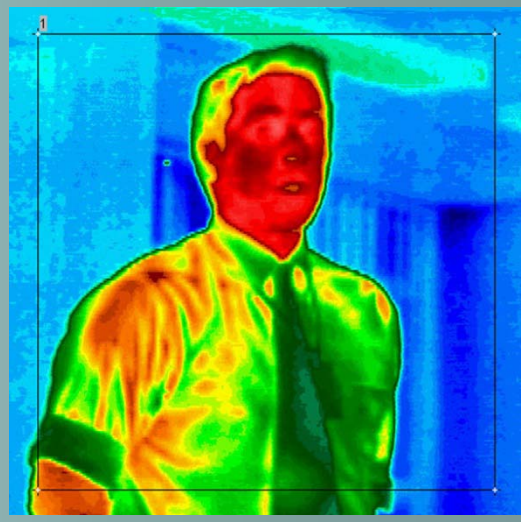
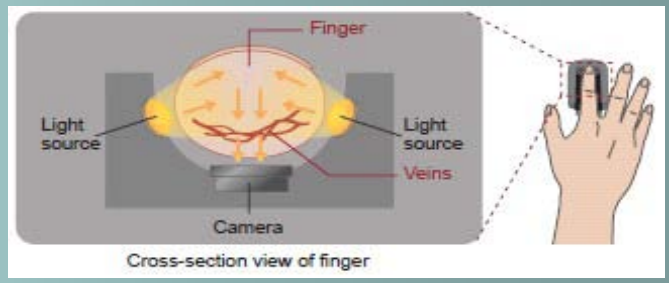
Types (modalities) of biometrics

- Physiological
  - Fingerprint
  - Face
  - Iris
  - Retina
  - Hand geometry
  - DNA
- Behavioral
  - Voice
  - Gait
  - Keystroke dynamics
  - Signature

Exotic stuff!



- Thermograms
- Ear lobe
- Palm/finger vein
  - www.fujitsu.com/global/about/rd/200506palm-vein.html
  - www.hitachi.co.jp/Prod/comp/fingervein/global
- Body odor
  - www.it.lut.fi/kurssit/03-04/010970000/seminars/Korotkaya.pdf
- Heart signal
  - www.idesia-biometrics.com/index.html



Fingerprint

- Perhaps the oldest biometric used widely
  - 1892: Sir Francis Galton statistically analyzed fingerprints.
  - 1892: Juan Vucetich, a Argentine police officer, successfully used fingerprint to convict a woman for murdering her two sons.
- Now standard in police investigations
- Based on *minutiae*: ridge discontinuity
- Sensors:
  - optical, capacitance, pressure, ultrasound

Fingerprint

- Pros
  - Well-established
  - Large databases avail.
  - Cheap sensors
  - Highly accurate: 0.1% false reject, 1% false accept [FpVTE 2003]
- Cons
  - Stigma: associated with criminals or illiterate
  - Hygiene concerns
  - Wear and tear in fingerprint, as well as sensor
  - Failure to enroll

Fingerprint: stories

- After the **2004 Madrid train bombings**, American lawyer Brandon Mayfield was arrested by FBI
  - "100 percent positive" and "absolutely incontrovertible match"
  - Mayfield married Egyptian woman, convert to Islam
  - Problem: Never been to Spain in 11 years
- **Spanish Police** finally caught another man
  - FBI released Mayfield after 2 weeks in jail
- 29/11/06: US govt **apologized** and paid him US$2M

  www.nytimes.com/2006/11/30/us/30settle.html?ex=1322542800&en=0450419c94570958&ei=5088&partner=rssnyt&emc=rss

Face

- “Human readable”
- 1966: Bledsoe, Chan, Bisson first to try automatic face recognition.
- Gained popularity after Sept. 11, 2001
  - London Borough of Newham
  - Boston’s Logan Airport
  - ICAO passport standard
- Technologically less mature than fingerprint
  - No good features yet found
- Sensor: cameras
- Variations: 3D face scans, NIR, thermograms

Face

- Pros
  - Cheap sensors
  - User acceptance
  - Contactless
  - Non-intrusive
  - Good for mass screening
  - Human readable
- Cons
  - Not accurate enough
  - Susceptible to aging
  - Easy to thwart: disguise
  - Privacy abuse

Face: stories

- Immediately after Sept. 11, stock prices of face recognition vendors **skyrocketed**, then **plummeted** within a few months.
- **Privacy advocates**, such as the ACLU, had a field day denouncing the technology and trumpeting its failures.
- **10 Nov. 2005: Smiling Germans ruin biometric passport system**
  - This is no laughing matter. *By Robert Jaques, vnunet.com*
  - Germany started issuing biometric 'ePass' passports a week ago but has had to issue guidelines warning that people "must have a neutral facial expression and look straight at the camera". Visible teeth are apparently also a problem.

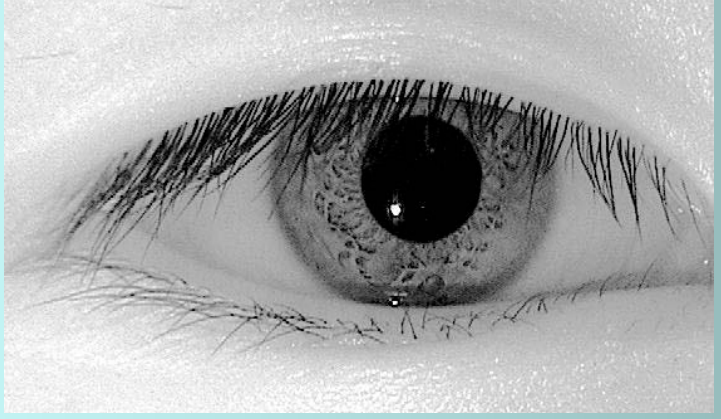
Voice

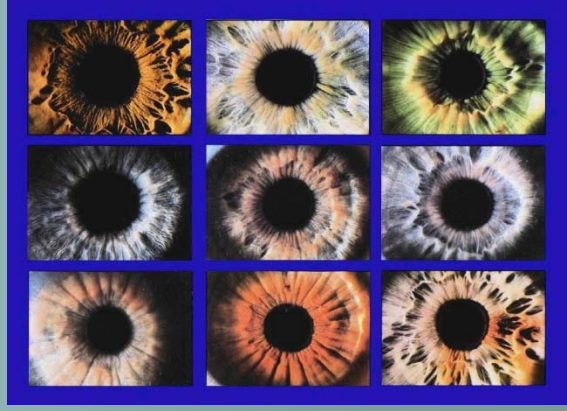
- a.k.a. speaker identification
- ***Not*** speech recognition
  - Speech recognition identifies the **words** that are spoken.
  - Voice recognition identifies the **speaker**.
- Human readable
- Word-independence possible
- Sensors: microphone, telephone

Voice

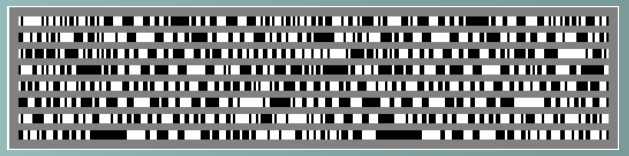
- Pros
  - Leverages existing infrastructure
  - User acceptance
  - Non-intrusive
  - Human readable
- Cons
  - Not accurate enough
  - Easy to thwart: voice imitation
  - Machine voice creates nonexistent identities

Iris





- Pattern on the front of the eye
- Iriscode: feature extracted from iris
  - John Daugman
  - http://www.cl.cam.ac.uk/~jgd1000

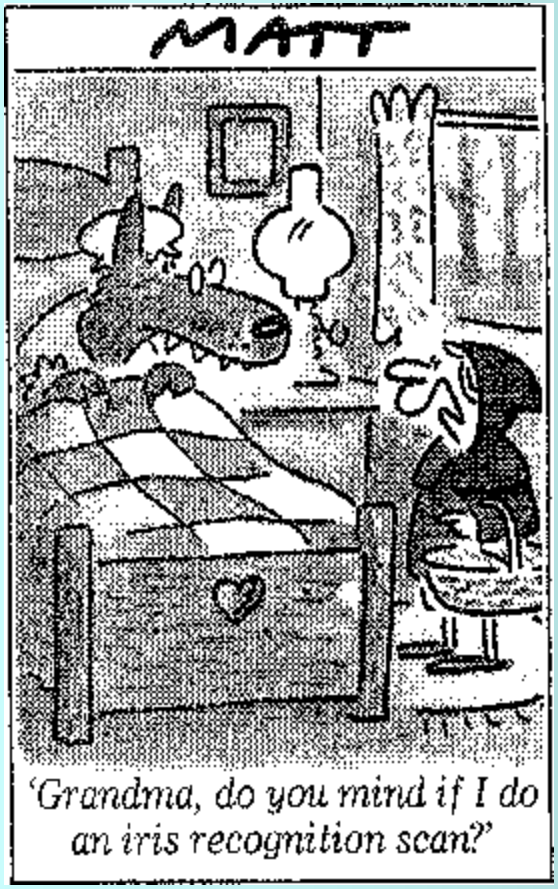


- Sensor: uses infrared light + camera
- Deployed in:
  - Airports: Boston, Tokyo, Milan, UAE
  - Bank ATMs
- Can be combined with face recognition

Iris

- Pros
  - Very low false accept rate
  - Hard to spoof
  - No stigma
- Cons
  - Specialized hardware
  - Hard to use
  - Users may be squirmish

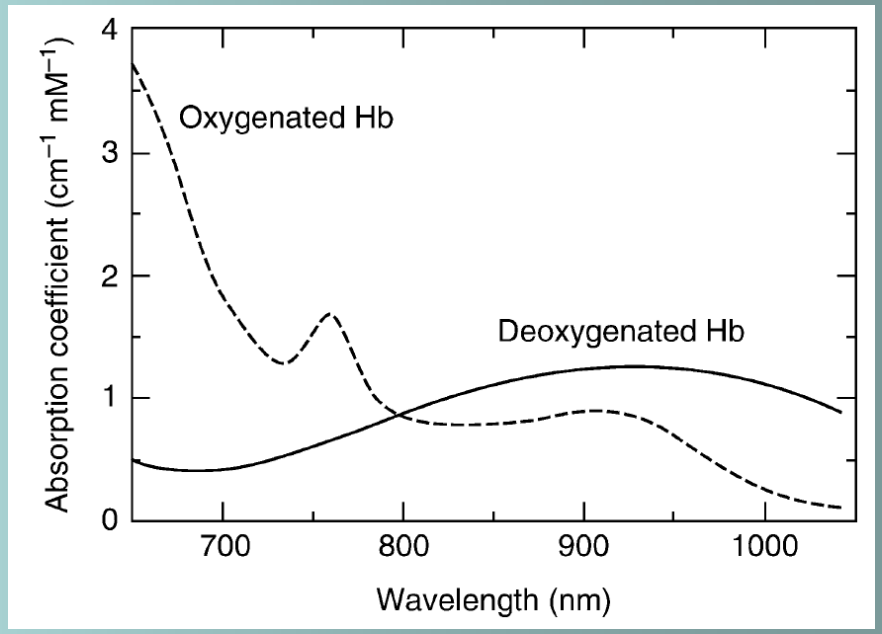
Iris: cartoons



- http://www.cl.cam.ac.uk/~jgd1000/cartoons.html

Vascular

- Artery and Vein patterns
- Arteries:
  - primarily oxygenated blood
  - Use near infrared (NIR) wavelength 760nm
- Veins:
  - primarily deoxygenated blood
  - NIR wavelength 850nm



Vascular

- Pros
  - Highly distinctive
  - Contactless
  - Non-intrusive
  - Hard to forge
- Cons
  - Cost
  - Reveals some medical condition,
    - e.g. pregnancy
  - ???