Biometric Authentication

Vitaly Shmatikov
Biometric Authentication

- Nothing to remember
- Passive
  - Nothing to type, no devices to carry around
- Can’t share (usually)
- Can be fairly unique
  - ... if measurements are sufficiently accurate
Identification vs. Authentication

◆ Goal: associate an identity with an event
  • Example: a fingerprint at a crime scene
  • Key question: given a particular biometric reading, does there exist another person who has the same value of this biometric?

◆ Goal: verify a claimed identity
  • Example: fingerprint scanner to enter a building
  • Key question: do there exist any two persons who have the same value of this biometric?
    – Birthday paradox!
Problems with Biometrics

- Private, but not secret
  - Biometric passports, fingerprints and DNA on objects...
- Even random-looking biometrics may not be sufficiently unique for authentication
  - Birthday paradox!
- Potentially forgeable
- Revocation is difficult or impossible
Forging Handwriting

[Ballard, Monrose, Lopresti]

Generated by computer algorithm trained on handwriting samples
Biometric Error Rates (Benign)

◆ “Fraud rate” vs. “insult rate”
  • Fraud = system accepts a forgery (false accept)
  • Insult = system rejects valid user (false reject)

◆ Increasing acceptance threshold increases fraud rate, decreases insult rate

◆ For biometrics, U.K. banks set target fraud rate of 1%, insult rate of 0.01% [Ross Anderson]
  • Common signature recognition systems achieve equal error rates around 1% - not good enough!
Biometrics (1)

◆ Face recognition (by a computer algorithm)
  • Error rates up to 20%, given reasonable variations in lighting, viewpoint and expression

◆ Fingerprints
  • Traditional method for identification
  • 1911: first US conviction on fingerprint evidence
  • U.K. traditionally requires 16-point match
    – Probability of a false match is 1 in 10 billion
    – No successful challenges until 2000
  • Fingerprint damage impairs recognition
    – Ross Anderson’s scar crashes FBI scanner
Biometrics (2)

◆ Iris scanning
  - Irises are very random, but stable through life
    - Different between the two eyes of the same individual
  - 256-byte iris code based on concentric rings between the pupil and the outside of the iris
  - Equal error rate better than 1 in a million

◆ Hand geometry
  - Used in nuclear premises entry control, INSPASS (discontinued in 2002)

◆ Voice, ear shape, vein pattern, face temperature
Biometrics (3)

Identifies wearer by his/her unique heartbeat pattern.
Biometrics (4)

“All you need to do is sit”

“Forget Fingerprints: Car Seat IDs Driver’s Rear End”

360 disc-shaped sensors identify a unique “buttprint” with 98% accuracy

¥70,000

[Advanced Institute of Industrial Technology, Japan]
Biometrics (5)

I AM MORDAC, THE PREVENTER OF INFORMATION SERVICES, AND I BRING YOU MY NEWEST BIOMETRIC SCANNER.

INSTEAD OF A PASSWORD, I PUT THIS ON YOUR HEAD AND SQUEEZE UNTIL YOU SCREAM IN A WAY THAT ONLY YOU CAN SCREAM.

NO, THAT'S NOT YOU.

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Risks of Biometrics

◆ Criminal gives an inexperienced policeman fingerprints in the wrong order
  • Record not found; gets off as a first-time offender

◆ Can be cloned or separated from the person
  • Ross Anderson: in countries where fingerprints are used to pay pensions, there are persistent tales of “Granny’s finger in the pickle jar” being the most valuable property she bequeathed to her family

◆ Birthday paradox
  • With the false accept rate of 1 in a million, probability of a false match is above 50% with only 1609 samples
Surgical Change

'B Fake fingerprint' Chinese woman fools Japan controls

A Chinese woman managed to enter Japan illegally by having plastic surgery to alter her fingerprints, thus foiling immigration controls, police claim.

Lin Rong, 27, had previously been deported from Japan for overstaying her visa. She was only discovered when she was arrested on separate charges.

Tokyo police said she had paid $15,000 (£9,000) to have the surgery in China.

It is Japan's first case of alleged biometric fraud, but police believe the practice may be widespread.

Japanese police suspect Chinese brokers of taking huge sums to modify fingerprints surgically.

Local media reports said Ms Lin had undergone surgery to swap the fingerprints from her right and left hands.

Skin patches on her thumbs and index fingers were removed and then re-grafted on to the matching digits of the opposite hand.

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Stealing Biometrics

Malaysia car thieves steal finger

By Jonathan Kent
BBC News, Kuala Lumpur

Police in Malaysia are hunting for members of a violent gang who chopped off a car owner’s finger to get round the vehicle’s hi-tech security system.

The car, a Mercedes S-class, was protected by a fingerprint recognition system.

Accountant K Kumaran's ordeal began when he was run down by four men in a small car as he was about to get into his Mercedes in a Kuala Lumpur suburb.
Involuntary Cloning

Clone a biometric without victim’s knowledge or assistance

“my voice is my password”

cloned retina

Fingerprints from beer bottles
Eye laser scan

Bad news: it works!
Cloning a Finger

Making an Artificial Finger from a Residual Fingerprint

Materials

A photosensitive coated Printed Circuit Board (PCB)
“10K” by Sanhayato Co., Ltd.

Solid gelatin sheet
“GELATINE LEAF”
by MARUHA CORP

320 JPY/sheet

200 JPY/30 grams
Cloning Process

Residual Fingerprint
- Enhancing
- Capturing

Image Processing

Fingerprint Image
- Printing
- Mask
- Exposing
- Developing
- Etching

Mold

Cyanoacrylate Adhesive

Adobe Photoshop 6.0

Digital Microscope
- KEYENCE VH6300: 900k pixels

Inkjet Printer
- Canon BJ-F800: 1200x600dpi

Transparent Film

UV light

Photosensitive Coated PCB

Yokohama Nat. Univ. Matsumoto Laboratory
Fingerprint Image

An Enhanced Fingerprint  A Fingerprint Image  A Mask with Fingerprint Images
Molding

Gelatin Liquid

Drip the liquid onto the mold.

Put this mold into a refrigerator to cool, and then peel carefully.
The Mold and the Gummy Finger

Mold: 70 JPY/piece
(Ten molds can be obtained in the PCB.)

Gummy Finger: 50 JPY/piece

[Matsumoto]
Side By Side

Pores can be observed.

**Enhanced Fingerprint**

**Captured Fingerprint Image of the Gummy Finger with the device H (a capacitive sensor)**
Play-Doh Fingers

◆ Alternative to gelatin
◆ Play-Doh fingers fool 90% of fingerprint scanners
  • Clarkson University study
◆ Suggested perspiration measurement to test “liveness” of the finger

[Schuckers]