

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, Monroe, Lopresti]

graphic language target	crisis management target	solo concert target
graphic language human forgery	crisis management human forgery	solo concert human forgery
graphic language generative forgery	crisis management generative forgery	solo concert generative forgery

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)

The advertisement features a black smartwatch with a white display and four sensors on the back. The background is a teal gradient with a faint heart rate line. The NYMI logo, consisting of a heart rate icon and the word 'nymi', is in the top left. The text 'PUT YOUR HEART INTO IT' is centered, followed by 'SAY GOODBYE TO PASSWORDS, PINS, AND EVEN KEYS AND CARDS.' Below this is a thin heart rate line. At the bottom, it says 'PRE-ORDER NOW FOR \$79 VISIT GETNYMI.COM'.

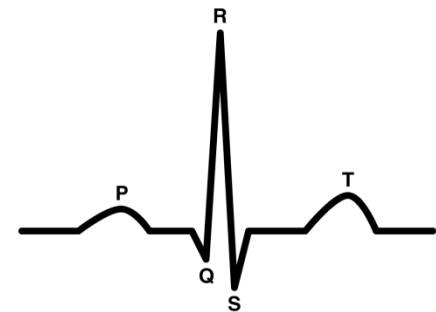
nymi

PUT YOUR HEART INTO IT

SAY GOODBYE TO PASSWORDS, PINS, AND EVEN KEYS AND CARDS.

PRE-ORDER NOW FOR \$79
VISIT GETNYMI.COM

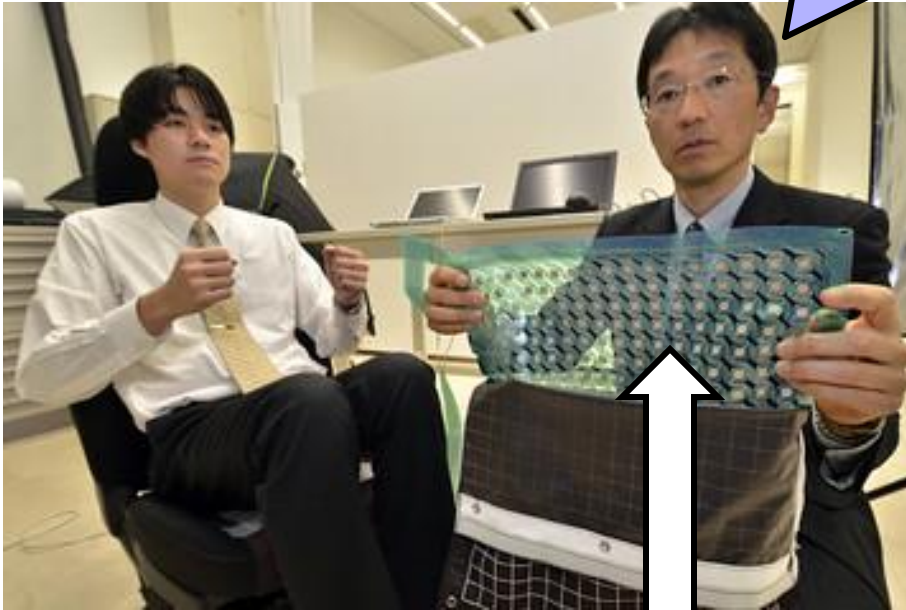
Identifies wearer by his/her unique heartbeat pattern



Biometrics (4)

[Advanced Institute of Industrial Technology, Japan]

"All you need to do is sit"

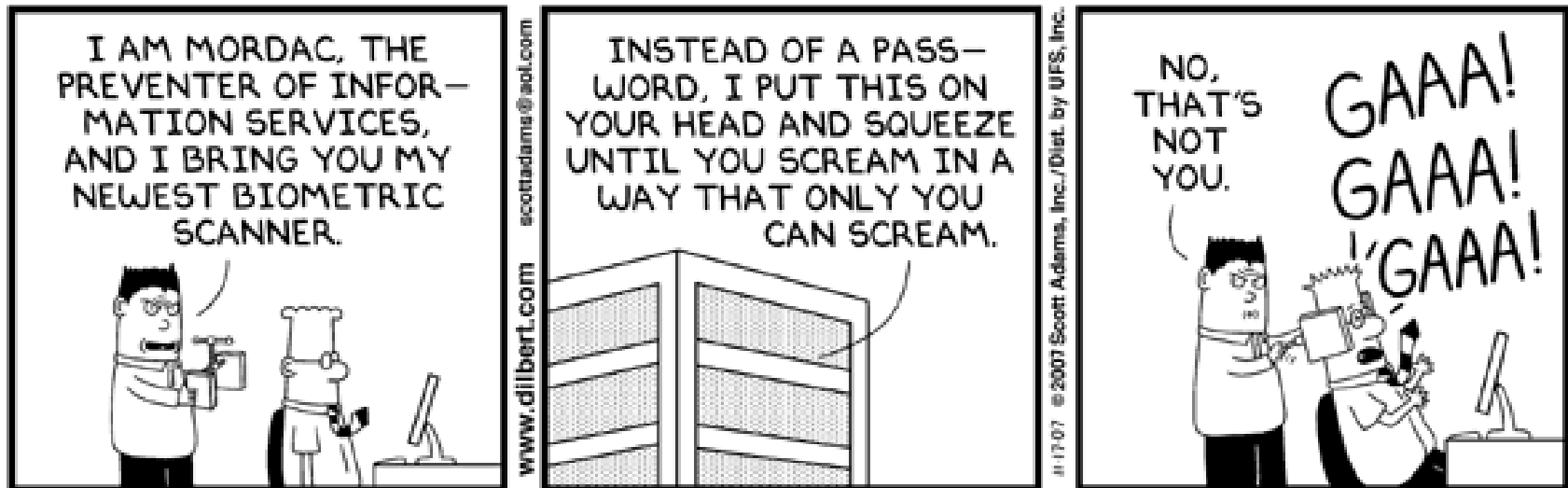


"Forget Fingerprints:
Car Seat IDs Driver's
Rear End"

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

¥70,000

Biometrics (5)



© Scott Adams, Inc./Dist. by UFS, Inc.

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

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Page last updated at 18:27 GMT, Monday, 7 December 2009

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'Fake fingerprint' Chinese woman fools Japan controls

A Chinese woman managed to enter Japan illegally by having plastic surgery to alter her fingerprints, thus fooling 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.

SEE ALSO

- Japan ups checks for foreigners 20 Nov 07 | Asia-Pacific

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Stealing Biometrics

The screenshot shows a web browser window displaying a BBC News article. The browser's address bar shows the URL: <http://news.bbc.co.uk/2/hi/asia-pacific/4396831.stm>. The page title is "BBC NEWS | Asia-Pacific | Malaysia car thieves steal finger - Windows". The article is dated Thursday, 31 March, 2005, at 10:37 GMT 11:37 UK. The headline is "Malaysia car thieves steal finger" by Jonathan Kent, a BBC News reporter in Kuala Lumpur. The article text states: "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."

BBC NEWS | Asia-Pacific | Malaysia car thieves steal finger - Windows

← → **BBC** <http://news.bbc.co.uk/2/hi/asia-pacific/4396831.stm>

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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.

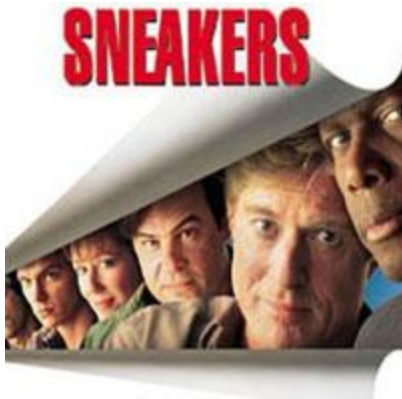
The car, a Mercedes S-class, was protected by a fingerprint recognition system.

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.

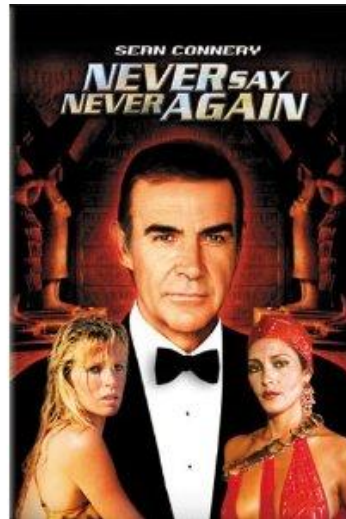
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Involuntary Cloning

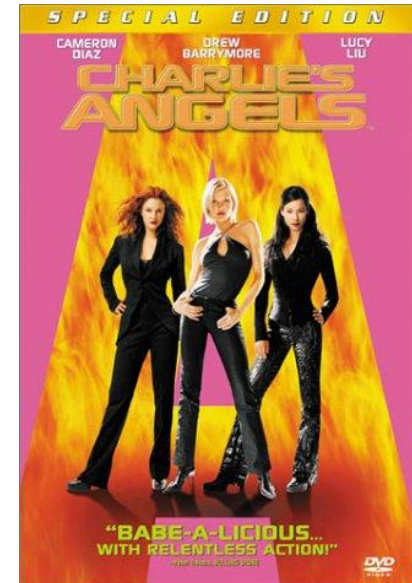
Clone a biometric without victim's knowledge or assistance



"my voice is my password"



cloned retina



Fingerprints from
beer bottles
Eye laser scan

Bad news: it works!

Cloning a Finger

[Matsumoto]

Making an Artificial Finger from a Residual Fingerprint

Materials

A photosensitive coated Printed Circuit Board (PCB)

“10K” by Sunhayato Co., Ltd .



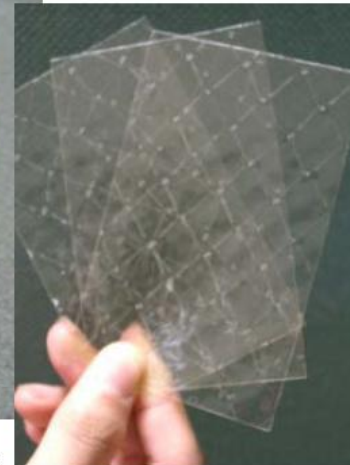
320JPY/sheet



Solid gelatin sheet
“GELATINE LEAF ”
by MARUHA CORP

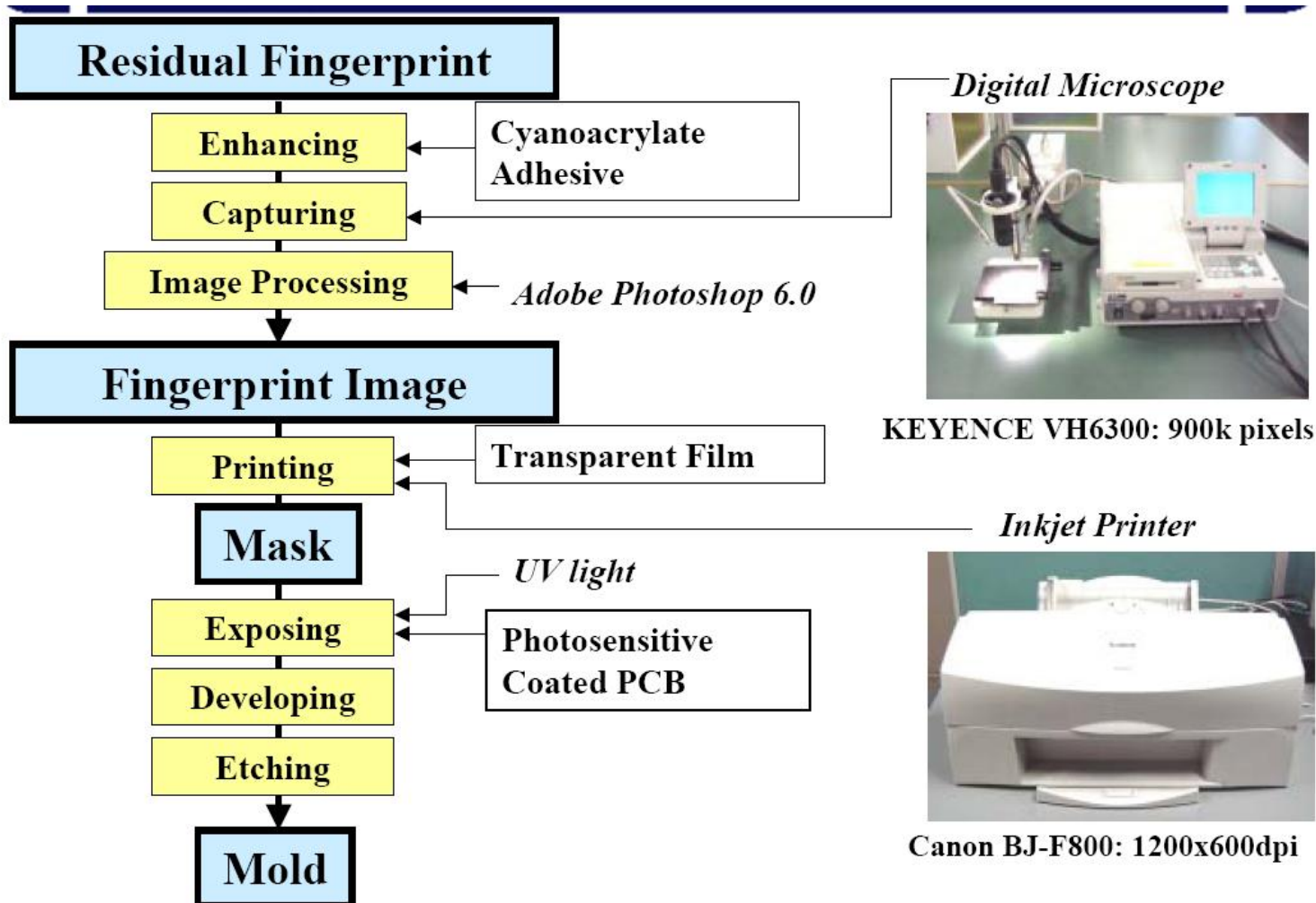


200JPY/30grams



Cloning Process

[Matsumoto]



Fingerprint Image

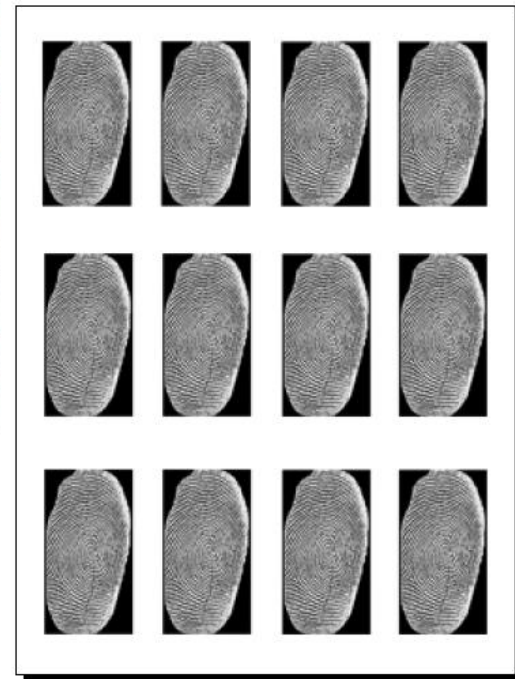
[Matsumoto]



An Enhanced Fingerprint



A Fingerprint Image

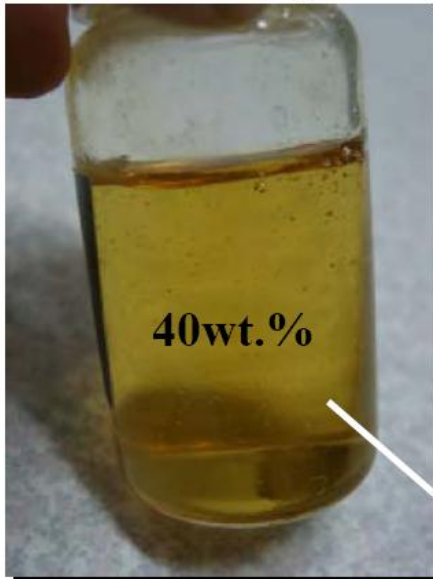


A Mask with Fingerprint Images

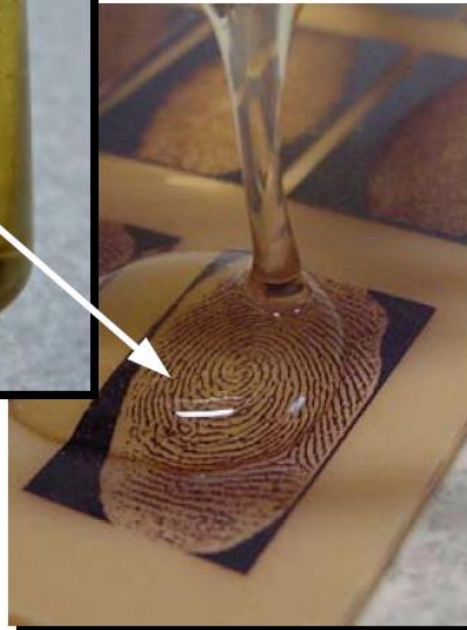
Molding

[Matsumoto]

Gelatin Liquid



Drip the liquid onto the mold.



Put this mold into a refrigerator to cool, and then peel carefully.

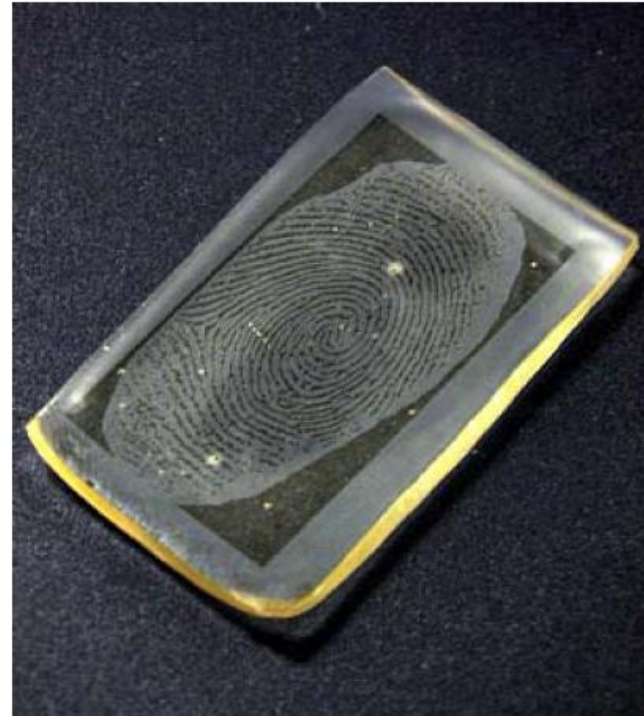


The Mold and the Gummy Finger

[Matsumoto]



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



Gummy Finger: 50JPY/piece

Side By Side

[Matsumoto]

Pores can be observed.



Enhanced Fingerprint



Captured Fingerprint Image of
the Gummy Finger
with the device H (a capacitive sensor)

Play-Doh Fingers

[Schuckers]

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

