

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

Identification: 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?

Authentication: 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?
 - Collisions are more frequent than you might think (birthday paradox!)

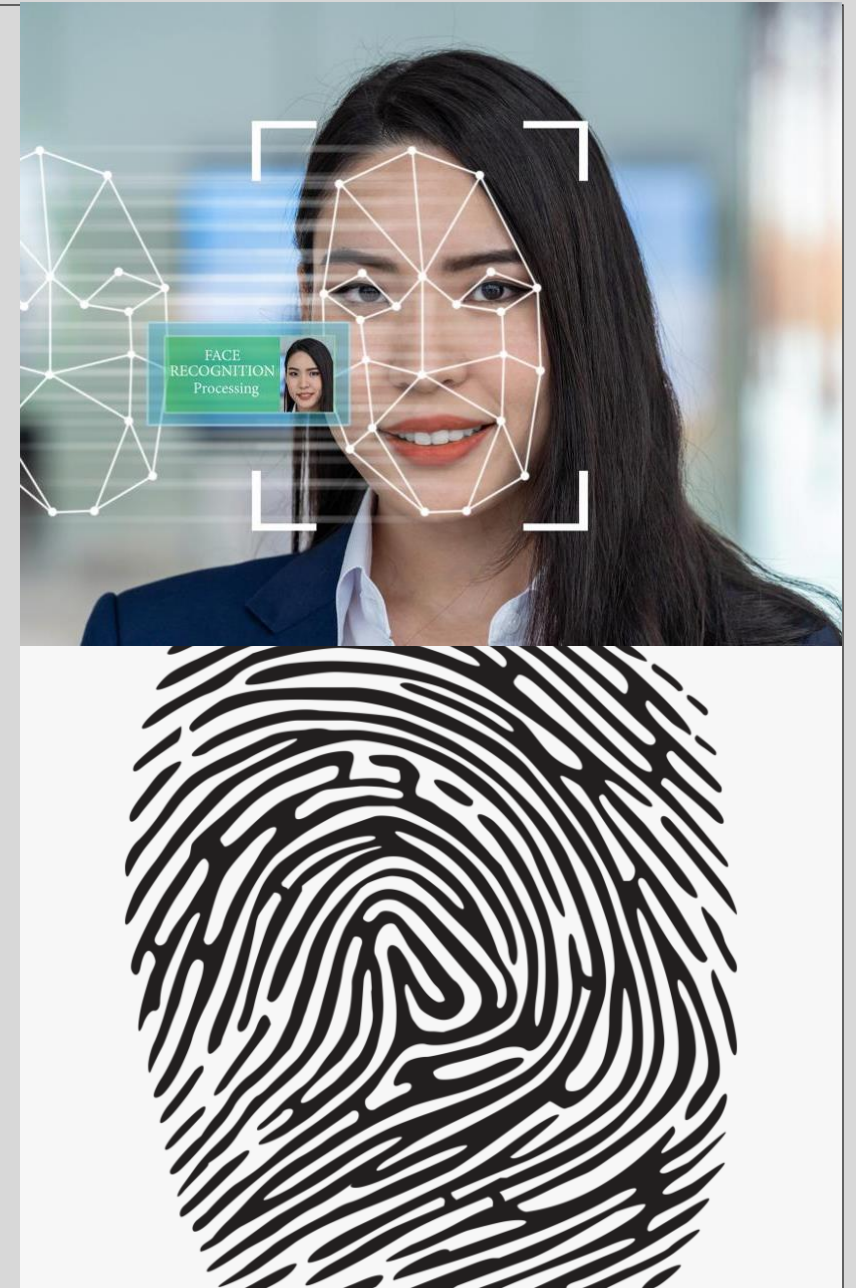
Biometrics (1)

Face recognition (by a computer algorithm)

- Error rates up to 20%, given reasonable variations in lighting, viewpoint, 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



The IRS website will soon require facial recognition to log in to your account

using ID.me, a third-party service

‘A big deal, and it’s bad’: IRS facial scanning plan raises privacy fears

Treasury Weighing Alternatives to ID.me Over Privacy Concerns

- Taxpayers filing online had to verify identity with a selfie
- Research shows AI-driven technology suffers from racial bias

Biometrics (2)

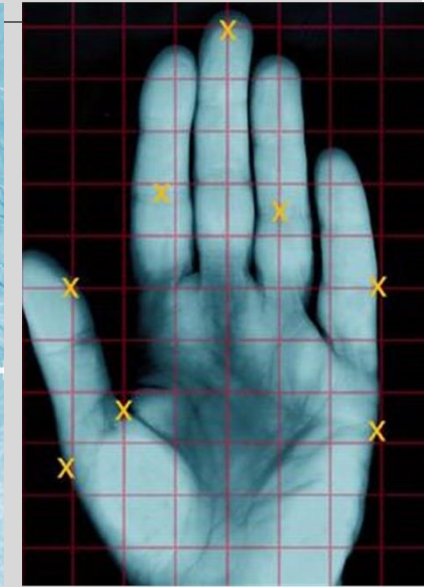
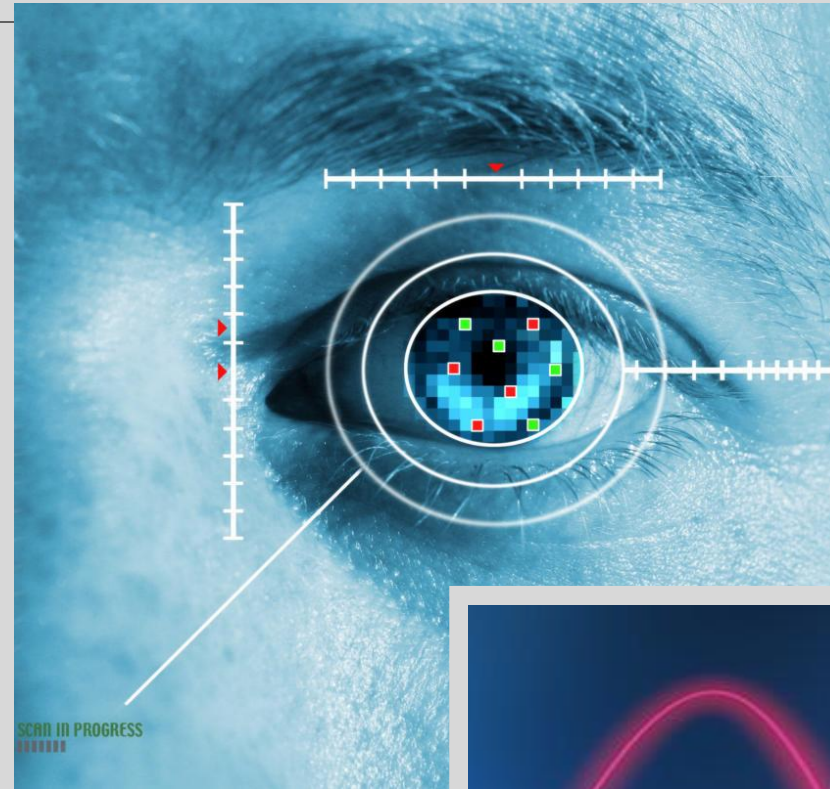
Iris scanning

- Irises are very random (different even in the same individual), but stable through life
- 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

- Nuclear premises entry control

Voice, ear shape, vein pattern, face temp



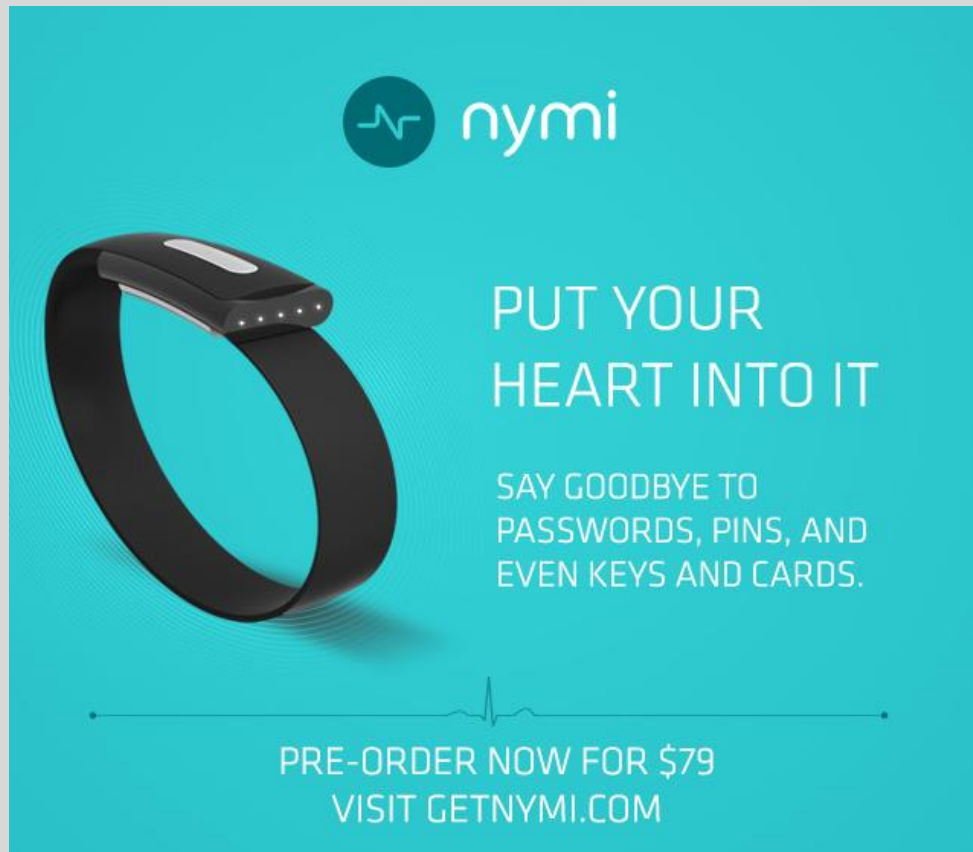


Amazon One

A **fast, FREE identity service** that allows you to enter, identify, and pay using only your palm.

Use it at Whole Foods, Amazon Go stores, some sports arenas...

Biometrics (3)



The advertisement features a teal background. In the top left, there is a circular logo with a white ECG line and the word "nymi" in white lowercase letters. To the left of the text is a black wristband with a white sensor on the back. The text "PUT YOUR HEART INTO IT" is written in white, all-caps, bold font. Below it, in a smaller white font, is "SAY GOODBYE TO PASSWORDS, PINS, AND EVEN KEYS AND CARDS." At the bottom, a white ECG line is shown, with the text "PRE-ORDER NOW FOR \$79 VISIT GETNYMI.COM" in white, all-caps font.

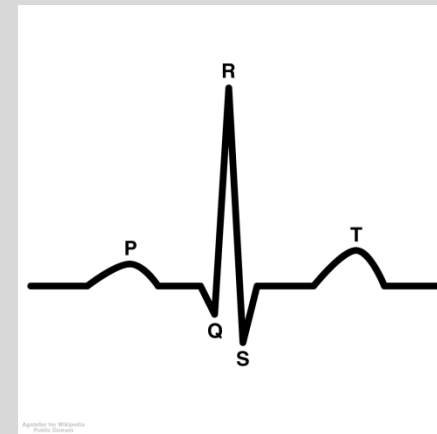
nymi

PUT YOUR HEART INTO IT

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

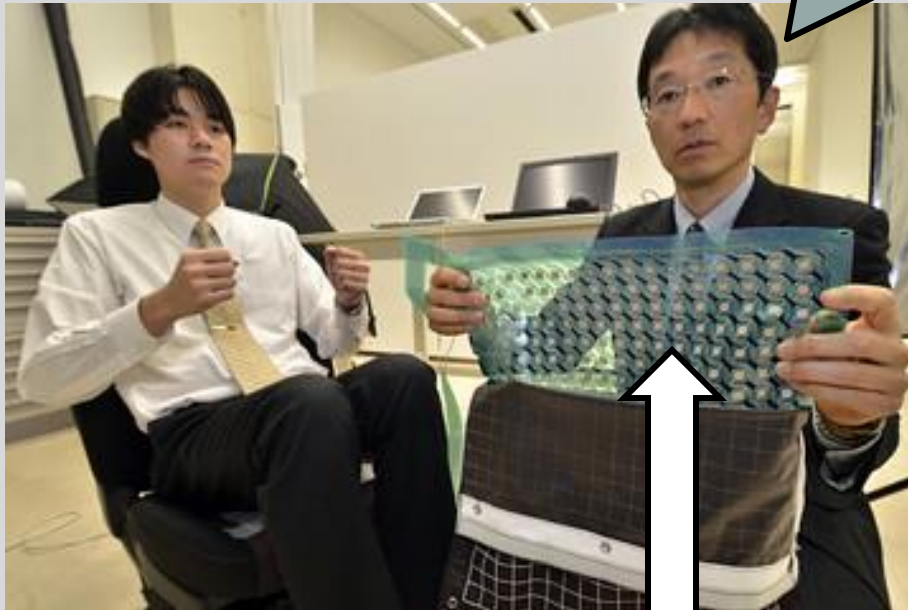
PRE-ORDER NOW FOR \$79
VISIT GETNYMI.COM

Identifies wearer by his/her unique heartbeat pattern



Biometrics (4)

"All you need
to do is sit"



¥70,000

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

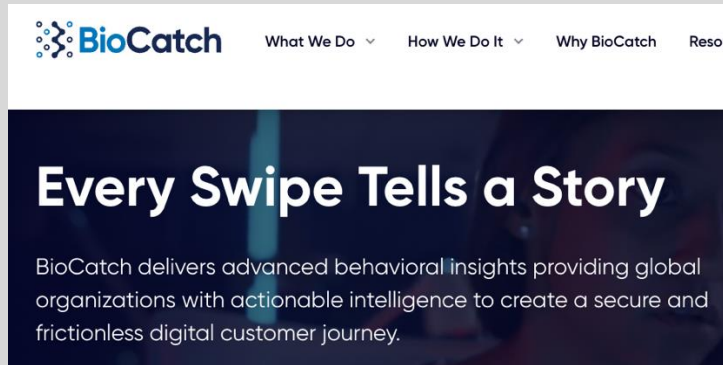
360 disc-shaped sensors identify a
unique "buttprint" with 98% accuracy

Advanced Institute of Industrial Technology, Japan

Biometrics (5)



Behavioral Biometrics



Builds a profile of each user's gestures:

- Angles at which the device is held
 - Fingers used to swipe and tap
 - Pressure applied
 - Speed of scrolling
- ... more than 2000 different interactive gestures

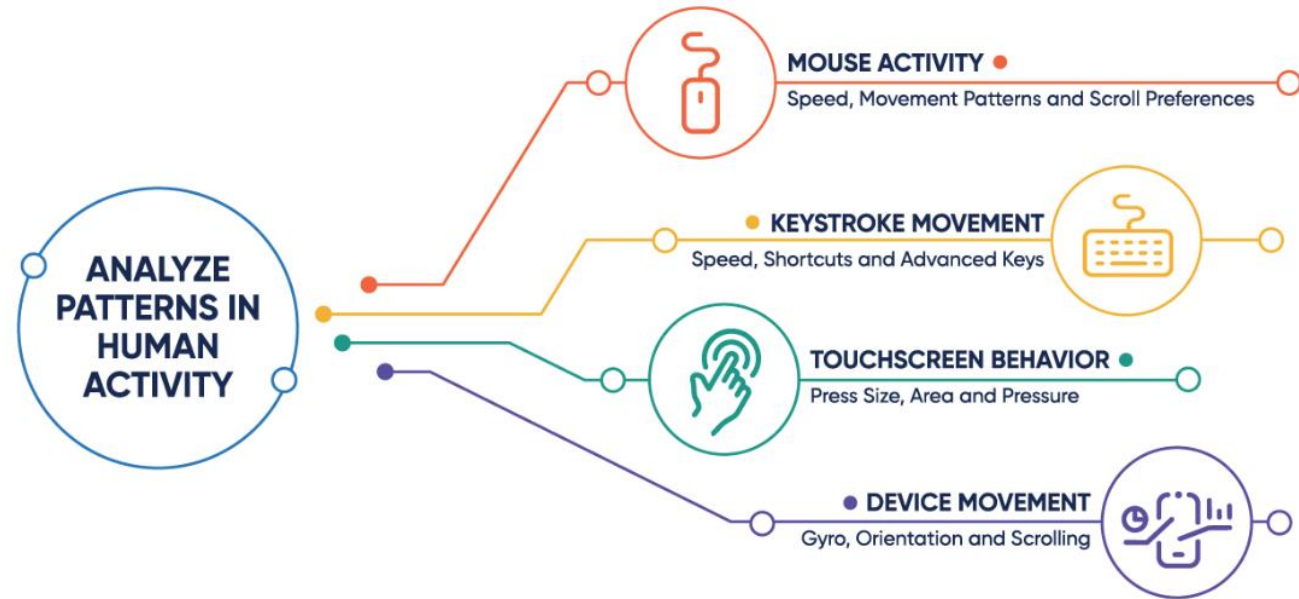




Profiles on 70 million individuals (2018)

Protection that Never Sleeps

BioCatch continuously monitors a user's physical and cognitive digital behavior, analyzing thousands of interactions per session to distinguish between genuine users and cybercriminals.



Sometimes elicits reaction from the user: speeds up the selection wheel for data like dates and times, makes mouse cursor disappear for a fraction of a second, etc. (Different users react differently).

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!

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



AFGHANISTAN AUTOMATED BIOMETRIC IDENTIFICATION SYSTEM

IDENTIFYING THOSE THAT DO HARM

“

The biometric program answers two basic questions, who a

Lt. Col. Cristiano Marchiori - US Air Force

Summary

Since 2005, the DoD ABIS has made 4.05M biometric matches of non-US citizens using la in implementing force protection measures; target enemy combatants; identify IED bomb Forces; and identify known/suspected terrorists attempting to enter our Na



DoD system for biometric identification of terrorists -- and also Afghan civilians who worked for the coalition forces

Massive biometric database of Afghans who helped US, RAW in Taliban's control now

The Taliban have confirmed that they have access to the database and have mobilised a special unit, called Al Isha, to hunt down Afghans who helped US and allied forces

FP Staff | August 29, 2021 13:58:37 IST

<https://www.firstpost.com/world/massive-biometric-database-of-persons-who-helped-us-nato-and-raw-in-taliban-control-now-say-reports-9921801.html>

This is the real story of the Afghan biometric databases abandoned to the Taliban

By capturing 40 pieces of data per person—from iris scans and family links to their favorite fruit—a system meant to cut fraud in the Afghan security forces may actually aid the Taliban.

a US-funded database known as APPS, the Afghan Personnel and Pay System

... The data is collected “from the day they enlisted,” says one individual who worked on the system, and remains in the system forever, whether or not someone remains actively in service

... Our sources say that each profile in APPS holds at least 40 data fields. These include obvious personal information such as name, date, and place of birth, as well as a unique ID number that connects each profile to a biometric profile kept by the Afghan Ministry of Interior. But it also contains details on the individuals’ military specialty and career trajectory, as well as sensitive relational data such as the names of their father, uncles, and grandfathers, as well as the names of the two tribal elders per recruit who served as guarantors for their enlistment.

<https://www.technologyreview.com/2021/08/30/1033941/afghanist-an-biometric-databases-us-military-40-data-points/>

For Sale on eBay: A Military Database of Fingerprints and Iris Scans

German security researchers studying biometric capture devices popular with the U.S. military got more than they expected for \$68 on eBay.



Secure Electronic Enrollment Kit (SEEK II)

Last used in Afghanistan in 2012

Names, photos, fingerprints, iris scans of 2632 people, collected at detainment facilities, on patrols, during screening of local hires

<https://www.nytimes.com/2022/12/27/technology/for-sale-on-ebay-a-military-database-of-fingerprints-and-iris-scans.html>

Risks of Biometrics

Usability

- 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

False matches due to the 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

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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.

All foreigners are fingerprinted when they arrive in Japan

SEE ALSO

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

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Theft

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/2/1/asia-pacific/4590651.stm>. The browser's title bar indicates the page is titled "BBC NEWS | Asi...". The page layout includes a navigation menu with links for Home, News, Sport, Radio, TV, Weather, and Languages. Below the navigation menu, there are radio buttons for "UK version" and "International version", with the latter being selected. The main content area features the BBC News logo, a "WATCH One-Minute World News" button, and a globe graphic. The article's title is "Malaysia car thieves steal finger", written by Jonathan Kent. The article text describes a car theft in Malaysia involving a Mercedes S-class with a fingerprint recognition system. The article is dated Thursday, 31 March, 2005, at 10:37 GMT 11:37 UK. A sidebar on the left lists various news categories, with "Asia-Pacific" highlighted.

http://news.bbc.co.uk/2/1/asia-pacific/4590651.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.

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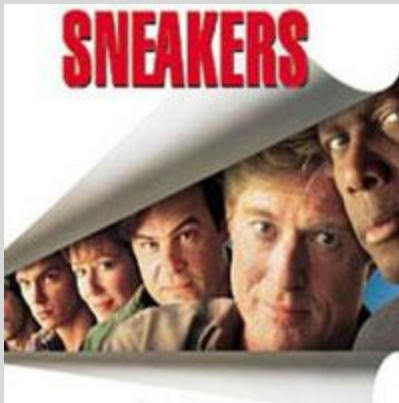
Generative Forgery

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

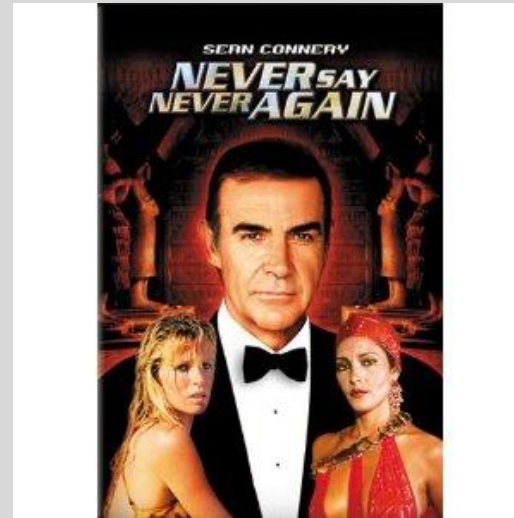
Generated by a computer algorithm
trained on handwriting samples

Involuntary Cloning

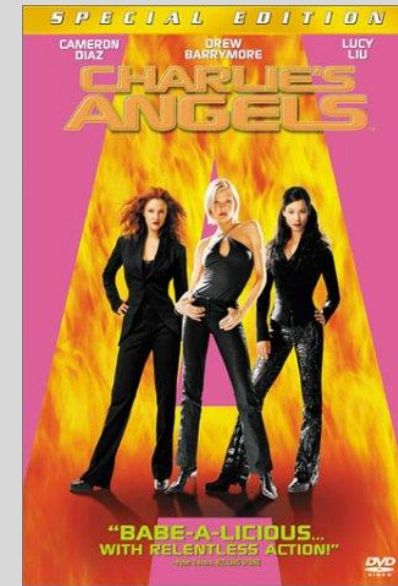
Clone a biometric without victim's knowledge or assistance



"my voice is my passport"



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 .



320JPY/sheet



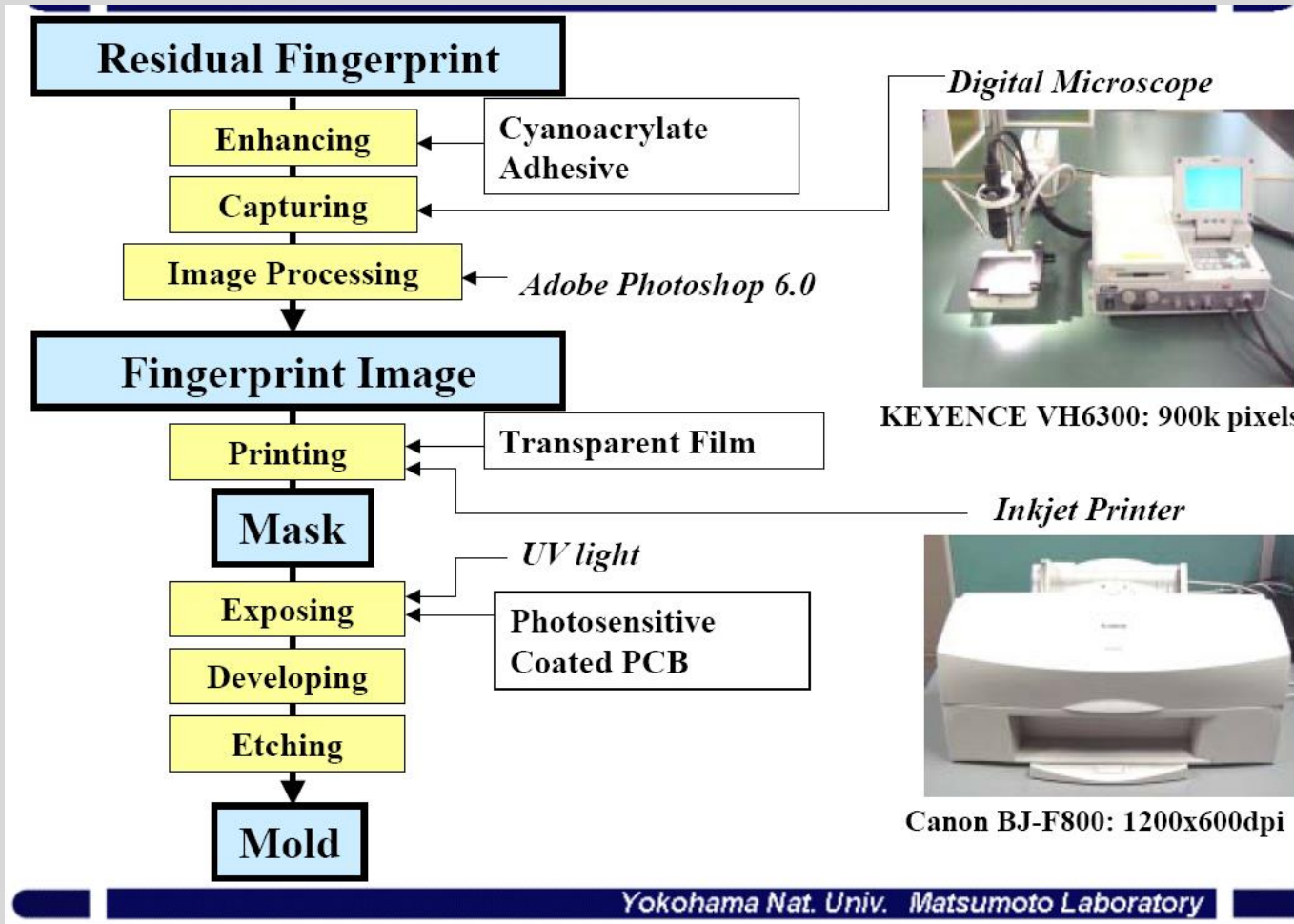
Solid gelatin sheet
“GELATINE LEAF ”
by MARUHA CORP



200JPY/30grams



Cloning Process



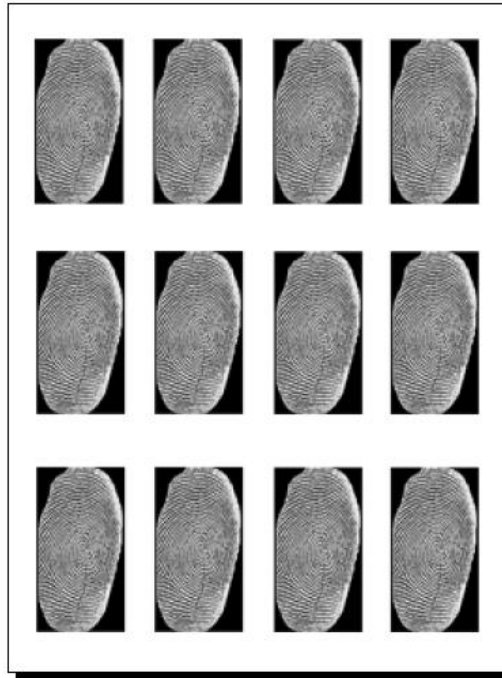
Fingerprint Image



An Enhanced Fingerprint



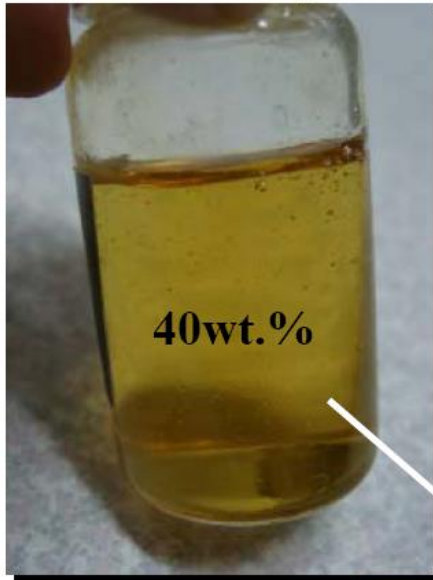
A Fingerprint Image



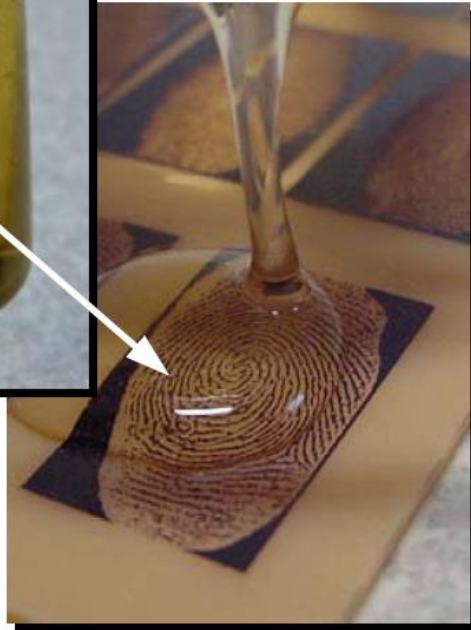
A Mask with Fingerprint Images

Molding

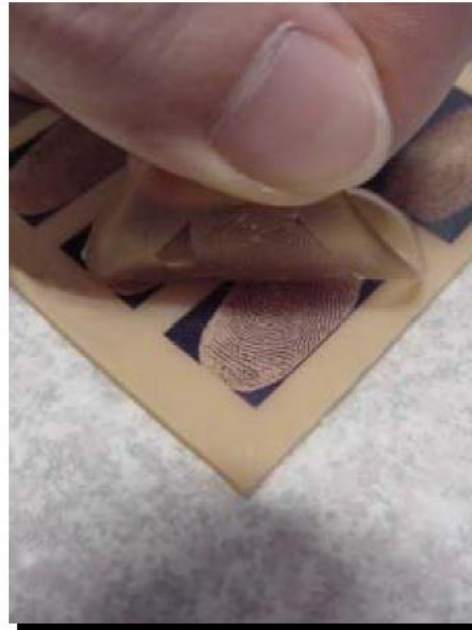
Gelatin Liquid



Drip the liquid onto the mold.



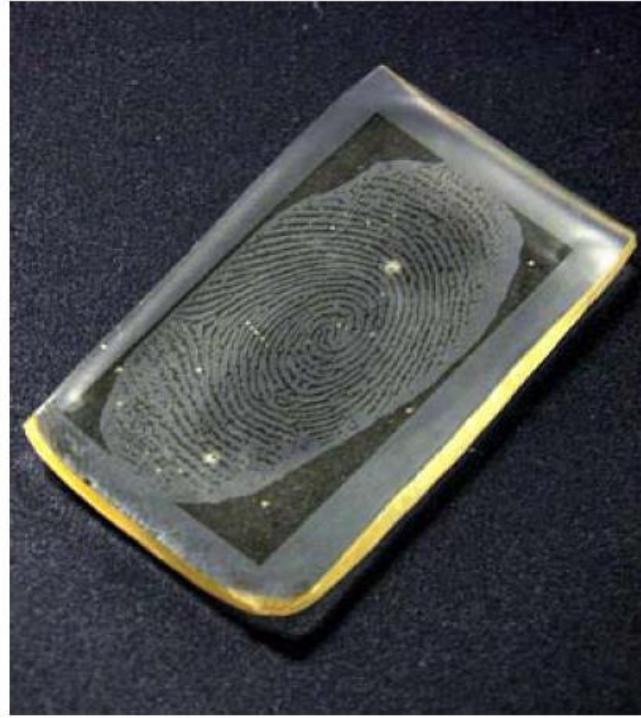
Put this mold into a refrigerator to cool, and then peel carefully.



The Mold and the Gummy Finger



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



Gummy Finger: 50JPY/piece

The Print and the Clone

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