

Biometrics Technology for Human Recognition

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<http://biometrics.cse.msu.edu>

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Foreigners Arriving at Incheon



G20 Seoul Summit 2010



Face recognition system at the COEX entrance

Security Concerns

We now live in a society where people cannot be **trusted** based on **credentials**

- Something you have: ID card, passport
- Something you know: PIN, password



Fake Passports



- Two of the Sept. 11 attackers used stolen Saudi Arabian passports
- Spanish police arrested seven men, connected to al Qaeda, tasked with stealing 40 passports per month (Dec 2, 2010)

<http://press.homeoffice.gov.uk/press-releases/passport-warning?version=1>

<http://www.pbs.org/wgbh/pages/frontline/shows/trail/etc/fake.html>

<http://www.lonelyplanet.com/thorntree/thread.jsa?threadID=2071874>

Too Many Passwords!

Copyright 1996 Randy Glasbergen. www.glasbergen.com



“Sorry about the odor. I have all my passwords tattooed between my toes.”

Most common passwords: 123456, password
Hacker-resistant passwords?

Two-Factor Authentication

- Card + 4-digit PIN
- “skimming” attacks,
“shoulder surfing”
- ~10% of Americans victims
of credit card fraud



<http://www.bankinfosecurity.com/chase-hit-in-atm-skimming-attacks-a-4663>

<http://www.statisticbrain.com/credit-card-fraud-statistics/>

Phishing Attack



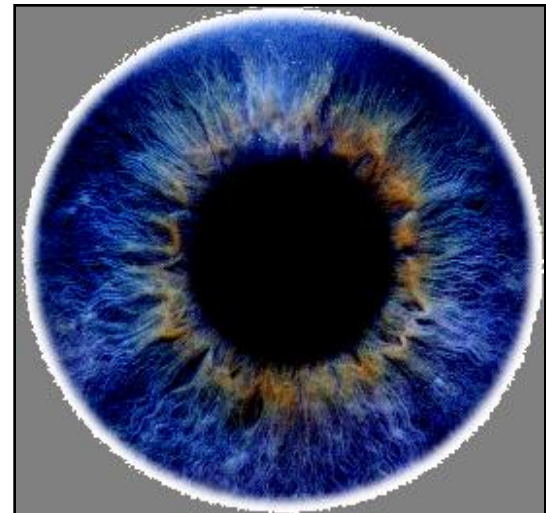
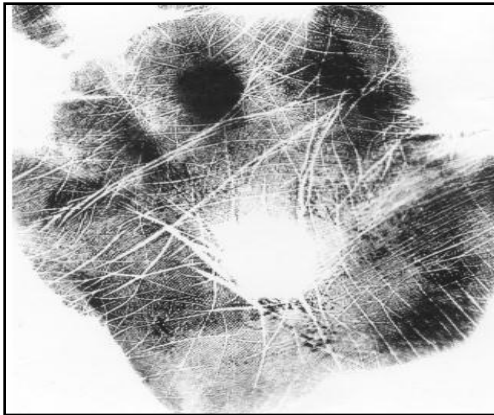
~5 million U. S. citizens are victims

Outline

- Recognition by body traits
- Biometric System
- Applications
- Challenges

Biometric Recognition

Recognition by body traits (**Who you are**)



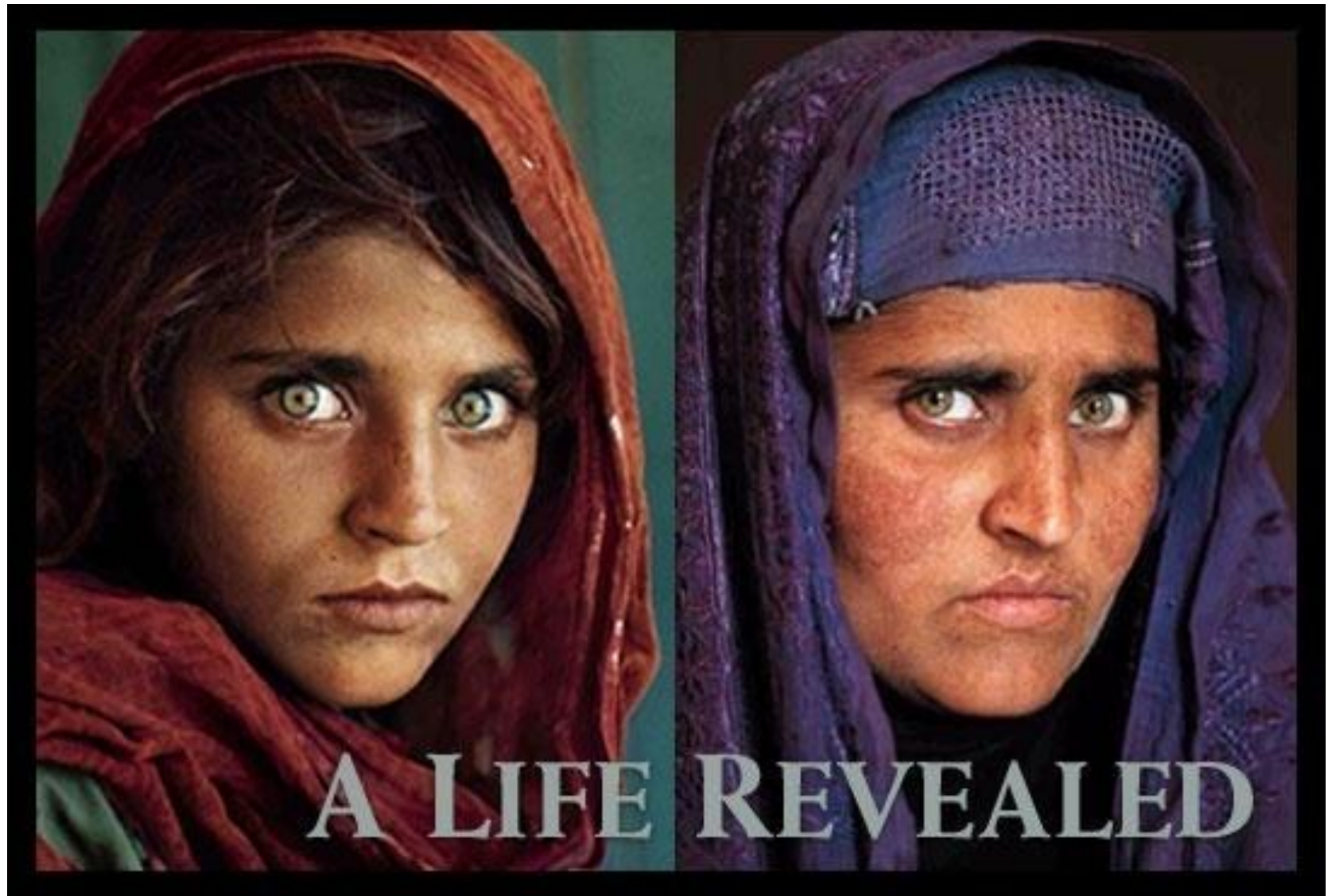
Uniqueness



Identical twins

Persistence

Sharbat Gula in 1985 & 2002; Steve McCurry, National Geographic



Published in the June 1985 issue (~12 years old) 17 years later in the April 2002 issue

Rejected Biometric Traits



Why Biometrics?

- Cannot be stolen or forged
- Discourages fraud
- Enhances security
- Audit trail
- User convenience



Palmvein system at Bradesco bank, Brazil

Habitual Criminal Act (1869)

British Parliament required that repeat offenders be identified



(L. H. Brown)

Height	1m 79.6	Head l'ght	19.8	L. Foot	27.1	Circle	leh	Age	22	Born in	
Eng. H'ght	5-10 3/4	Head width	16.3	L. Mid. F.	11.2	Periph Z		Apparent Age			
Outs. A	1m 75.5	Cheek width	14.4	L. Lit. F.	8.7	Color of Left Eye	leh-Mel	Nativity	Louisville Ky.		
Trunk	94.9	R. Ear	6.8	L. Fore A.	46.6	Pecul		Occupation	showman		

Remarks Incident to Measurement

DESCRIPTIVE

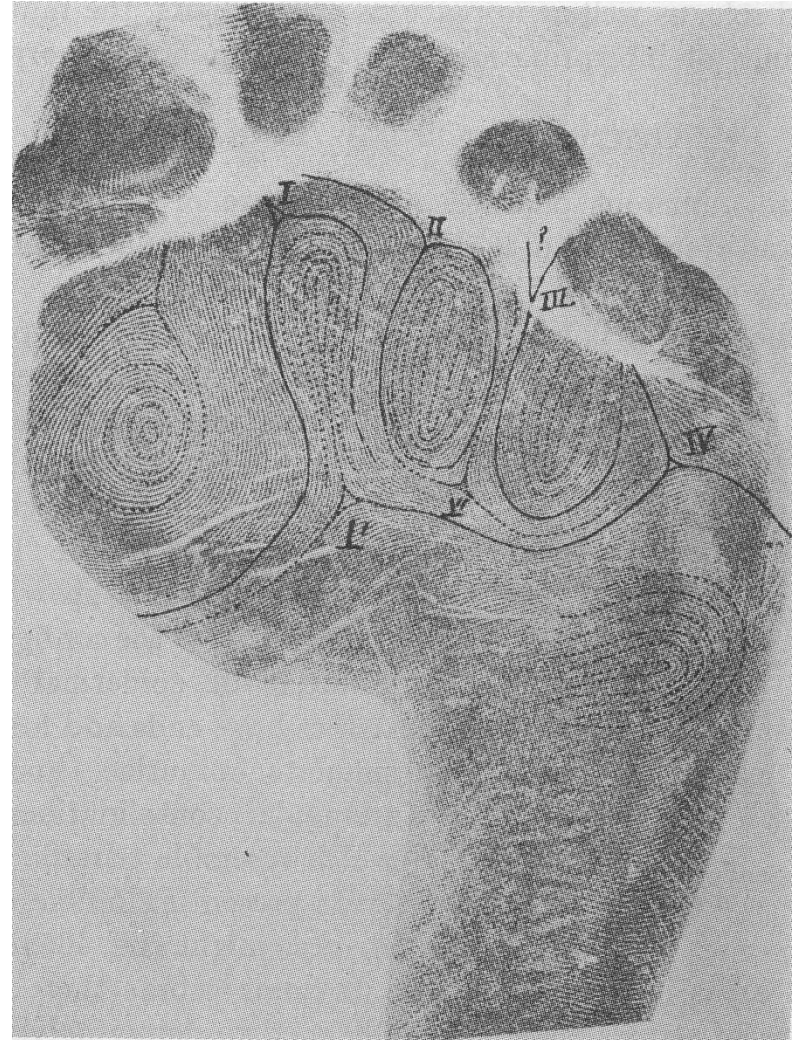
Inclu.	Body	Profile	Ridge	Base	Root	Teeth	Beard	Shaved
Height	m		(Ear)		Shel		Hair	Black
Width	Brd	DIMENSIONS					Complexion	M. Dark
Pecul		Length	Projection	Breadth			Weight	165
		br	br	m			Build	M. Slim
		Pecul				Chin		

BUREAU OF IDENTIFICATION
Department of Police,
Tulane Ave. and Saratoga St.
New Orleans, La.

Measured *Feb 1 1913*
By *Jno. B. Amis*














Alphonse Bertillon

Friction Ridge Patterns

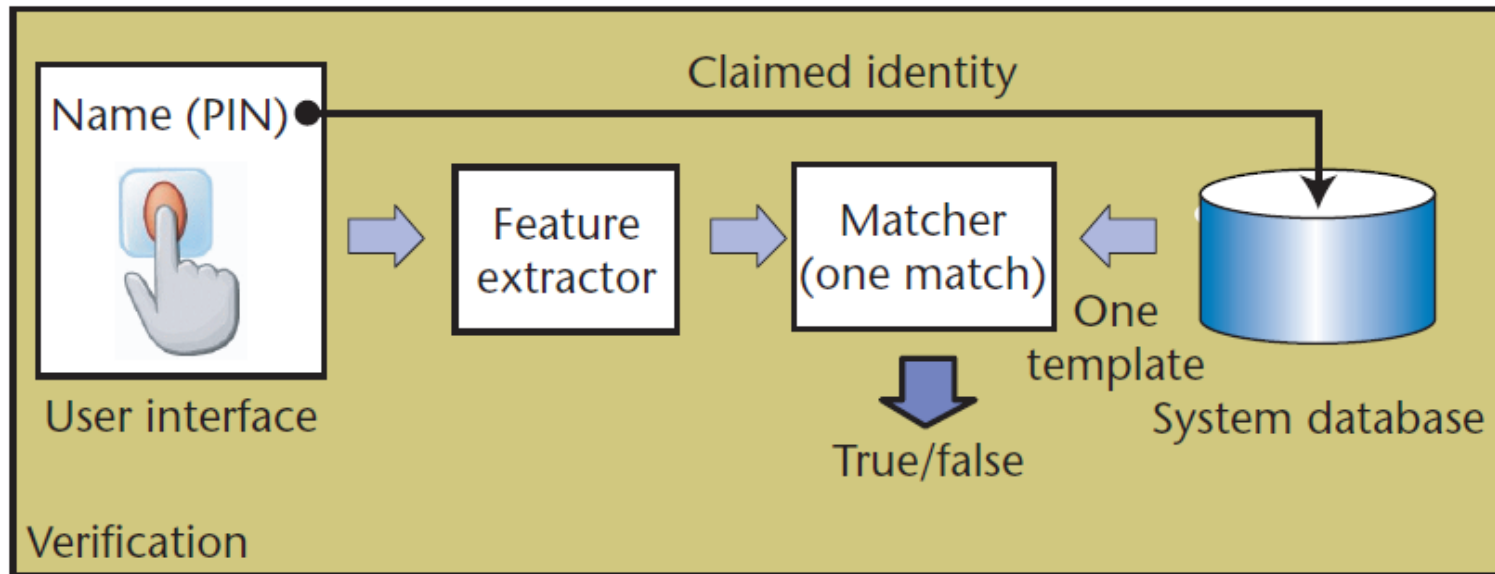
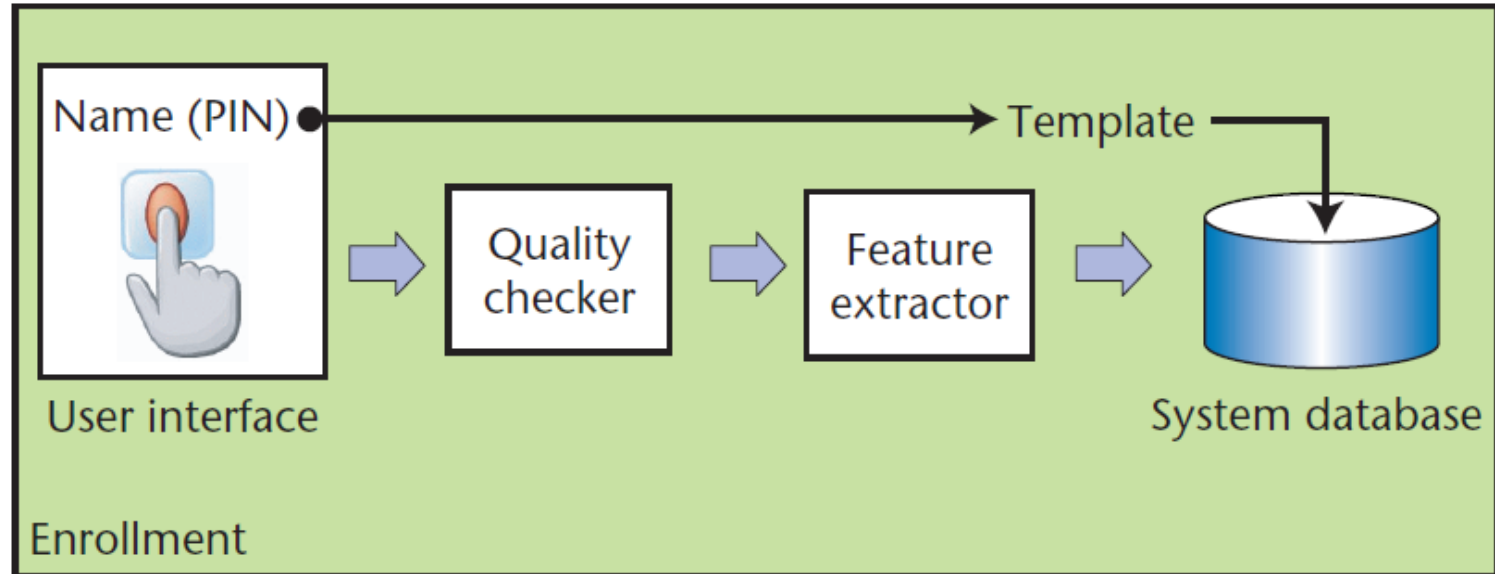


Cumins and Midlo, Finger Prints, Palms and Soles, Dover, 1961

Fingerprints

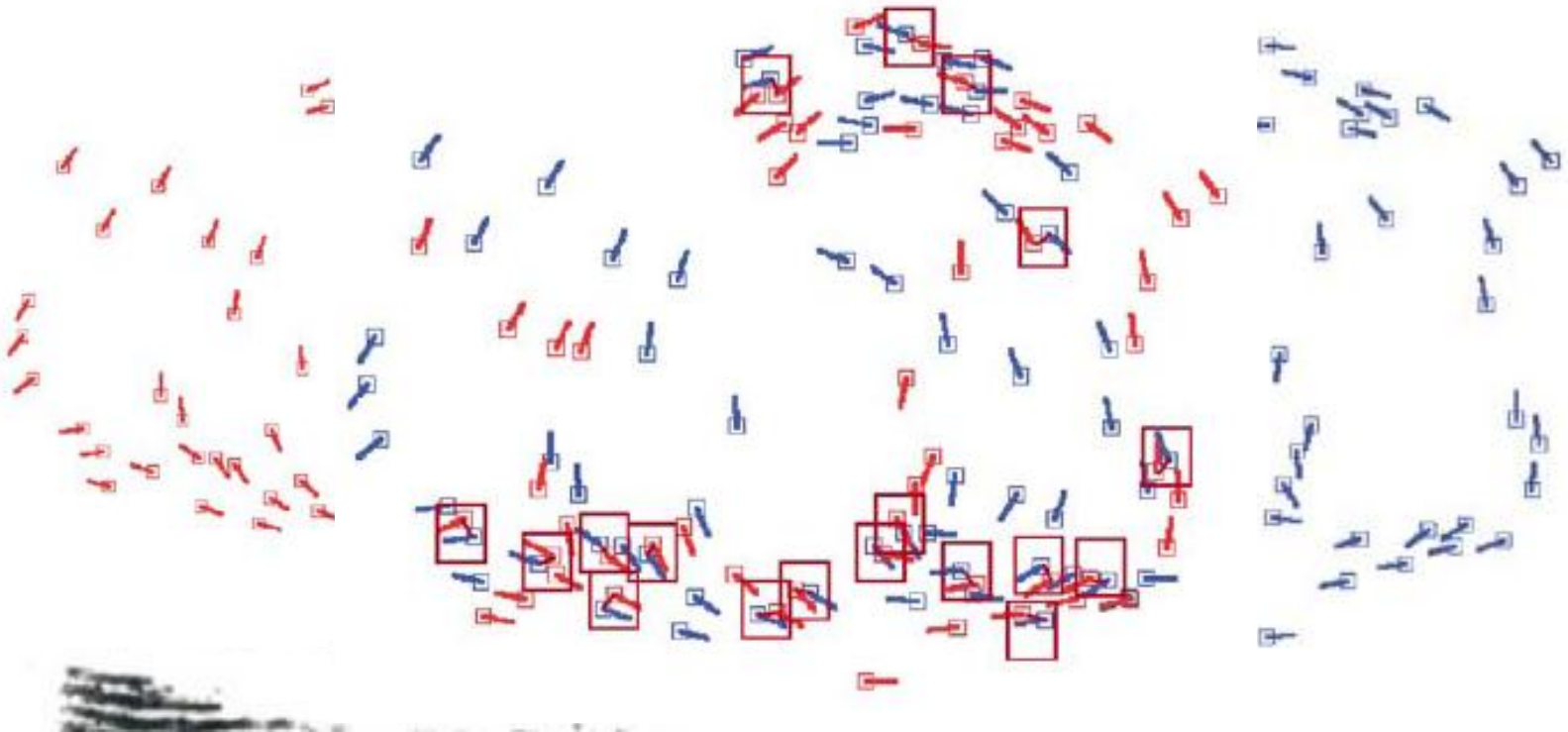
APPLICANT		LEAVE BLANK <i>Leave Blank</i>		TYPE OR PRINT ALL INFORMATION IN BLACK LAST NAME FIRST NAME MIDDLE NAME Teacher, Theresa C.				FBI LEAVE BLANK <i>Leave Blank</i>	
SIGNATURE OF PERSON FINGERPRINTED		ALIASES AKA Formerly: Theresa Smith		O R I NY9219402 NYSTED Dept-FPU ALBANY, NY		DATE OF BIRTH DOB 12/31/70			
RESIDENCE OF PERSON FINGERPRINTED 318 School Street Hometown, NY 11111		CITIZENSHIP FTY US		SEX F	RACE W	HTY 5'7"	BOY 155	POW Gr	POB Ohio
DATE 5/01/02	SIGNATURE OF OFFICIAL TAKING FINGERPRINTS		STREET NO. POB Leave Blank		LEAVE BLANK				
EMPLOYER AND ADDRESS <i>(if applicable)</i> Smart Falls Central School Dist Smart Falls, NY 11111		CITY Leave Blank		CLASS Leave Blank					
REASON FINGERPRINTED Leave Blank		ARMED FORCES NO. MNI Leave Blank		REF Leave Blank					
		SOCIAL SECURITY NO. XNC 000-10-1111							
		BIOCELL ANALYSIS NO. MNI Leave Blank							
									
									
IDENTIX TP600 1259						ADS004228.LEX004229			
									
LEFT FOUR FINGERS TAKEN SIMULTANEOUSLY				L. THUMB R. THUMB		RIGHT FOUR FINGERS TAKEN SIMULTANEOUSLY			

Biometric Recognition System



Verification (1:1 Matching)

Fingerprint Matching



Match score = 38 on a scale of 0-999

US-VISIT

United States Visitor and Immigrant Status Indicator Technology



UAE Iris Border Crossing System



Time and Attendance



Cash Register Login



Meijer supermarket, Okemos, Michigan

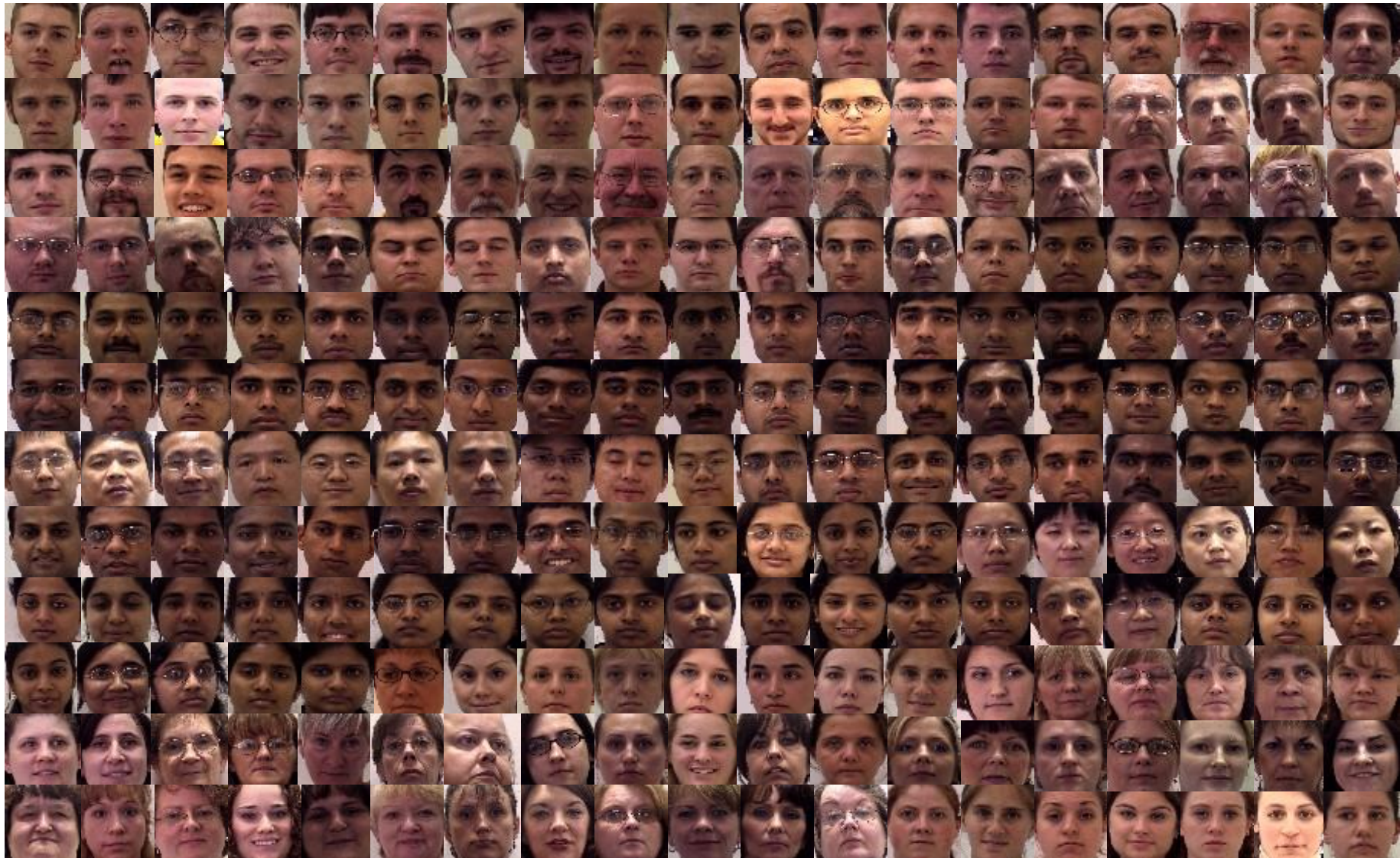
Disney Parks



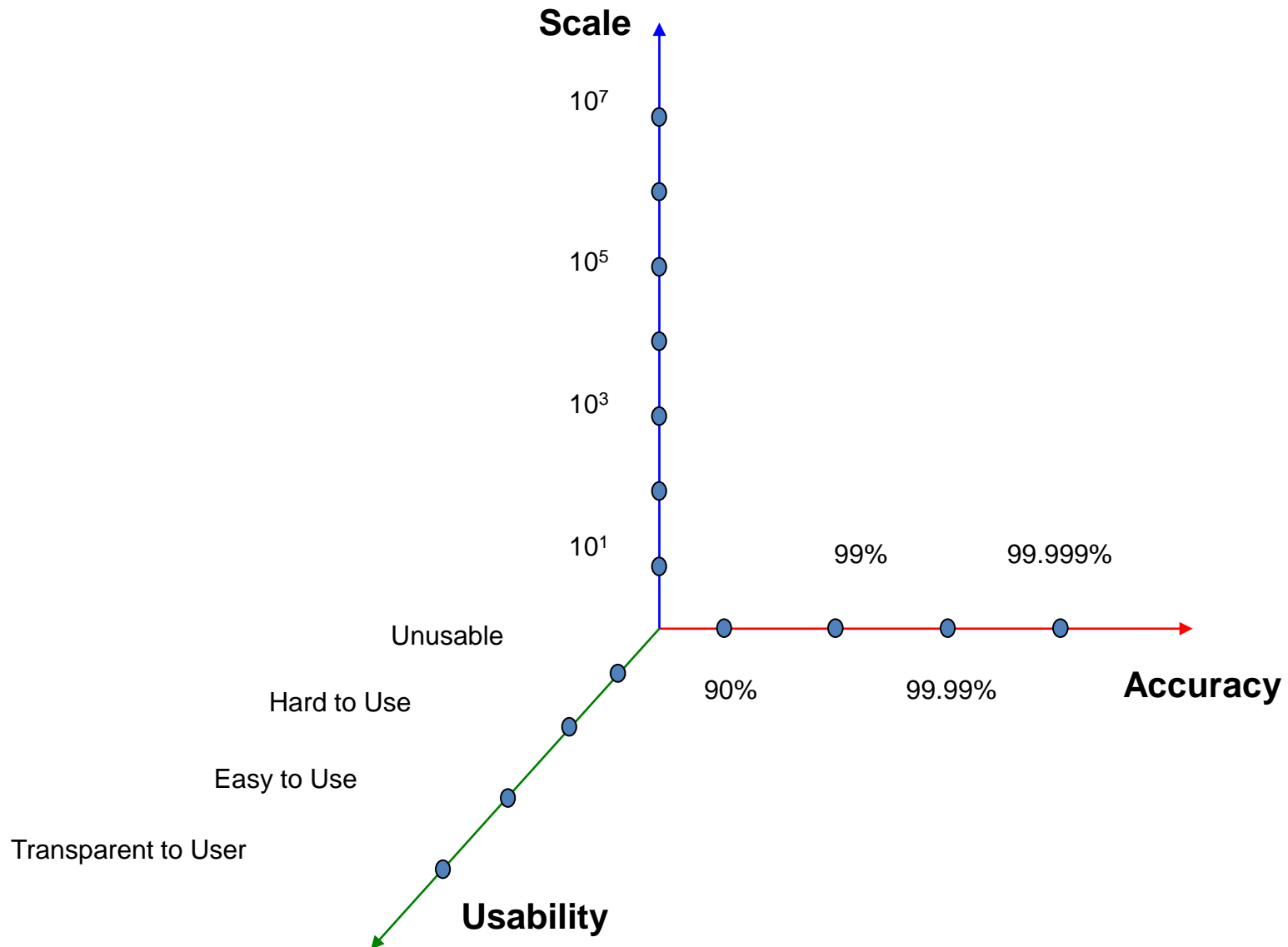
200K visitors per day, 365 days per year

De-duplication (1:N Matching)

Prevent a person from obtaining multiple ID documents



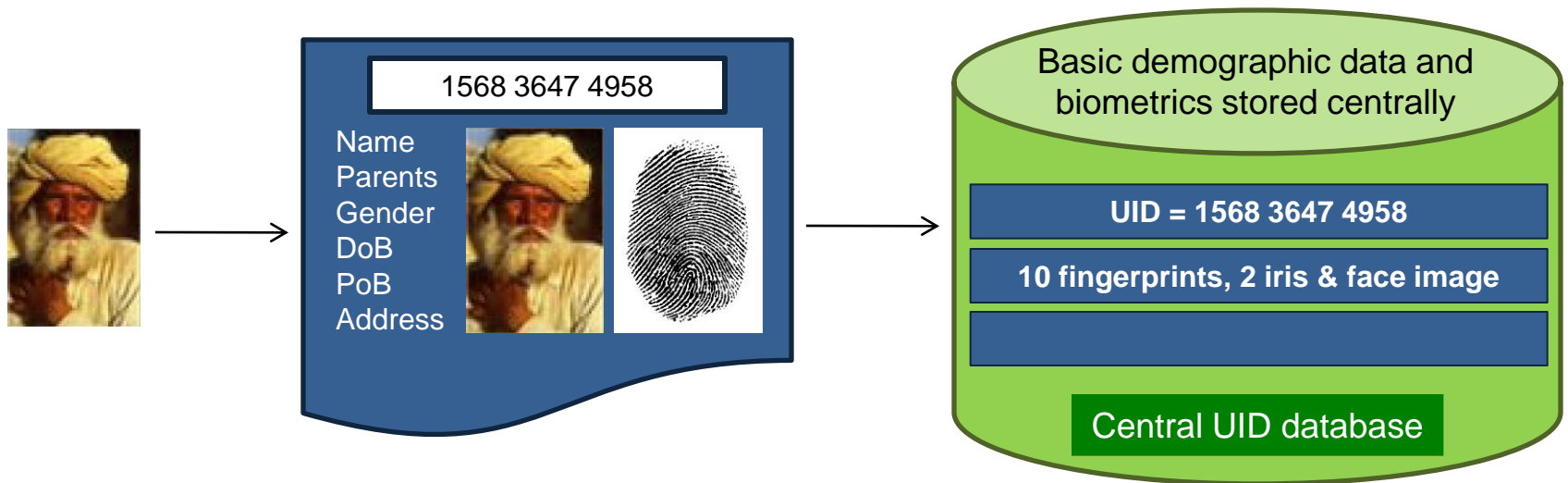
Next Generation Biometric Systems



For 1: N matching ($N \sim 1$ billion), 1:1 matching accuracy must be very high

Large Scale Identification

“Issue a unique identification number (**UID**) to Indian residents that can be verified and authenticated in an online, cost-effective manner, and that is robust to eliminate duplicate and fake identities.”



600 million numbers to be issued in 4 years



<http://uidai.gov.in/>



Biometric Capture

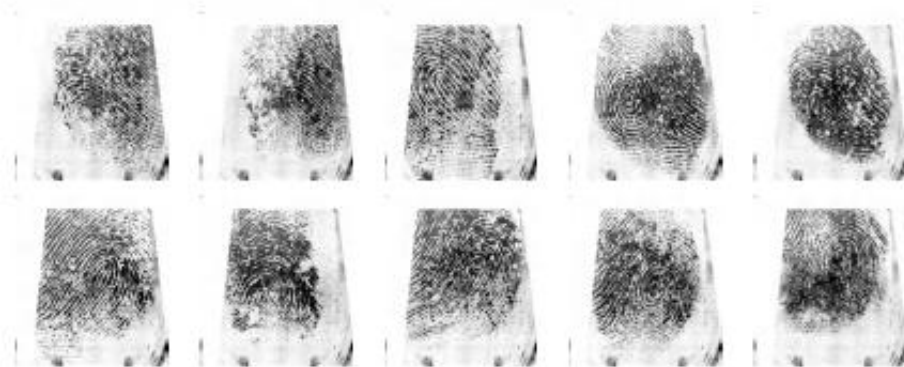
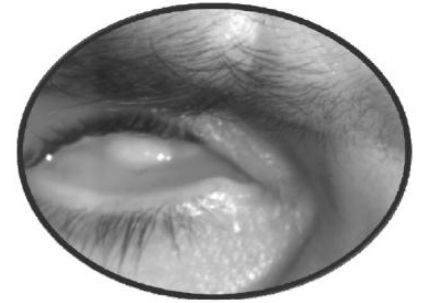
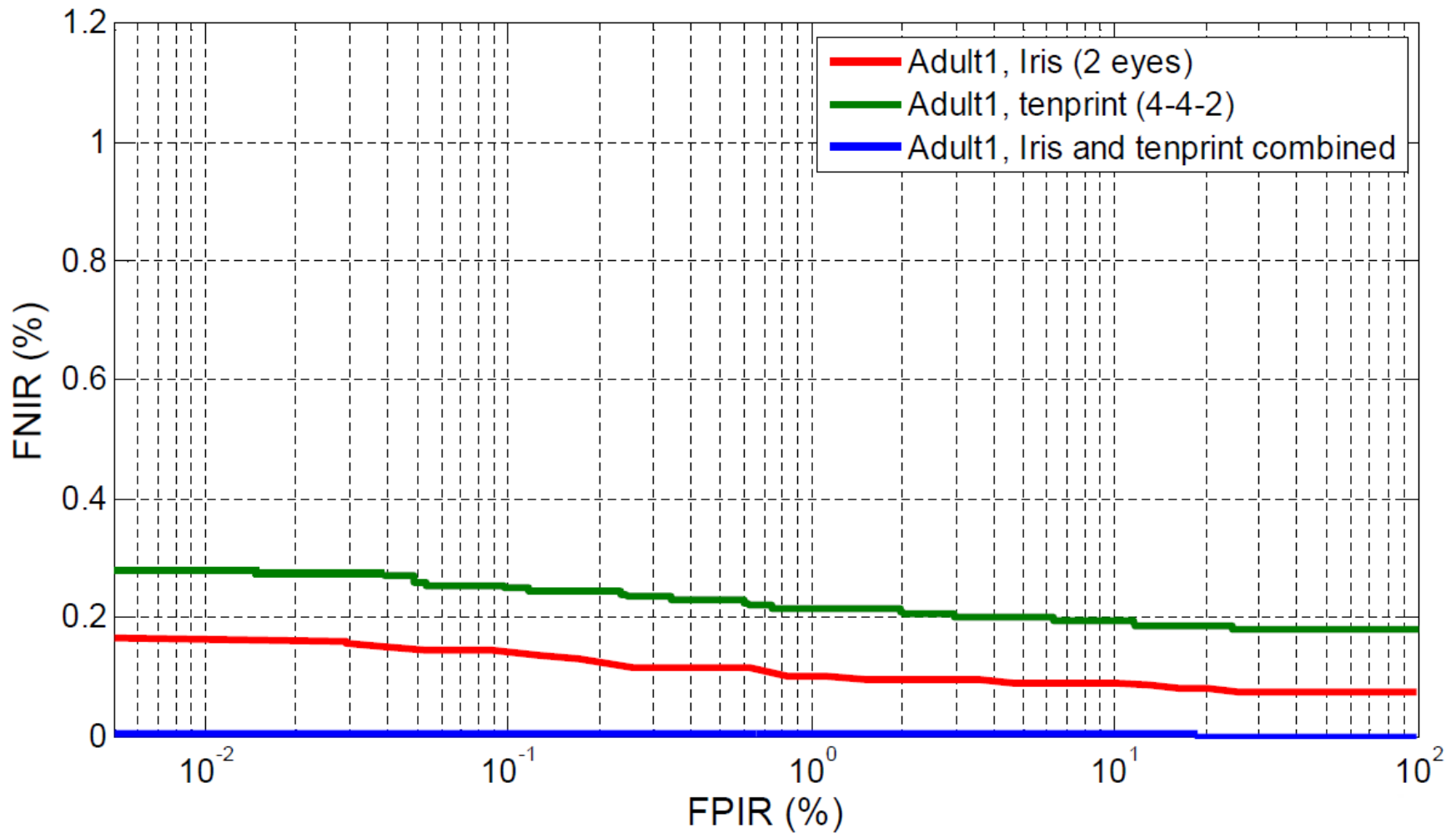


Image Quality



Fusion of Iris and Fingerprints



FPIR: Likelihood that a person's biometrics is seen as a duplicate

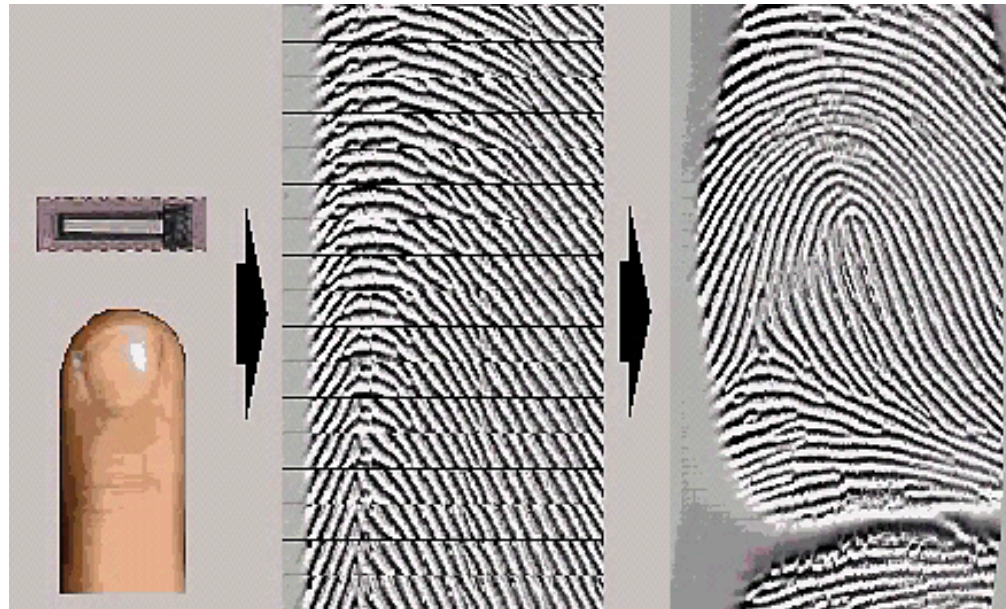
FNIR: Likelihood that system is unable to identify a duplicate enrollment

Securing Mobile Devices

- No. of mobile devices will exceed world's population by 2012
- By 2015, consumers will buy \$1.3 trillion worth of goods with mobile devices; 1.5% of the transactions will be fraudulent



Voice, face, fingerprint, iris

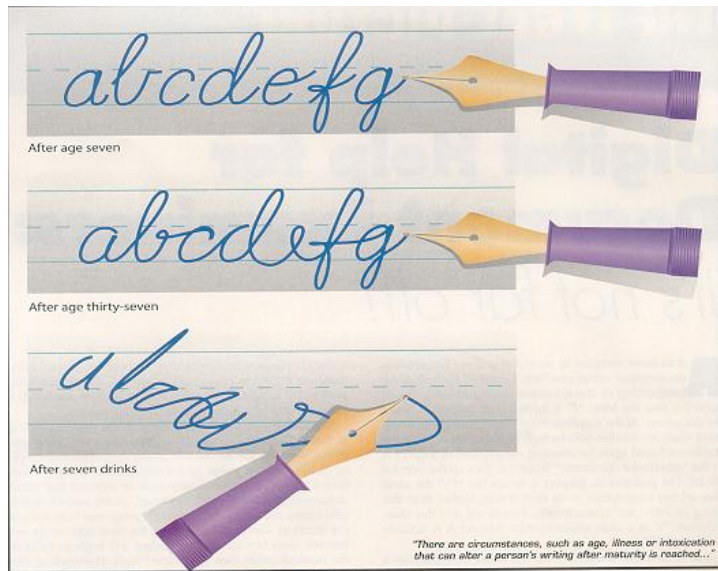
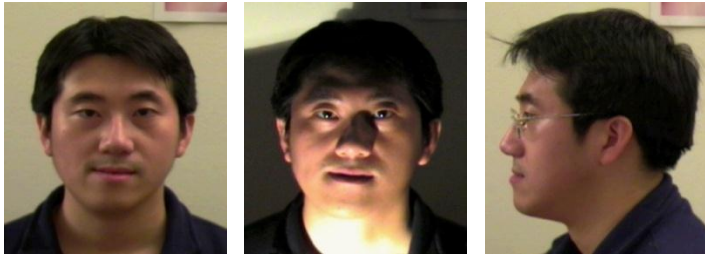


Apple buys AuthenTec for \$356 million
(July 2012)

Challenges

- Intra-class and inter-class variations
- Fingerprint matching
 - Touchless sensors
 - Latent fingerprint matching
- Face recognition
 - Age invariant face recognition
 - Heterogeneous face recognition
 - Unconstrained face recognition
- Fake & altered biometric traits
- Soft biometrics

Intra-Class & Inter-Class Variations



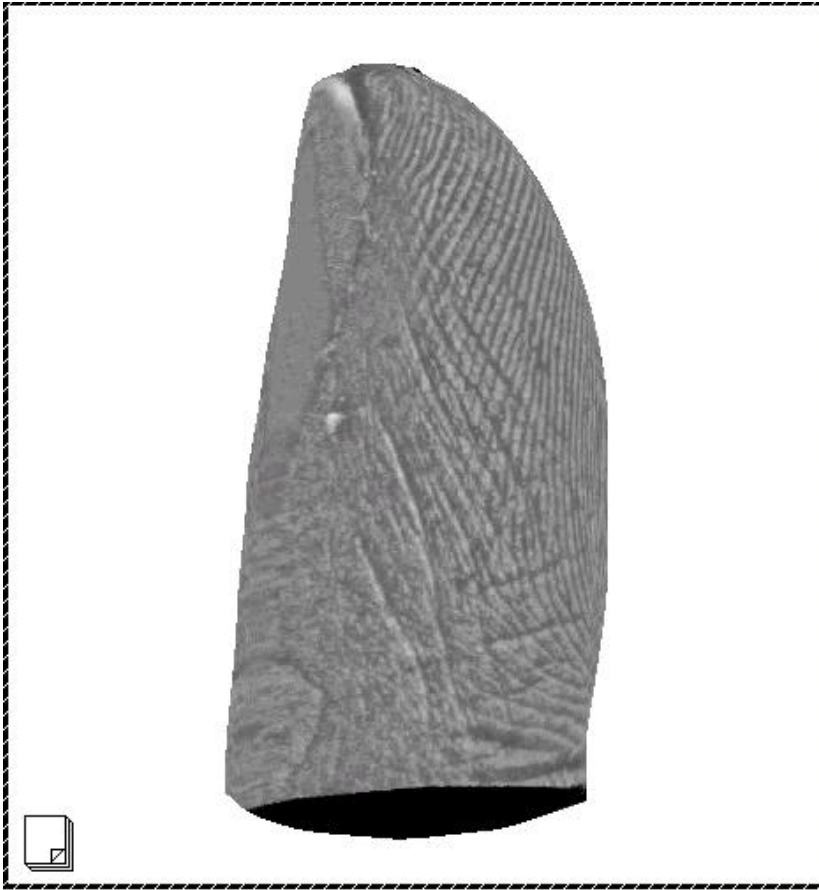
"There are circumstances, such as age, illness or intoxication that can alter a person's writing after maturity is reached..."



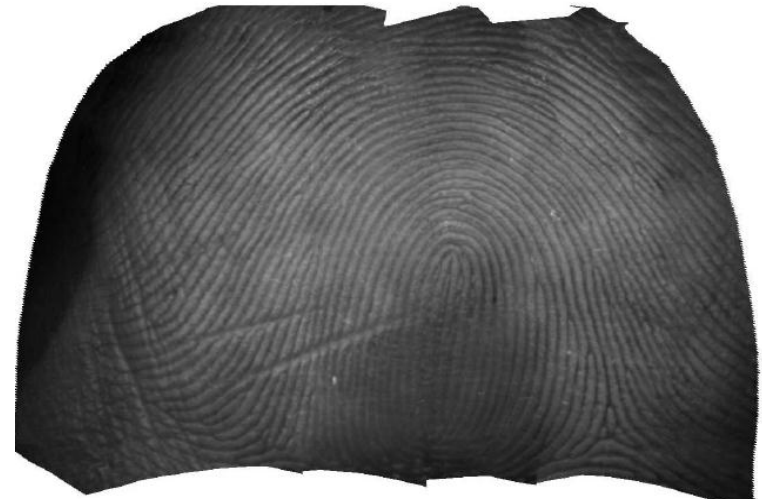
Large intra-class variability

Large inter-class similarity

3D Touchless Sensor



TBS Touchless 3D image



Virtual "rolled" image



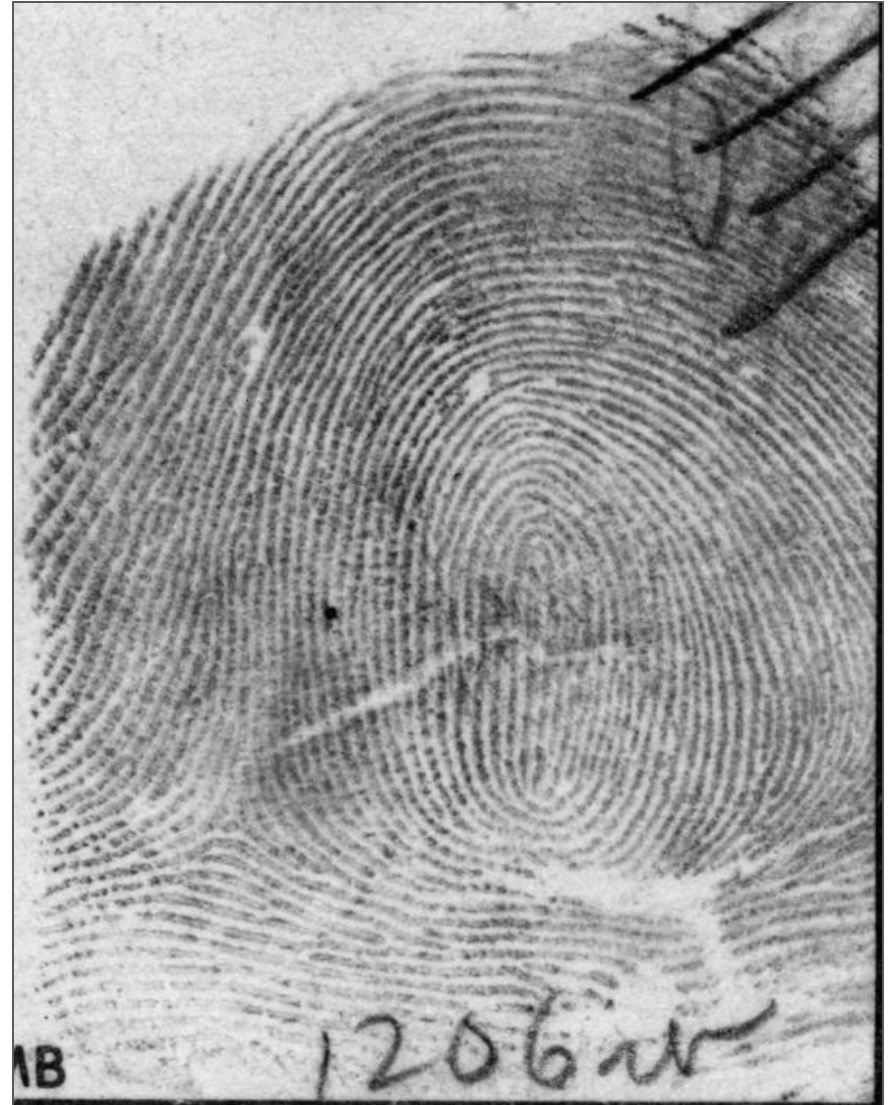
Ink on paper

Rolled Fingerprint Matching



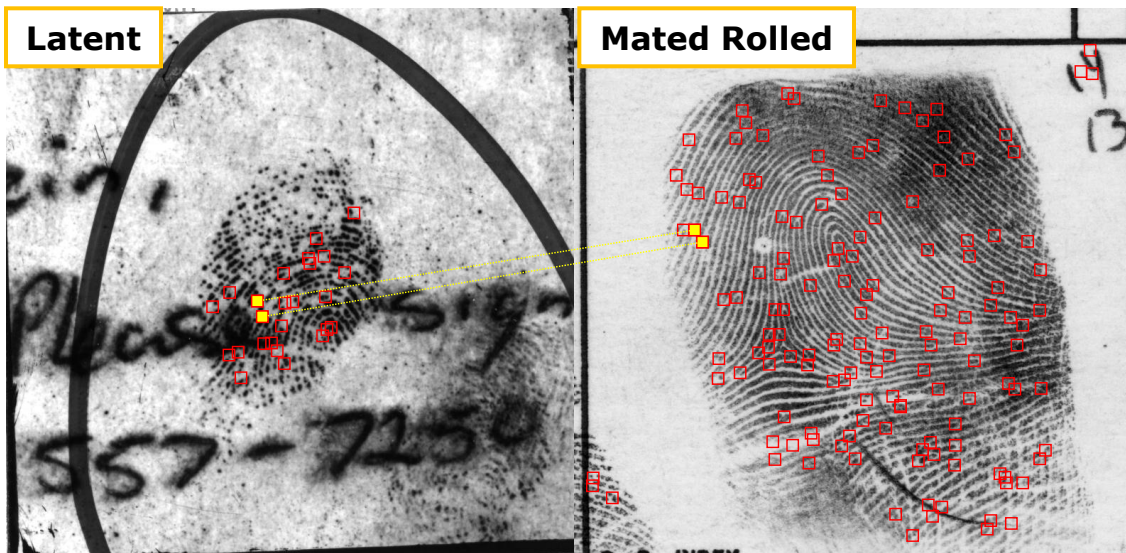
True accept rate of 99.4% @ false accept rate of 0.01%

Latent Fingerprint Matching

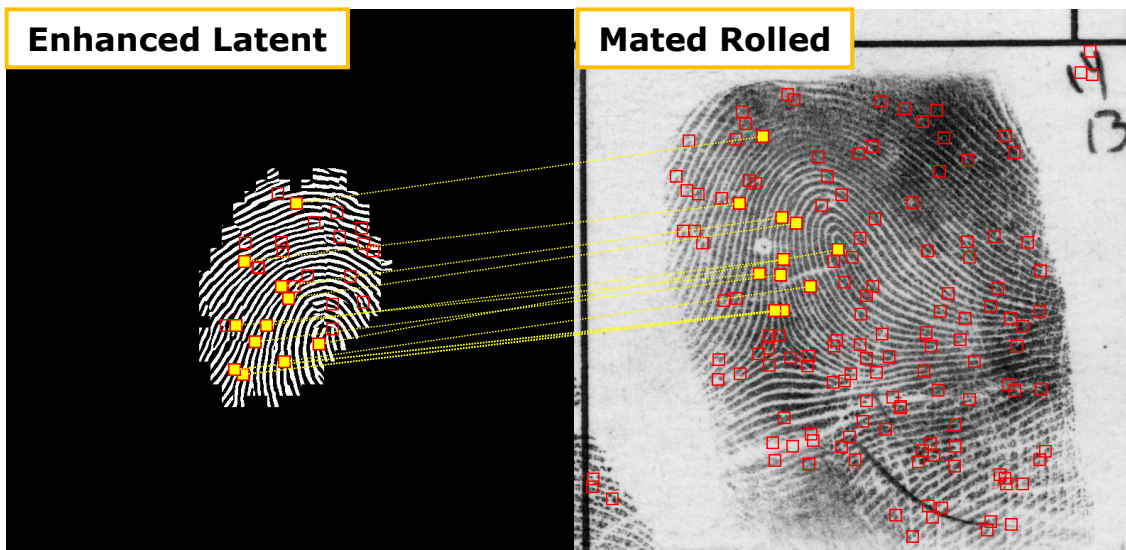


Rank-1 identification rate of only 68%

Latent Fingerprint Enhancement



Matched Minutiae = 2
Match Score = 3



Matched Minutiae = 13
Matching Score = 38

Age Invariant Matching

Jan 1995



Gallery seed

Jul 1998



Score=0.99

Nov 1999



Score=0.62

Nov 2003



Score=0.41

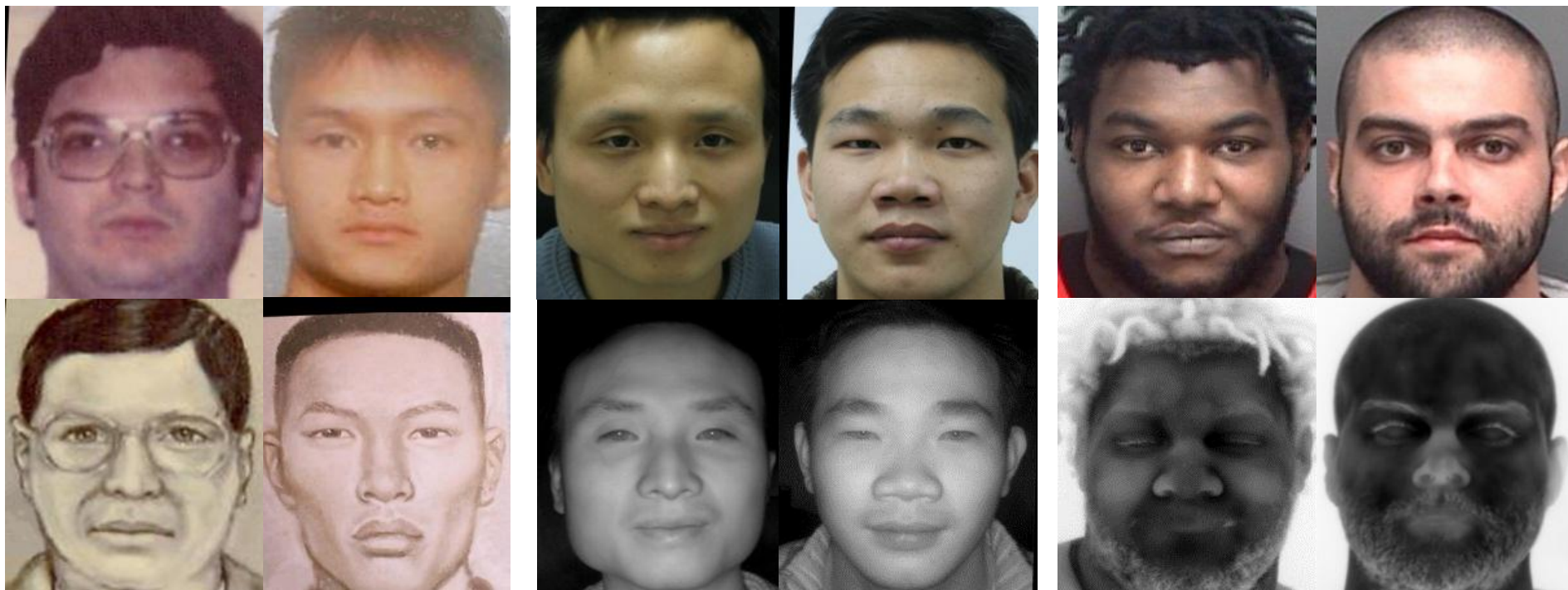
Feb 2005



Score=0.26

- Learn invariant features
- Synthesize appearances to offset facial variations

Heterogeneous Face Recognition



Large intra-class variability due to change in modality

Video Surveillance



1 million CCTV cameras in London & 4 million in U.K.; average Briton is seen by 300 cameras/day; 3 million cameras in S. Korea

Unconstrained Face Recognition



Attacks on Biometric Systems



Dummy finger from
a lifted impression



Face disguise



Fake eyeball

Fingerprint Alteration



Mutilated
fingertips

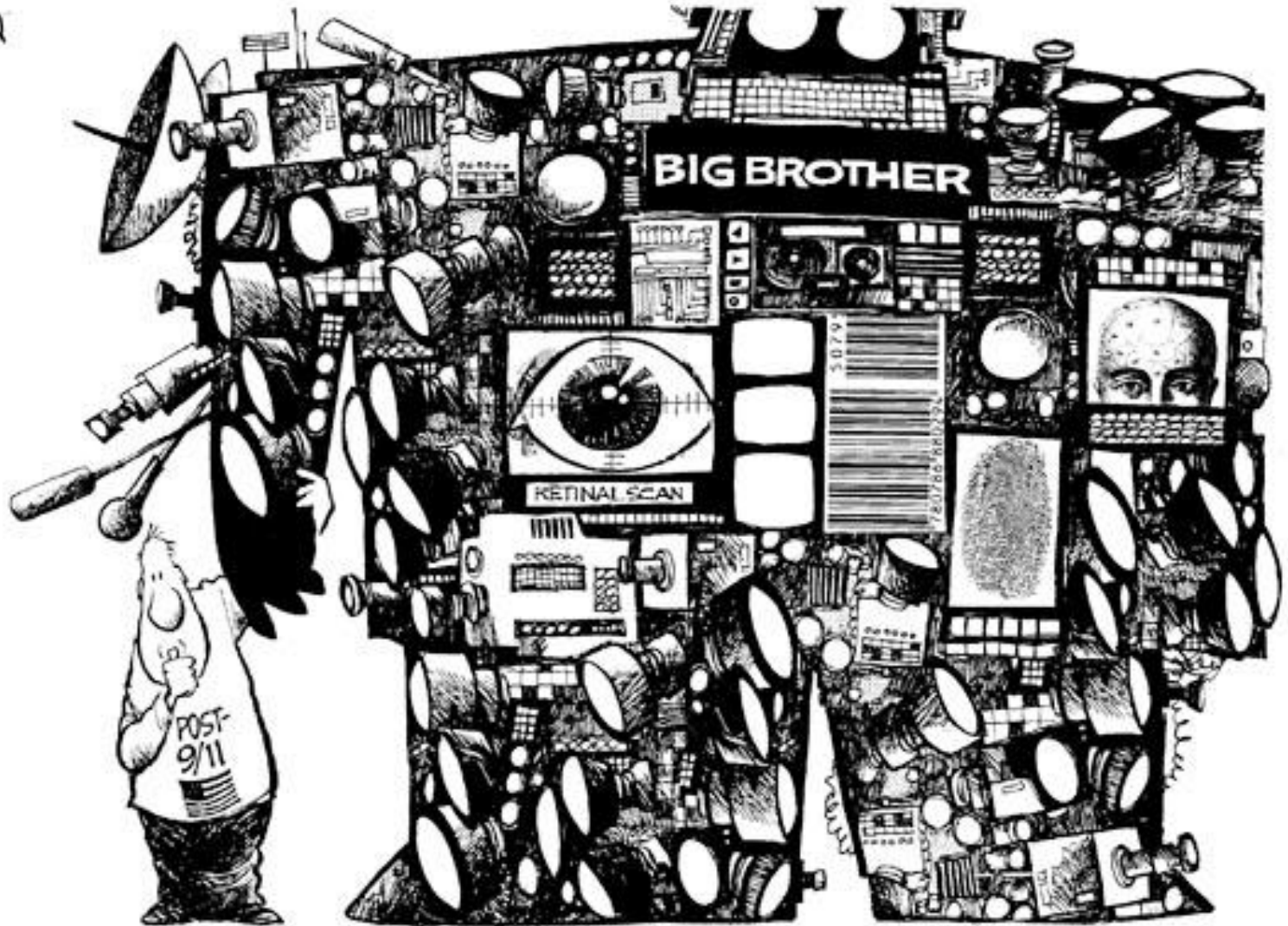


Pre-altered
fingerprint



Altered
fingerprint

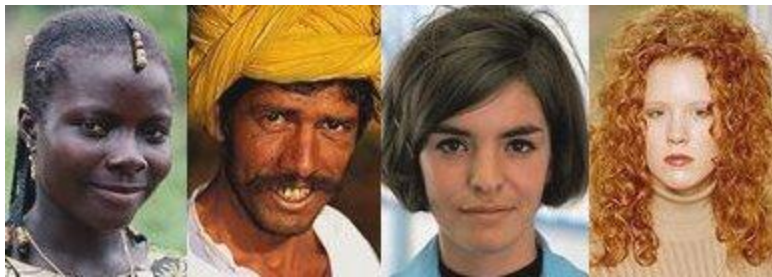
Privacy Concerns



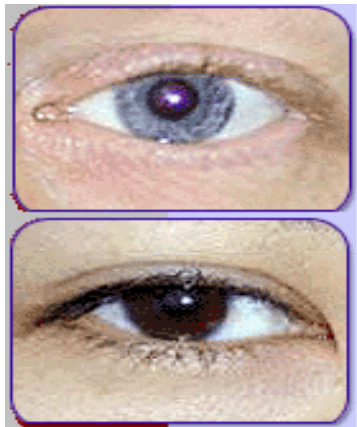
Will biometric be used to track people?

Soft Biometrics

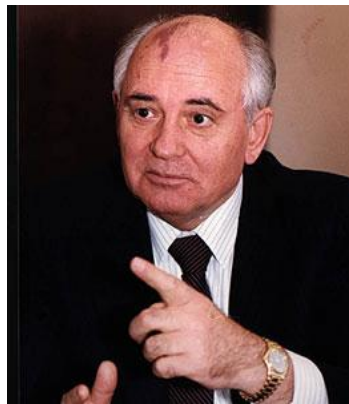
Provide some information about an individual, but lack the distinctiveness and permanence



Ethnicity, Skin Color, Hair color



Periocular



Birthmark



Height



Weight



Tattoos

Tattoo Caught in Surveillance Image



Detroit police linked at least six armed robberies at an ATM after matching a tipster's description of the suspect's distinctive tattoos

www.DetroitisScrap.com/2009/09/567/

Summary

- Biometric recognition is indispensable in efforts to enhance security and eliminate fraud
- Fingerprint matching has been successfully used in forensics for over 100 years
- New deployments for civil registration, border crossing, financial transactions
- Market for mobile devices is emerging
- Seamless integration, recognition under non-ideal conditions, user privacy, system integrity