Banking on Biometrics

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Federal Reserve Bank of Atlanta

Outline

- What is biometrics?
- Design of biometric Systems
- Applications
- Biometrics in Banking
- Summary

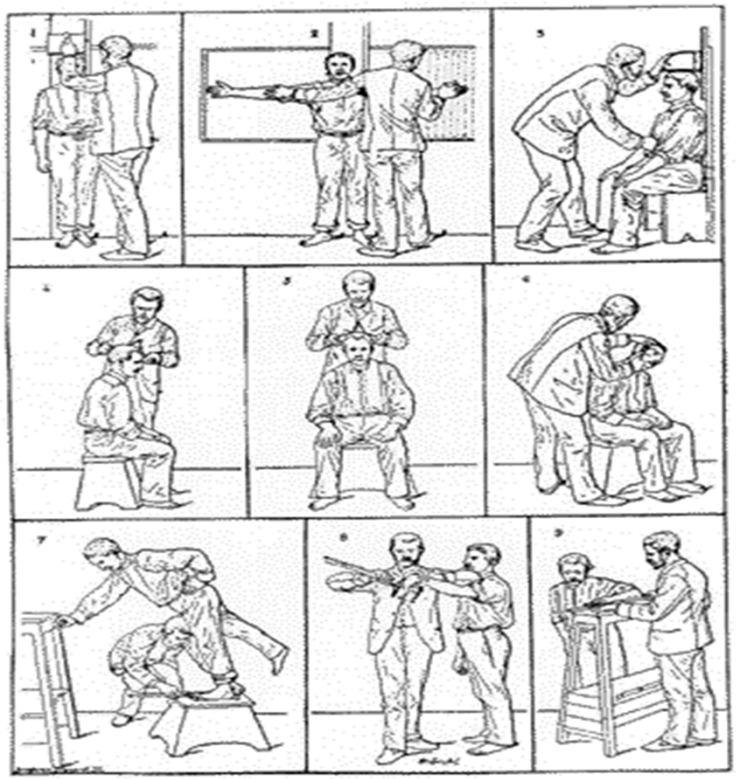
Origin of the Term Biometrics

- Morris (1875): Derived from the Greek words *Bios:* life and *Metron: a measure*
- Pollack (1981): "What makes each person unique?" Use of biometrics in the context of access control
- Automated recognition of individuals based on their behavioral and biological characteristics [ISO/IEC JTC1 2382-37:2012]

Stigler, "The Problematic Unity of Biometries", BIOMETRIC5, S6 , Sept. 2000; Pollack, "Technology: Recognizing the Real You", NYT, Sep. 24, 1981

First Biometric System (1882)

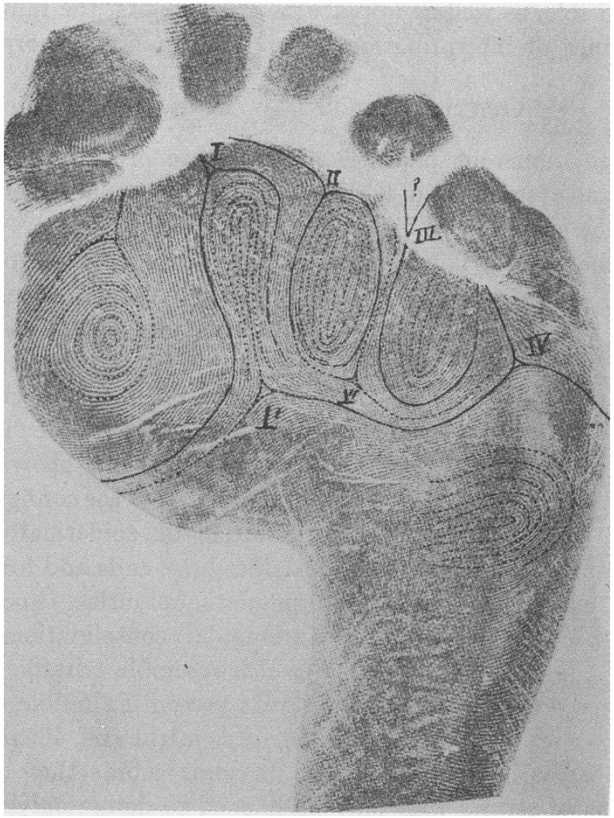
Identify repeat offenders



H.T. F. Rhodes, Alphonse Bertillon: Father of Scientific Detection, Harrap, 1956

Friction Ridge Patterns

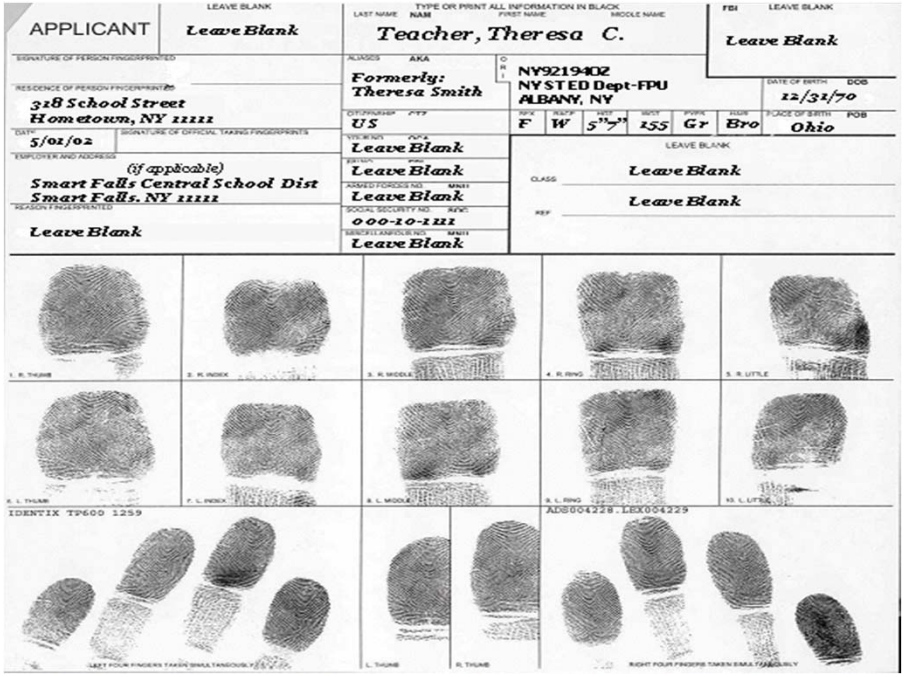
First Automatic Fingerprint identification system (AFIS): ~1980



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

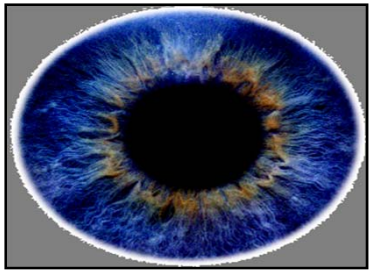
Fingerprints in Law Enforcement

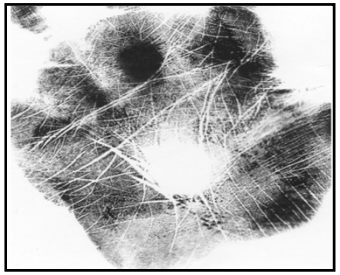
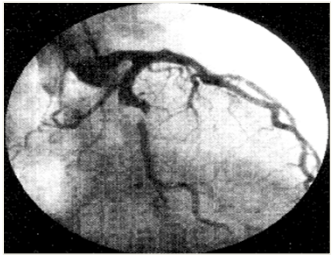
- Repeat Offenders: Compare rolled/slap tenprints
- Crime Scene evidence: Compare latents to tenprints

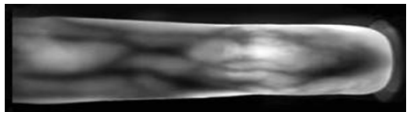


Beyond Fingerprinting

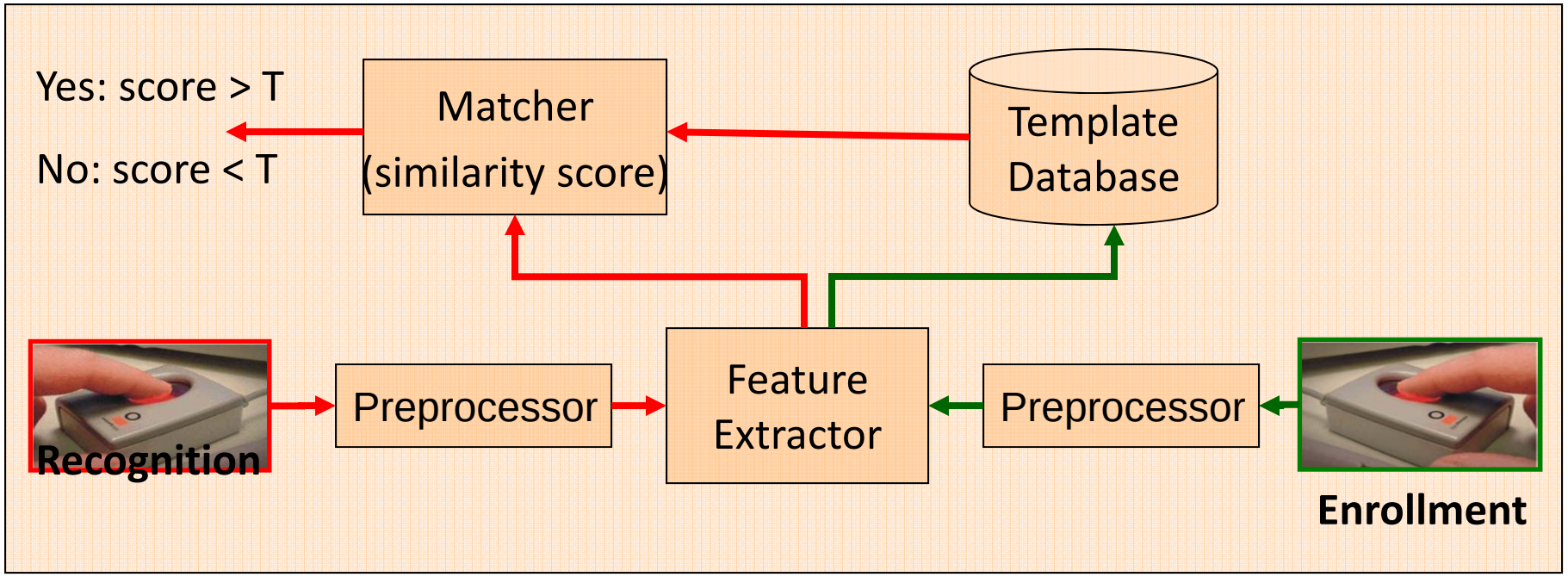




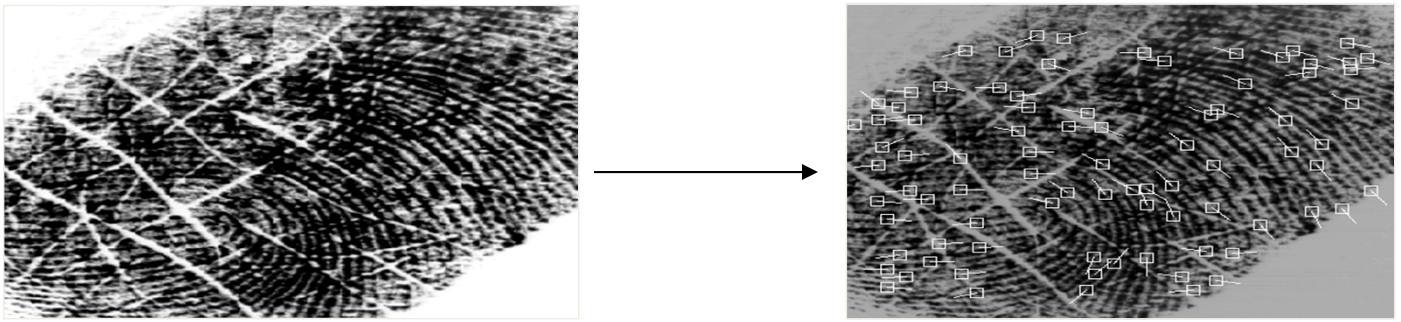



Design of Biometric System

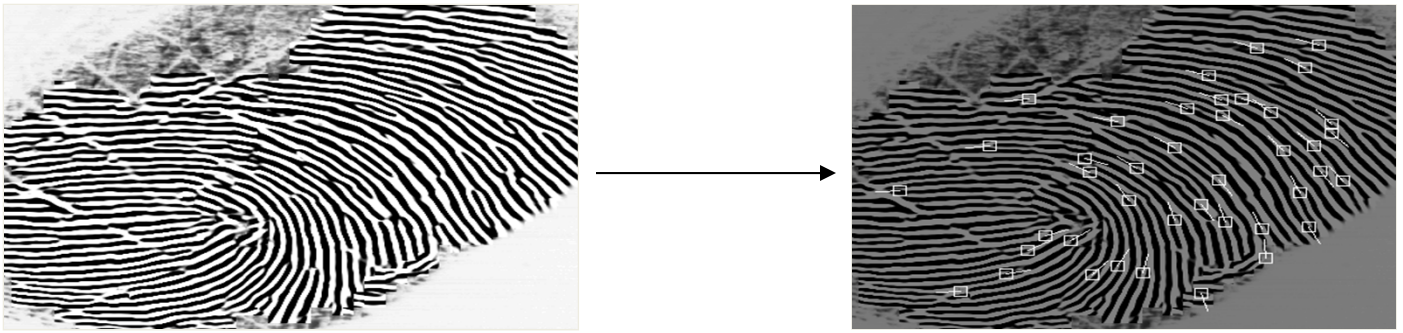


- Verify a claimed identity (1:1 comparison)
- Person enrolledd in the system? (1:N comparisons)

Pre-processing

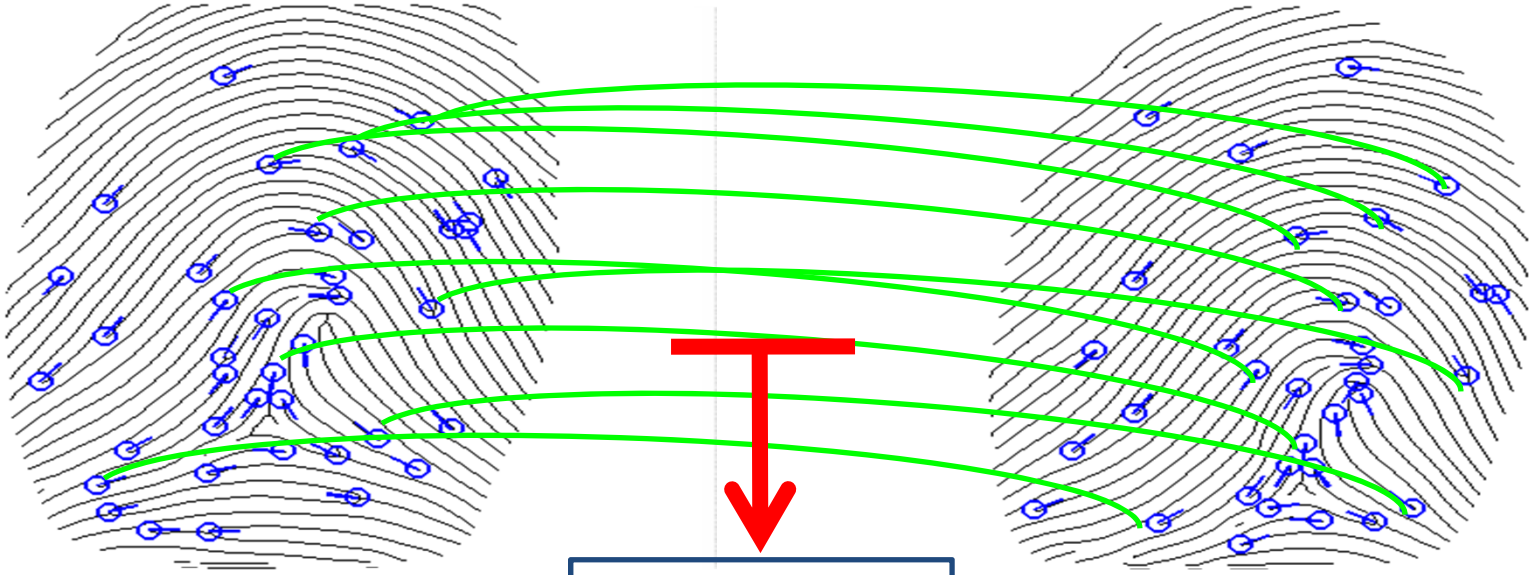


Minutiae extraction before enhancement



Minutiae extraction after enhancement

Fingerprint Matching

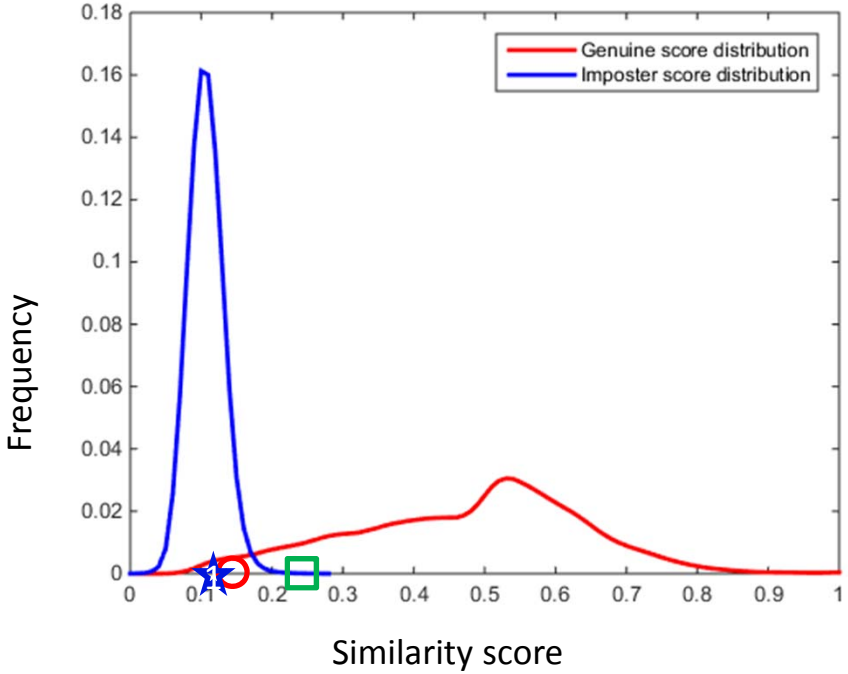


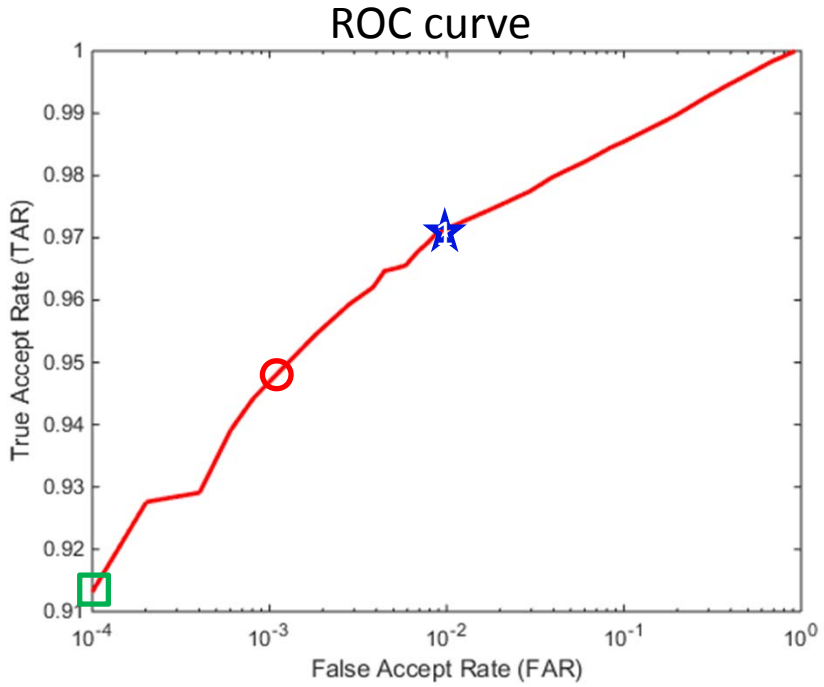
Query fingerprint

Similarity = 0.9
Match!

Enrolled fingerprint

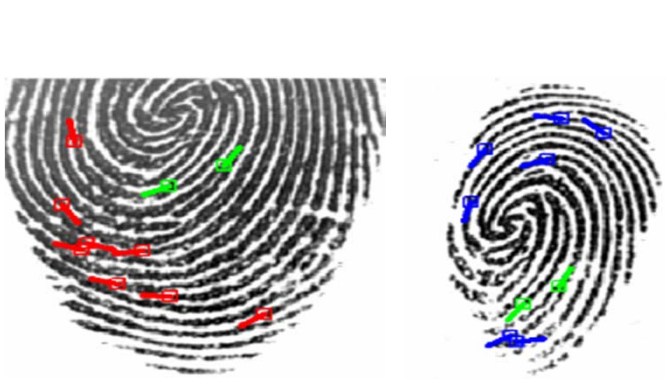
Matching Performance



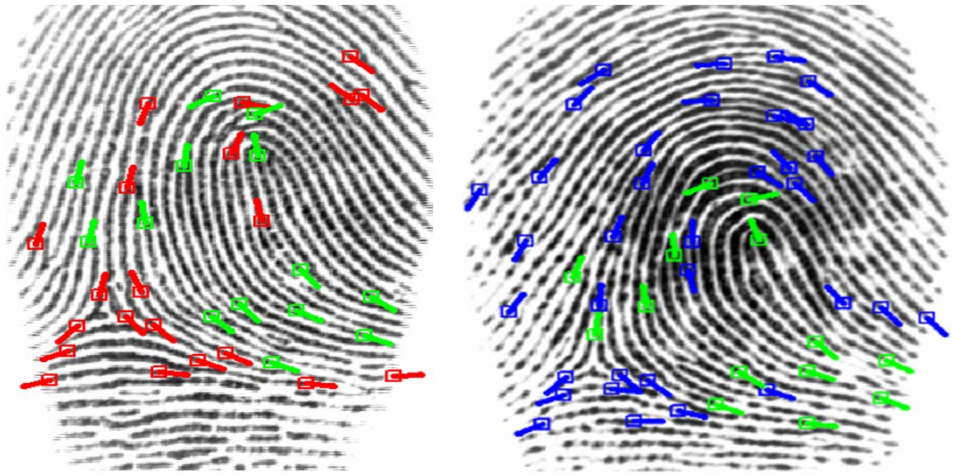


Three different operating points (threshold)

Sources of Matching Error



False Reject

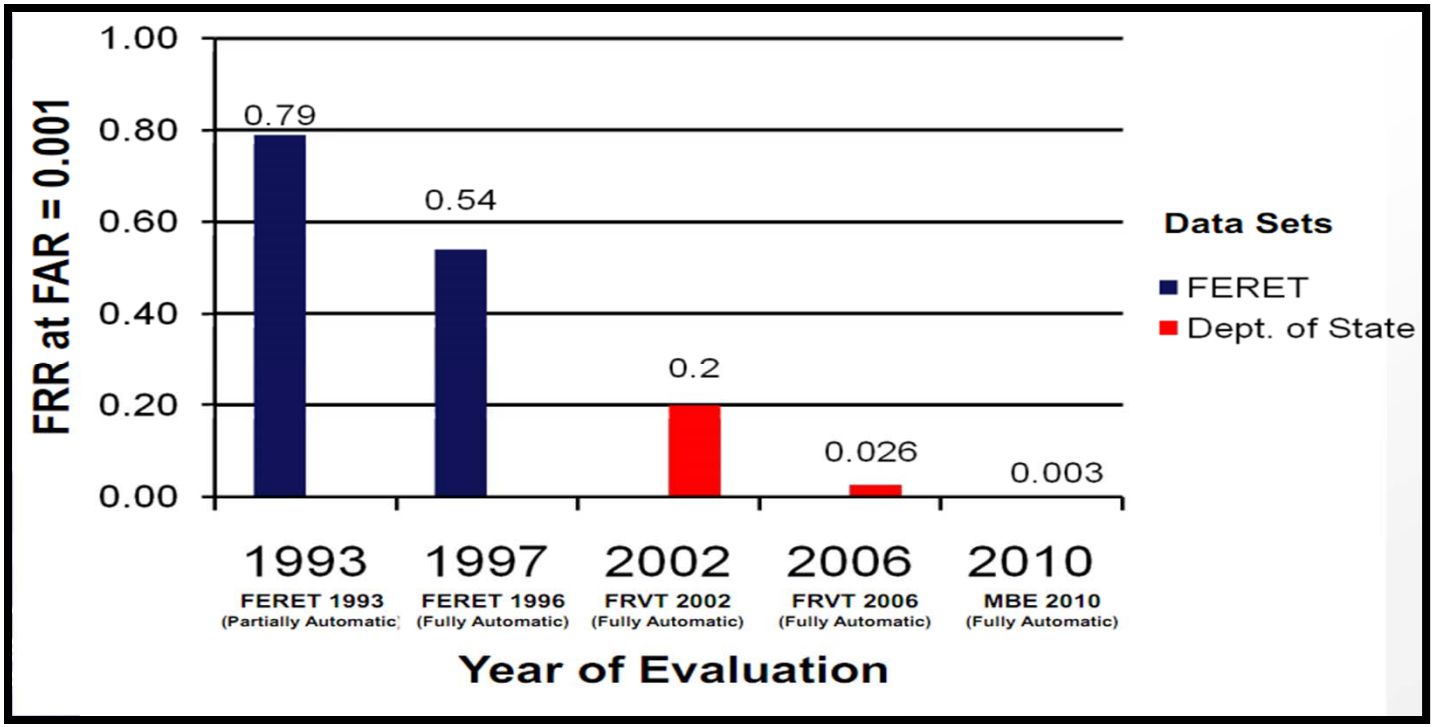


False Accept

Green squares: matched minutiae

Ergonomics, user habituation, acquisition environment

Accuracy of Face Recognition



J. Phillips, IEEE Fourth International Conference on Biometrics: Theory, Applications, and Systems (BTAS 2010)

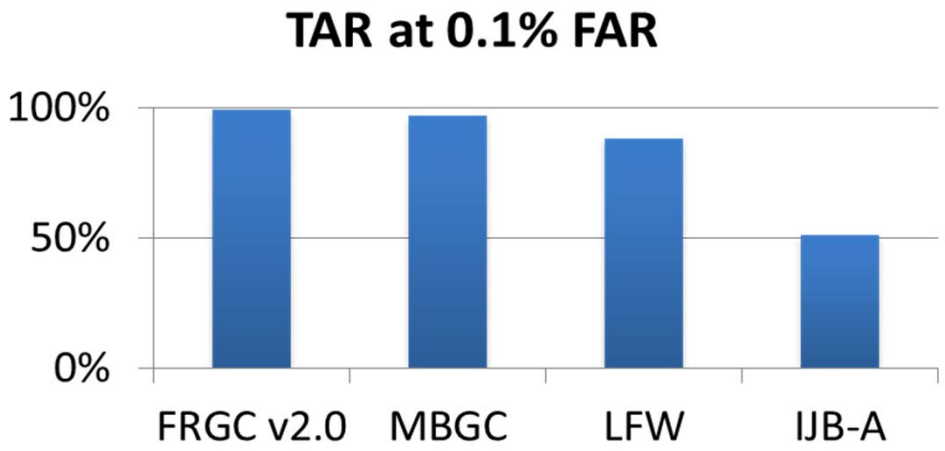
Errors in Face Verification

NIST FRGC v2.0 (2006)

NIST MBGC (2010)

LFW (2007)

NIST IJB-A (2015)



D. Wang, C. Otto and A. K. Jain, "Face Search at Scale: 80 Million Gallery", arXiv, July 28, 2015

Design Considerations

- Requirements

  Error rates (FAR, FRR, FTE, FTA); enrollment; throughput; single-factor v. multi-factor authentication

- Choice of biometric trait
- System security
- Exception handling; user recourse

Which Biometric Trait?

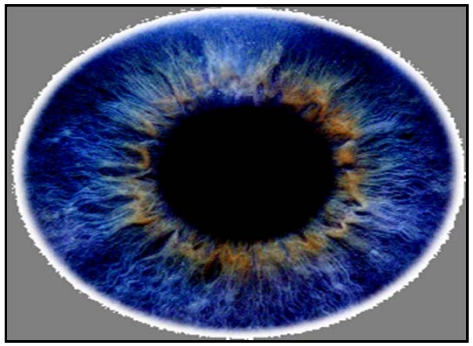
- Distinctiveness
- Permanence
- Universality
- Performance
- Collectability
- User acceptance
- Circumvention
- Integration

Multibiometrics

Enroll multiple traits

One of more fingers

2D and/or 3D face



One or both irises

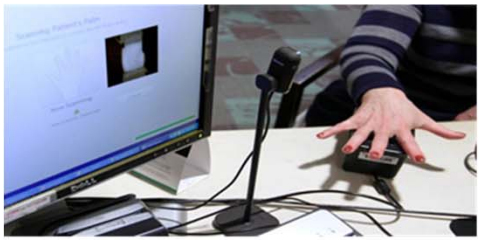
- Usability: User decides which trait to use for authentication
- Security: System decides; challenge-response

Biometric Applications

Meijer supermarket, Okemos

U.S. Visit (OBIM)

Time & Attendance



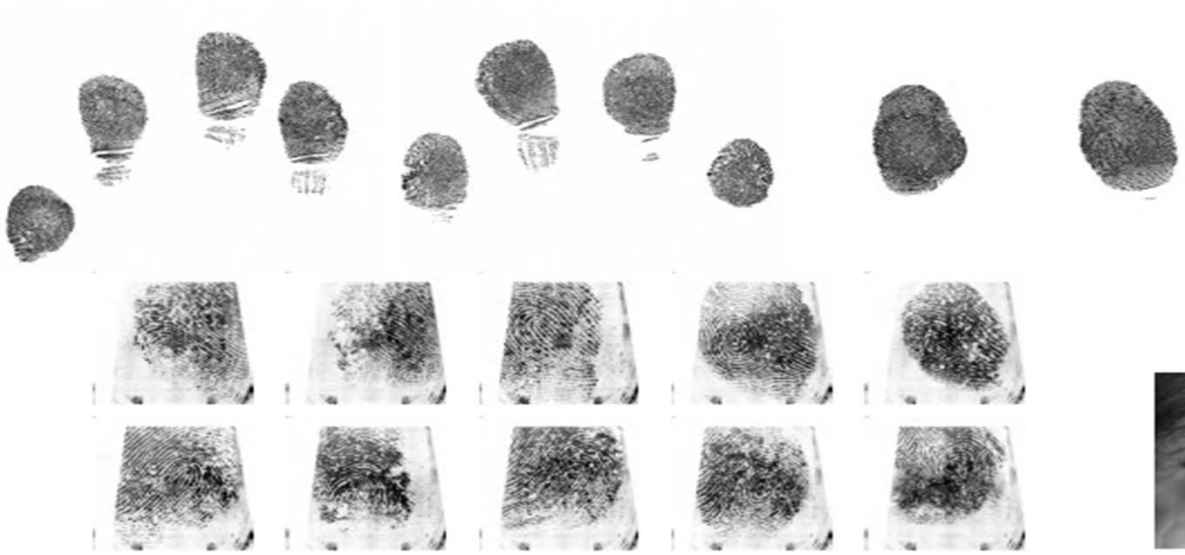
Texas hospital system
(2,488 named Maria Garcia, 231 with same DoB)

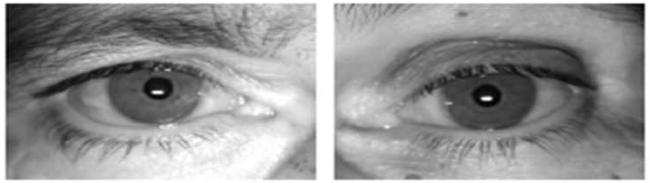
HK smartcard ID

Disney Parks

Coal mine safety

World's Largest Biometric System





~900M unique 12-digit IDs issued (Oct. 2015)

1: 900M biometric comparisons needed before issuing a new ID

https://uidai.gov.in/

Drivers for Biometrics in Banking

- Stolen & forged ID cards; weak passwords & PIN
  - Lack of Trust by bank customers
    - "U.S. Unseals indictment in Big case of Hacking"
  - Losses incurred by banks
    - Fraudulent transactions at ATMs on the rise
- Technology & algorithms meet the requirements
- Push for mobile payment
- Customer acceptance of biometrics over card & PIN

http://www.nytimes.com/2015/11/11/business/dealbook/prosecutors-announce-more-charges-in-jpmorgan-cyberattack.html?_r=0

ATM

(first installed by Barclays Bank, 1967)

Who is entering the card and the PIN?

Biometric-Enabled ATMs

Lanzhou, China

Finger vein

Iris scan

Banco Bradesco, Brazil

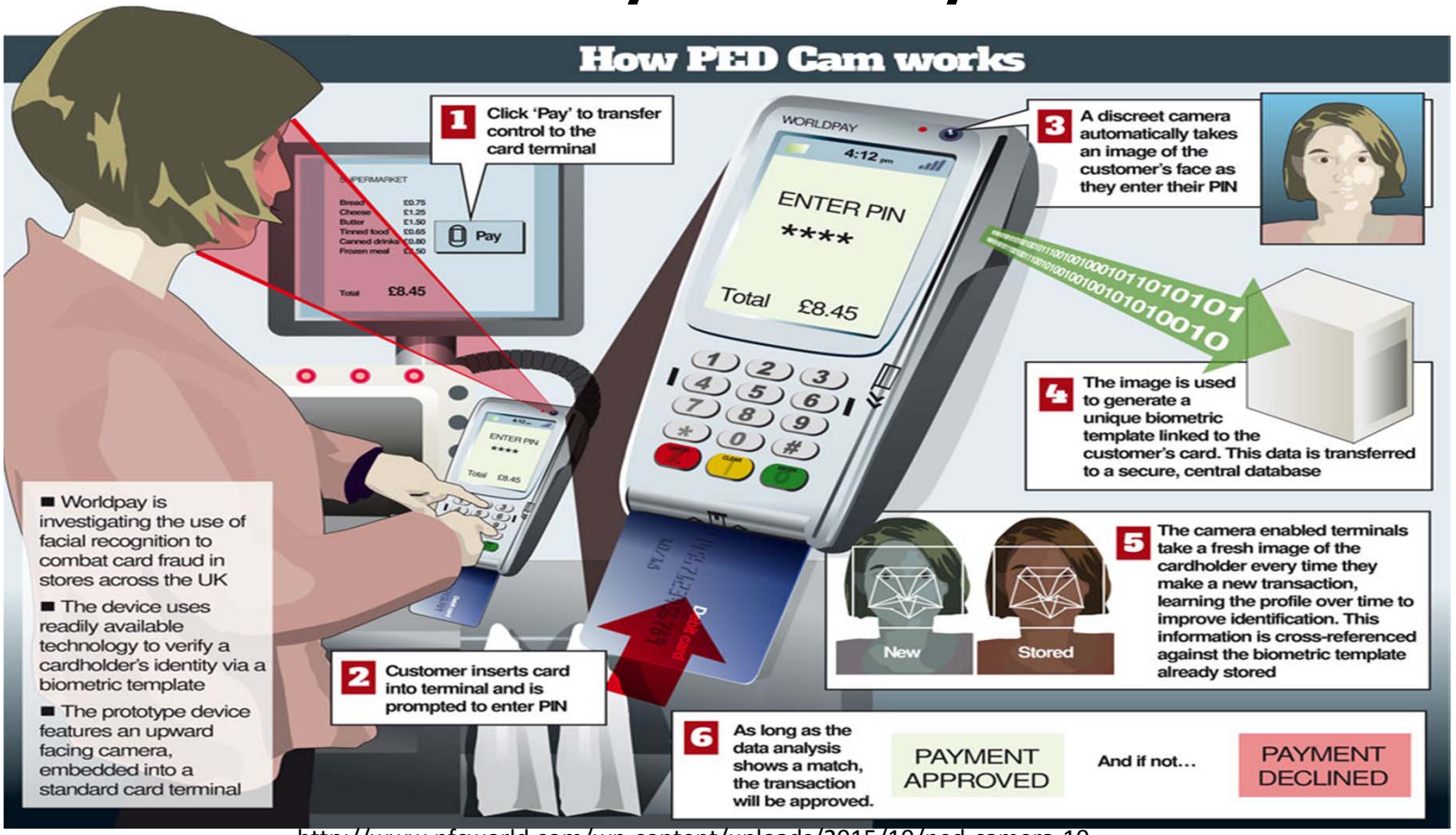
Palm vein

Over 80,000 biometric ATMs in Japan and 22,000 in Brazil

PoS Terminals Now

https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0CAYQjB1qFQoTCMTe9MTJiMkCFQV6Pgod8LsKaA&url=https%3A%2F%2Fmarketplace.secondlife.com%2Fp%2FM

World Pay POS System



http://www.nfcworld.com/wp-content/uploads/2015/10/ped-camera-10

Biometrics for Payment is Not New

"Pay By Touch" provided products in biometric financial transactions and payment processing; shut down in 1998

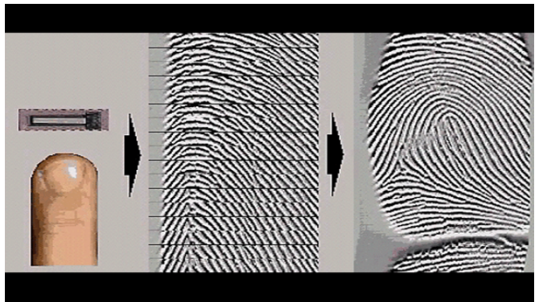
John Rogers, CEO of Pay by Touch: http://www.sfgate.com/news/article/How-visionary-raised-and-lost-a-fortune-3181454.php

Evolution of Fingerprint Readers

Identix (1995), $2.5K
12.5cm x 18cm x 6cm; 1 lb.

Digital Persona

Lumidigm



Authentec, Swipe sensor

Crossmatch

Morpho “Finger on the Fly”

Goodix

96x96 pixels

Processor & Memory Capabilities

Year	1989	2014
Enrollment	724K	4M
#Searches/day	400 tenprints	2,000 tenprints; 35 latents
Speed	15K comparisons/sec.	25M comparisons/sec.

Courtesy, Scott Blanchard, MSP

Apple iPhone 6s

1.84 GHz; 2 GB RAM

Mobile Phones

Joseph Van Os / Getty Images

~7B mobile subscriptions worldwide (ITU, May 2014); M-Pesa launched in Kenya in 2007

Early Biometric Enabled Phones

Toshiba G500 (2007)

HTC P6500 (2007)

Acer M900 (2009)

Smartphone Authentication

Face Unlock

2011

Android Fingerprint

2011

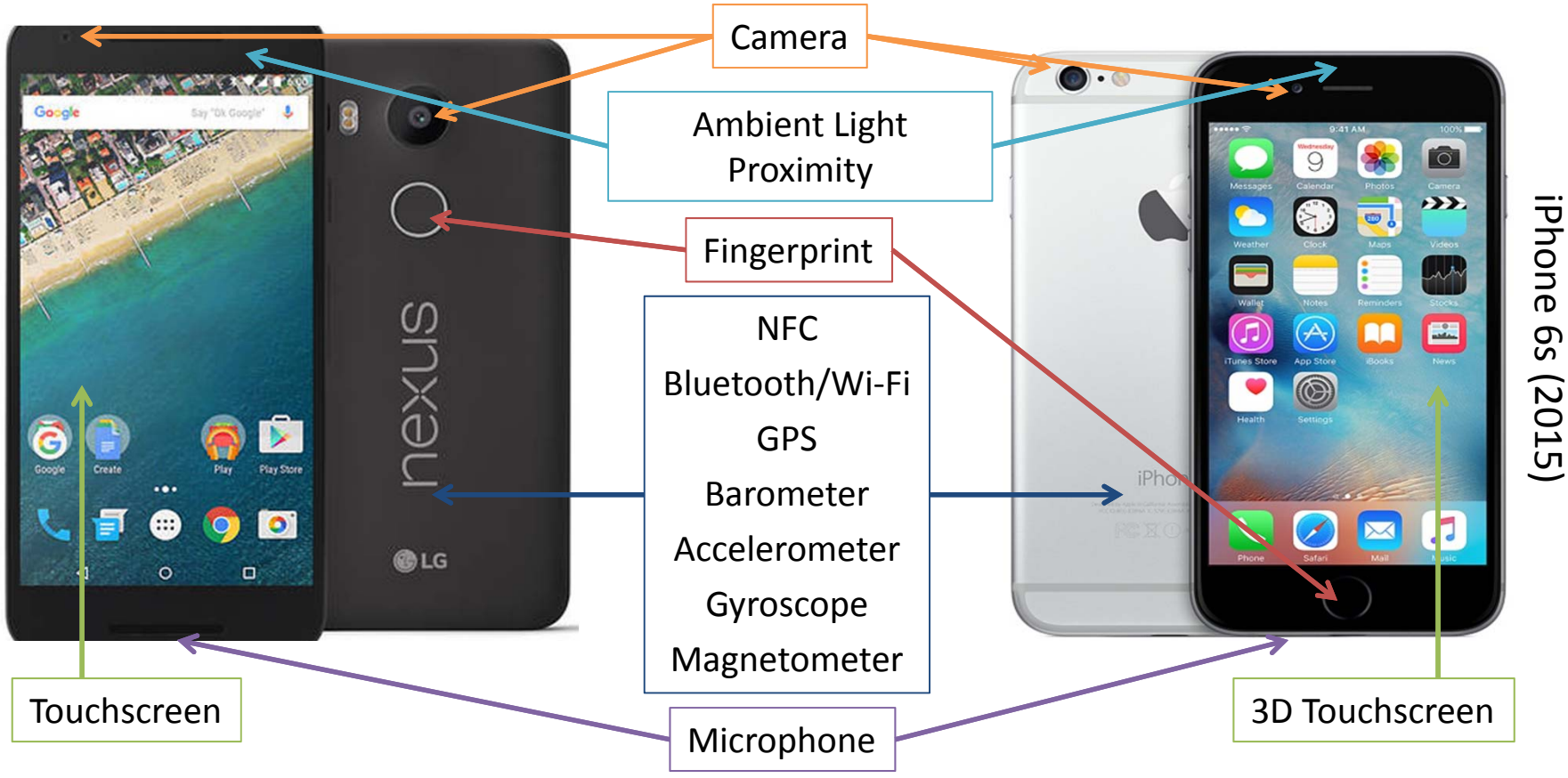
iOS Touch ID

2013

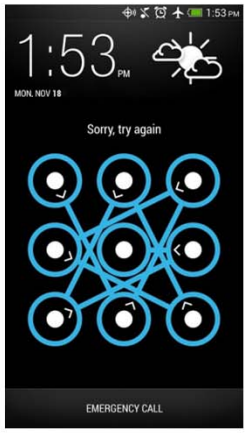
Iris Passport

2015

Smartphone Sensors

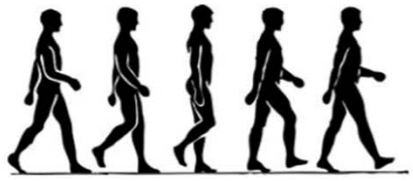


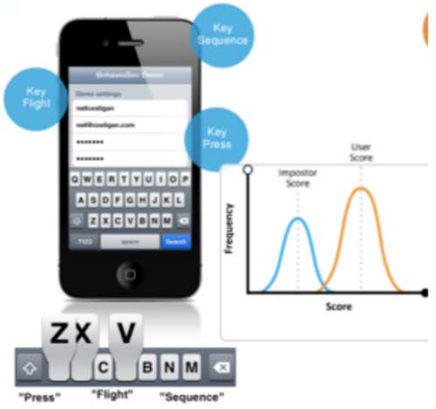
Authentication Types



Obtrusive

PIN, Visual pattern, Fingerprint, Iris, Face, Voice





Unobtrusive

Gait, Touch, Location, Keystroke, Face (partial)

Continuous Authentication

- Initial, obtrusive authentication (conscious user input) for unlocking phone
    - Keeping unauthorized users out is priority
- Continuous, unobtrusive authentication (without user's conscious awareness) as user operating phone
    - Uninterrupted user experience for valid user is priority

Smartphone Payment Systems

Android Pay

September, 2015

Accepted at 1 million+ stores

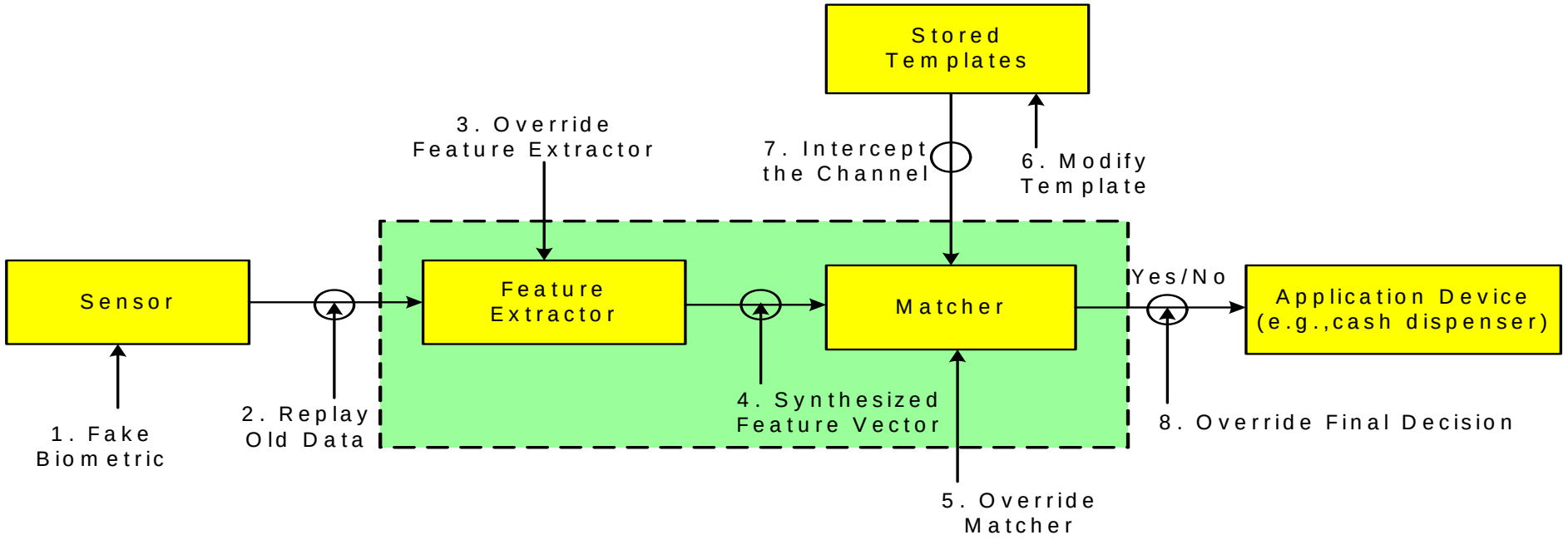
Apple Pay

October, 2014

Supported by 300+ Banks

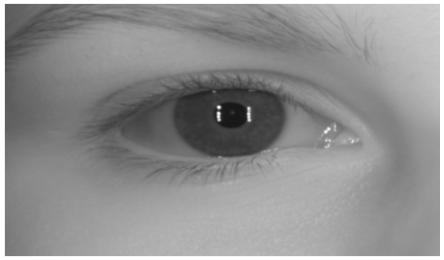
Millions of Capable Devices

Securing Biometric Systems

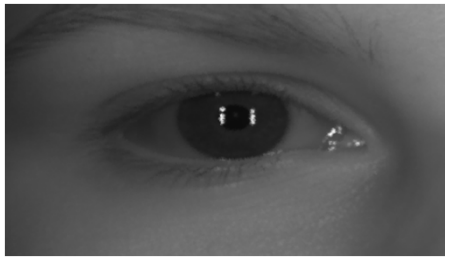


Insider attacks?

Spoof Attacks



Live Iris



Fake Iris

Live Fingerprint

Fake Fingerprint

Live Face

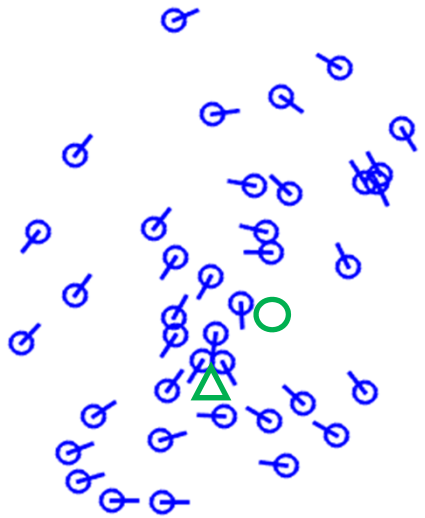
Printed Face

Video frame (replay attack)

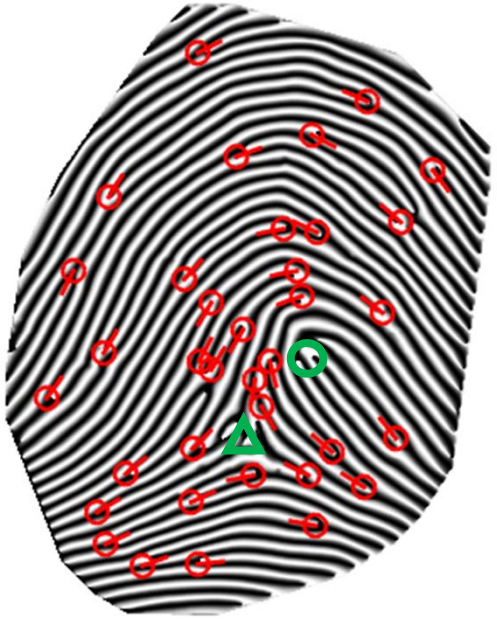
3D Face mask

Template Protection

(a) Fingerprint image



(b) ISO template



(c) Reconstructed image from template

Similarity score between (a) and (c) is 203 (Threshold at FAR=0.01% is 33)

Security v. Privacy

- **How will bank store customer biometric data?**
- **Will they share it with others?**

Summary

- Since its first use in law enforcement & forensics over 100 years back, biometrics is changing the way we conduct everyday transactions, especially payment
- Biometric authentication score needs to be combined with other user & transaction data to minimize risk
- Multi-biometrics, including soft biometrics, will provide stronger authentication & richer user experience
- Challenges: reduce error rate, provable security, testing,…..