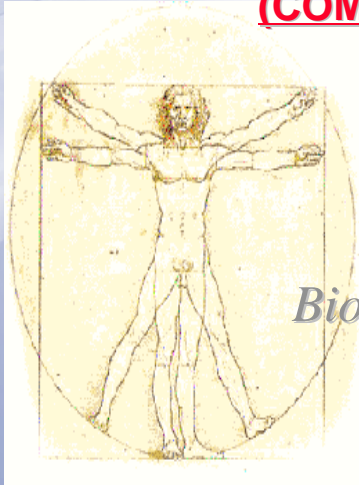


# Biometrics & Security (COMP435)



## Lecture 1

*Biometrics Authentication:  
Introduction*



## *Outline*

- Why Biometrics?
- What about Biometrics?
- Biometric Applications
- Useful Links

# *Why Biometrics?*

## **Why Security in e-World**

*Why?*

- ❑ We enter *the age of universal electronic connectivity* ⇒ *e-World*:
  - ⇒ *e-commerce*                    ⇒ *e-banking*
  - ⇒ *e-shop*                            ⇒ *e-purse*
  - ⇒ *e-phone*                         ⇒ *e-government .....*
- ❑ In an e-world, the more and more activities are related to **INTERNET**.
- ❑ With Internet development, there exist some troubles and problems.
  - ⇒ *Viruses*                            ⇒ *Hackers*
  - ⇒ *Computer theft*                ⇒ *Unauthorized access .....*



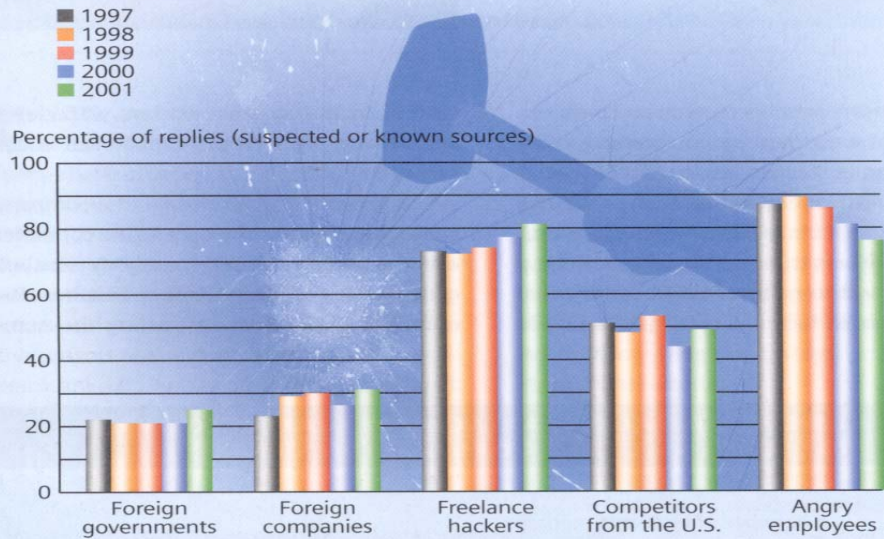
Why\_security



e-Banking

## Different Types of Attacks

### ATTACKS ON U.S. COMPANIES & GOVERNMENT AGENCIES



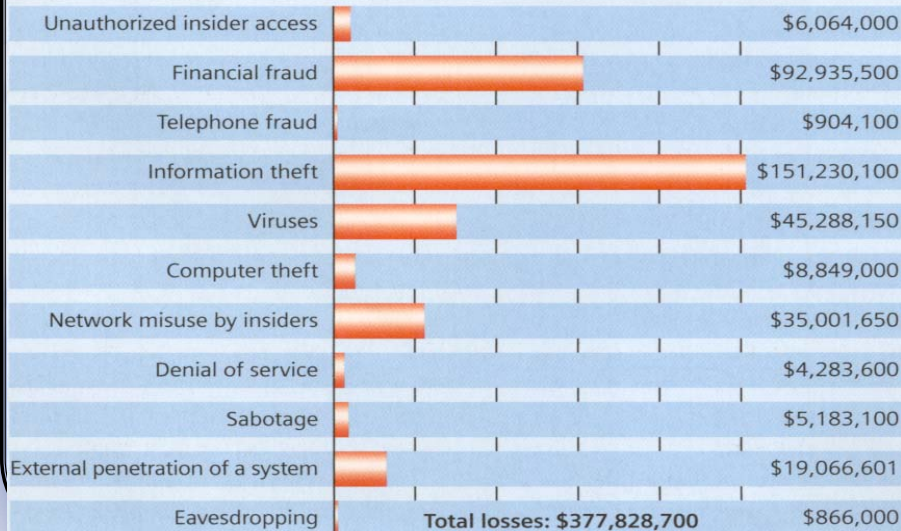
## Growing Attack Problems

### NUMBER OF HACKER ATTACKS REPORTED TO THE INDEPENDENT CERT COORDINATION CENTER



## Money Losses from the Troubles

### QUANTIFIABLE LOSSES IN 2001 (U.S.)



## Security Solutions

Why?

- ❑ All these problems threaten the prosperity and productivity of corporations and individuals.
  - ⇒ Security is increasingly important.
  - ⇒ Two approaches:
    - “Make Water Clear” - “使水变清”
    - “Make Water Chaotic” - “把水搅混”
- ❑ One security solution: **Authentication**
  - ⇒ Verify **message** and **user**.
- ❑ In fact, there is an ever growing need to **identify individuals** in e-world.
  - Should this person be given **access** to a secure system?
  - Does this person have **authorization** to perform a given transaction? .....

## User Authentication Problem

Why?

- Every day, questions like "Who Are You?" that are related to **establishing the identity of individuals** are asked **millions times**.

### PROBLEM 1: (Credit Card)

Each year, **billions of dollars are lost** through the fraudulent use of credit cards.

### PROBLEM 2: (Benefit Care)

**A lot of money losses** due to the abuse of health care unemployment insurance benefits and welfare systems.

### PROBLEM 3: (Immigration)

Many individuals **illegally enter the country** each year using falsified travel documents.

## A Great Challenge: User Authentication

Why?

- User authentication (identity verification): The computer can **identify certain people**.  
⇒ **Positive authentication** is crucial!
- Since more and more **highly fraudulent technologies** in today's complex society, the problem of identifying a person continues to pose **a great challenge**.
- User authentication is based on three methods:
  - What you know
  - What you have
  - What you are / What you do

## Traditional Methods

- Traditional means of automatic identification

### ⇒ Knowledge-based

- Use "something that you know"
- Examples: password, PIN

abc0123

Passwords/PINs

What you know

### ⇒ Token-based

- Use "something that you have"
- Examples: credit card, smart card, keys



Keys



Cards

What you have

## How Many Passwords can you Remember?

◆ Work	◆ Home
<ul style="list-style-type: none"> <li>- Internal network                             <ul style="list-style-type: none"> <li>» WinNT workstation</li> <li>» Unix workstation</li> </ul> </li> <li>- External computer                             <ul style="list-style-type: none"> <li>» WinNT workstation</li> <li>» Unix workstation</li> <li>» Mail server</li> <li>» Laptop computer</li> </ul> </li> <li>- Lab computers                             <ul style="list-style-type: none"> <li>» Face system</li> <li>» Iris system</li> <li>» Scanner workstation</li> </ul> </li> <li>- ID Badge</li> <li>- Personnel System</li> <li>- Door Access device</li> <li>- Government ATM card</li> </ul>	<ul style="list-style-type: none"> <li>- Bank                             <ul style="list-style-type: none"> <li>» ATM card</li> <li>» Spouse's ATM card</li> <li>» Telephone access</li> <li>» Spouse's telephone access</li> </ul> </li> <li>- Telephone                             <ul style="list-style-type: none"> <li>» AT&amp;T calling card</li> <li>» BellAtlantic calling card</li> </ul> </li> <li>- Internet                             <ul style="list-style-type: none"> <li>» Dial-in access TWA</li> <li>» Expedia SouthWest Airlines</li> <li>» Travelocity Mutual Funds</li> <li>» AT&amp;T</li> <li>» Bell Atlantic</li> <li>» Amazon.com</li> </ul> </li> <li>- Alarm System</li> </ul>

## What Problems for Traditional Methods?

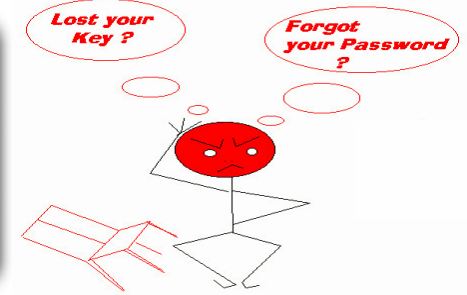
Why?

Methods	Drawbacks
User Id, Password, PIN	Shared, Many Passwords Easily Forgotten
Cards, Badges, Keys	Shared, Can Be Lost Or Stolen
ATM Card + PIN	Shared PIN a weak link

## What Problems

Why?

- ❑ At the NY Times web site, about 1,000 people per week forget their passwords
- ❑ Common hacker tools can typically guess 30% or more of the passwords on a network
  - Some hackers claim 90% success
- ❑ Tedious, time-consuming, inefficient & expensive



## Real ATM Problems

Why?

### ATM Transaction

- **Cards can be stolen**
  - **PINs can be guessed**
- (25% of people seem to write their PIN on their ATM card)
- ❑ Estimates of annual identity fraud damages:
    - \$1 billion in welfare disbursements
    - \$1 billion in credit card transactions
    - \$1 billion in fraudulent cellular phone use
    - \$3 billion in ATM withdrawals



1. Insert ATM card
2. Enter PIN

## Solution by Biometrics

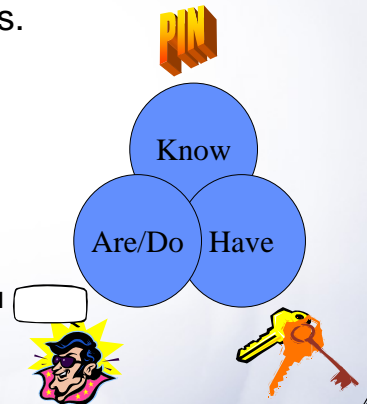
Why?

- ❑ Biometrics are automated methods of recognizing a person based on a physiological or behavioral characteristics.

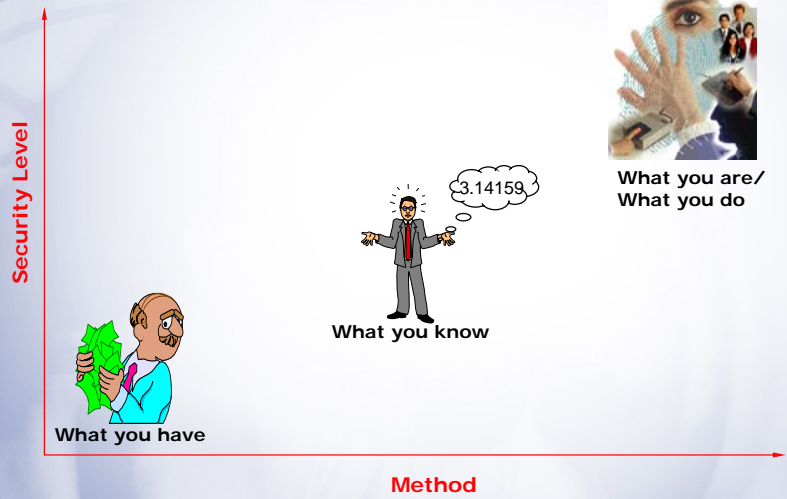
⇒ **WHAT YOU ARE / DO**

- ❑ Biometrics is based upon a distinguishable trait

- It is more secure
- Your unique trait is part of you
- It is user-friendly



## User Authentication Three Methods: Comparison



## Why Biometrics ?

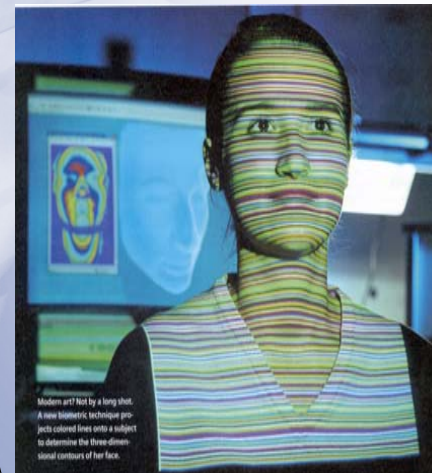
Biometrics complement existing security systems, in particular they

- enhance security, cannot be stolen or copied
- increase convenience, cannot be lost or forgotten
- increase audit trail, cannot be given to another person
- accuracy depends on human changes and environmental conditions



## What about Biometrics?

## Body Language: Biometrics



- ❑ No two people are the same.
- ❑ With this in mind, we can use the methods that enable the unique characteristics of eyes, faces and voices to be converted into data keys that enhance security and convenience.

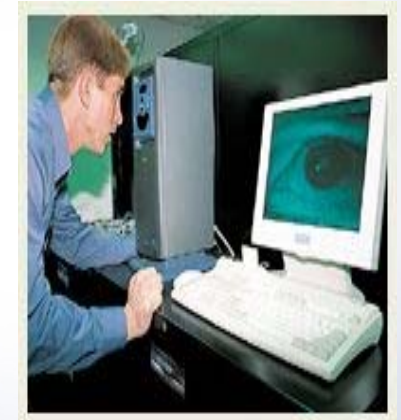
## Biometrics Authentication: Security and Privacy Concerns

- ❑ Biometrics can overcome some of the limitations, hence it offers *greater security and convenience* than traditional methods.
- ❑ In some applications, biometrics can **replace** or **supplement** the existing technology. In others, it is **the only viable approach**.
- ❑ Biometrics-based identification is emerging as the most reliable method.



## Advantage of Biometrics

- ❑ Identify the rightful owner of token/ knowledge
- ❑ User convenience
- ❑ Eliminate repudiation claims
- ❑ Difficult to copy or forge
- ❑ Enhanced security
- ❑ Cannot be Lost, forgotten or transferred



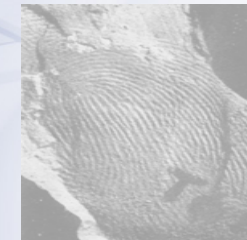
## History of Biometrics

What?

- Biometrics from the worlds “Bio” and “metrics”. Bio means living things. Metrics means measure.
- Currently, Biometrics stands for measuring human’s features for personal identification.
- We have used biometrics more than five thousand years – face recognition
- In the late 19th century, we have used fingerprint for criminal identification.
- We also use signatures for government, legal and commercial transactions long time.

## History of Biometrics

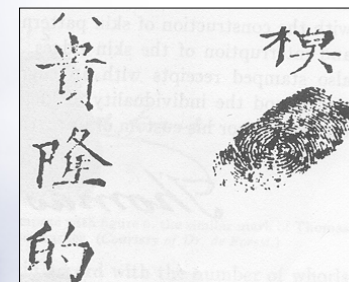
What?



Fingerprint on Palestinian lamp (400 A.D.)



Bewick's trademark



A Chinese deed of sale (1839) signed with a fingerprint

## History of Automatic Biometrics

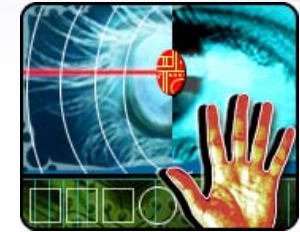
What?

- Since 1960, we started to design automatic methods for biometrics recognition.
  - Automated **Fingerprint** Identification System 1960
  - **Speaker** Identification, *Science, News Series*, vol. 166, no. 3903, 1969.
  - Computer Recognition of Human **Faces**, T. Kanade, Birkhauser, Basel and Stuttgart, 1977.
  - **Retinal** Identification, " *US Patent No.* 4109237, 1978.
  - Authentication by **Keystroke** Timing, Rand Report, R-256, *NSF, Rand Corp.*, 1980.
  - Automatic **Signature** Verification, *IEEE Trans, SMC-C* 1983
  - Iris Recognition, J. Daugman, *IEEE PAMI* 1993
  - Automated personal identification by **palmpoint**, D. Zhang, et al., *Optical Engineering*, 1998.

## Biometrics Definition

What?

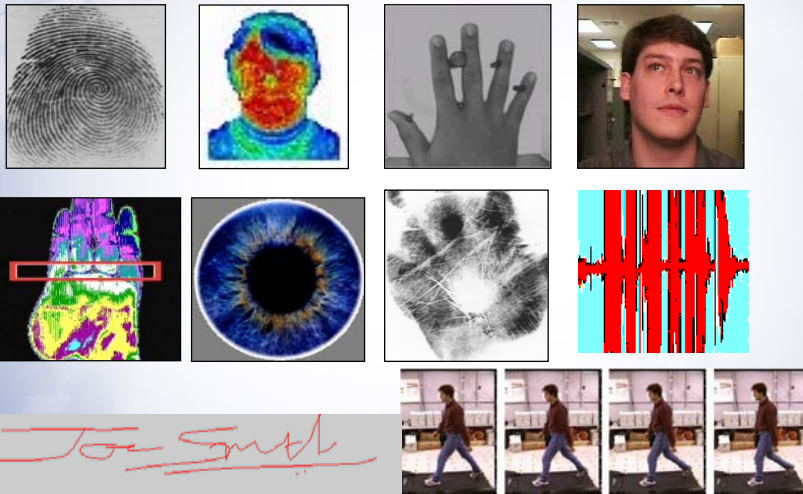
- ❑ Automated methods of recognizing individuals based on their traits



- ❑ A measurable *physical characteristics* or *personal behavioral trait* used to recognize the identity, or verify the claimed identity, of an enrollee

## Examples of Biometrics

What?



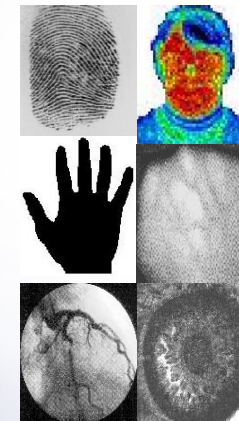
## Classification: Biometrics Data

What?

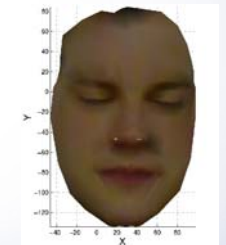
1D Biometrics



2D Biometrics



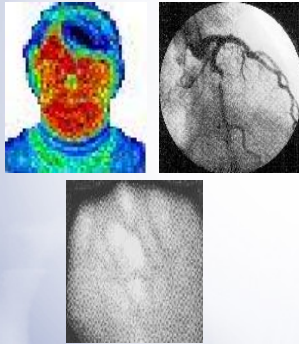
3D Biometrics



# Classification: Biometrics Features

What?

Inside Feature



Outside Feature



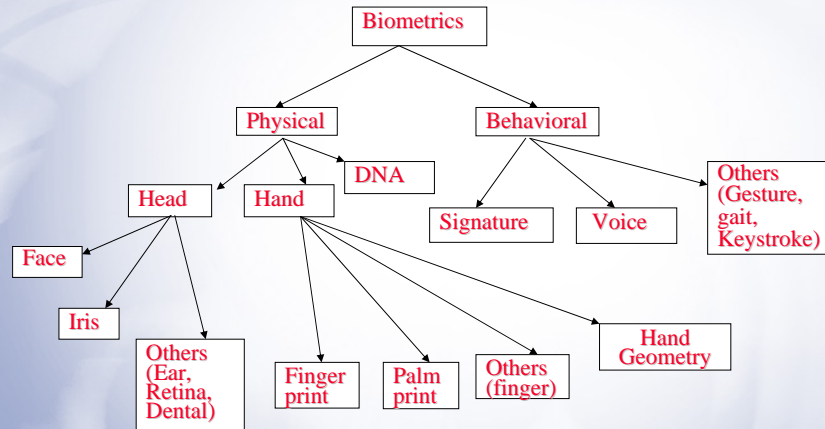
# Biometrics Classification

Two types of biometrics

- **Physiological:** fingerprint, iris, hand geometrics, palmprint, etc
- **Behavioral:** voice, signature, etc
- Selection of biometrics technology is *Application dependent*
- Different technologies may be appropriate for different applications, depending on perceived user profiles, the need to interface with other systems or databases, environmental conditions, and a host of other application-specific parameters

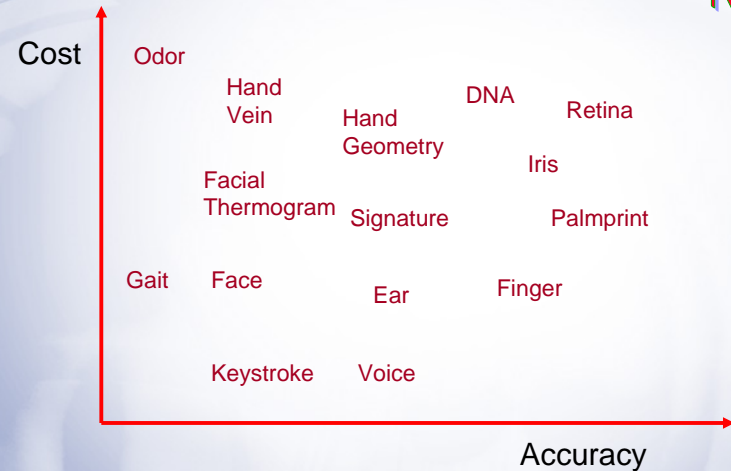
# Taxonomy of Biometrics

What?



# Our View of Biometric Evaluation

New

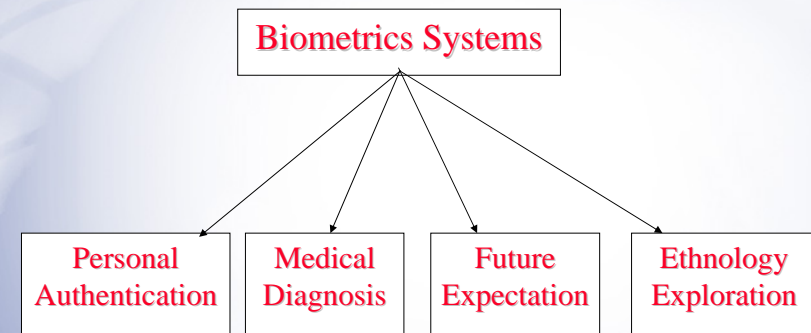




## Biometric Applications

## Taxonomy of Biometrics Applications

Applications



Taxonomy by Application Type

D. Zhang, 2000, *Automated Biometrics: Technologies & Systems*, Kluwer Academic Publishers, USA, 331pp, 2000, ISBN 0-7923-7856-3.

## Biometric Applications Applications

### Four general classes:

- **Access (Cooperative, known subject)**
  - Logical Access (Access to computer networks, systems, or files)
  - Physical Access (access to physical places or resources)
- **Transaction Logging**
- **Surveillance (Non-cooperative, known subject)**
- **Forensics (Non-cooperative or unknown subject)**

\* There are **two** types of identification system. The first one can reject unknown user. The second one only return a userID, whose feature is the most similar to the input features.

- The first approach normally uses for **commercial applications**
- The second approach normally uses for **forensic applications**

## Biometric Applications (2) Applications

Applications

- **Transactions via e-commerce**
- **Search of digital libraries**
- **Computer logins**
- **Access to internet and local networks**
- **Document encryption**
- **Credit cards and ATM cards**
- **Access to office buildings and homes**
- **Protecting personal property**
- **Tracking and storing time and attendance**
- **Law enforcement and prison management**
- **Automated medical diagnostics**
- **Access to medical and official records.**

## Selecting Biometrics Technology

- Selection of biometrics technology is *Application dependent*
- Different technologies may be appropriate for different applications, depending on perceived user profiles, the need to interface with other systems or databases, environmental conditions, and a host of other application-specific parameters

### Two kinds of Criteria

User Criteria	Technology Criteria
<b>1. Effort</b> <ul style="list-style-type: none"> <li>• How much time and effort is required on the part of the user.</li> </ul>	<b>1. Cost</b> <ul style="list-style-type: none"> <li>• Cost of hardware capture device</li> </ul>
<b>2. Intrusiveness</b> <ul style="list-style-type: none"> <li>• How intrusive the users perceives the system to be.</li> </ul>	<b>2. Accuracy</b> <ul style="list-style-type: none"> <li>• How well the system identifies individuals</li> </ul>

## Issues to Consider

1. Size of user group.
2. Place of use and mobility of user.
3. Ease of use & user training.
4. Error incidence (age, environment, health).
5. Security & Accuracy requirement.
6. User acceptance, privacy & anonymity.
7. Long term stability (mature tech, standard, support).
8. Cost –
  - Research & evaluation
  - Hardware & Software
  - Installation & testing
  - User education & productivity
  - Exception handling for those who can't use
  - Maintenance

## Factors for Choosing Biometrics

- **Distinguished trait**
  - Is the trait being measured unique?
  - i.e. Fingerprints - 100 years of history, well accepted
  - Height and weight - not very unique, subject to change
- **Easy to sample**
  - Time needed to collect a sample
  - User acceptance: face scan is good, but blood sample is bad
  - Cost for sampling equipment
- **Low system cost**
  - Total cost of purchasing equipment, enrolling users, etc
- **Bottom Line**
  - Fast and accurate, low-cost, and easy to use.

## Main Applications

Forensic	Government	Commercial
<b>Corpse Identification</b>	<b>National ID Card</b>	<b>ATM</b>
<b>Criminal Investigation</b>	<b>Driver's License</b>	<b>Access Control Web Access</b>
<b>Parenthood Determination</b>	<b>Welfare Disbursement*</b>	<b>Cellular Phone</b>
<b>Missing Children</b>	<b>Border Crossing</b>	<b>e-commerce Credit Card</b>

\* ~ \$1 billion dollars in welfare benefits are annually claimed by "double dipping" welfare recipients

# Domains of Application

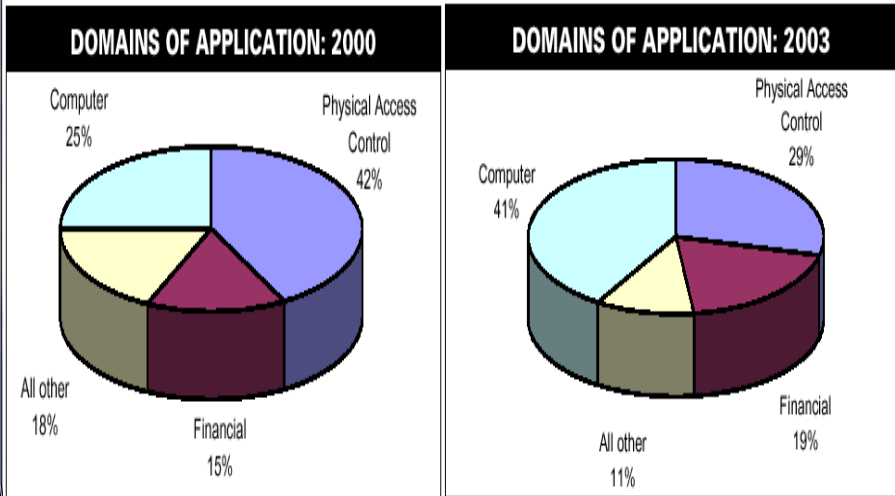
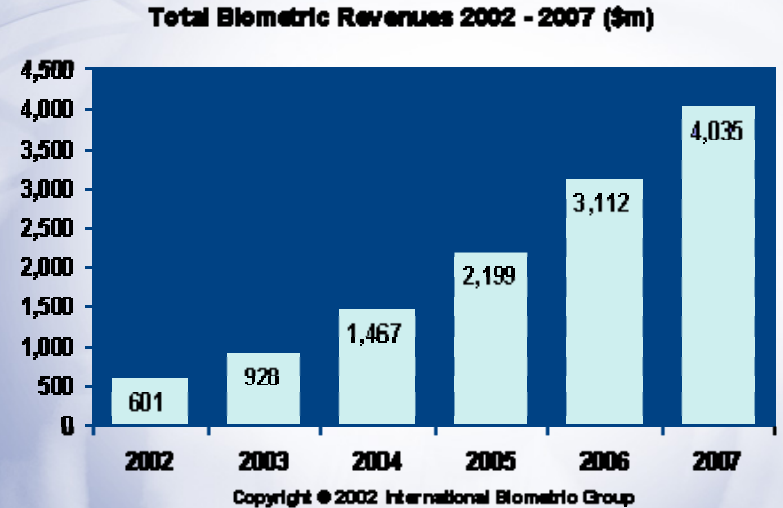


Figure 2 Source: Elsevier Advanced Technology

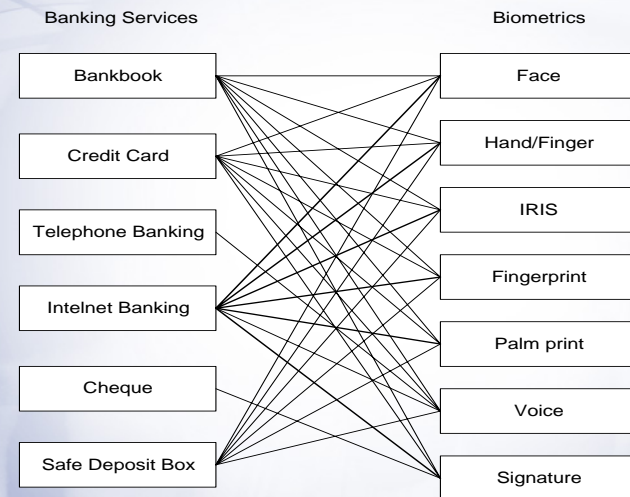
# Biometrics: A New Era in Security



# Biometrics Applications

Biometrics	Applications	Summary of Application
Dental	Recognition	Forensics
DNA	Recognition	Forensics, medicine, genetics
Fingerprint	Recognition/Verification	Immigration & naturalization, welfare distribution, military identification, forensics, access control
Face	Recognition/Verification	Suspect description & identification, missing persons, licenses, credit card, welfare distribution
Hand	Verification	Access control, immigration and naturalization, services distribution
Signature	Recognition/Verification	Signature verification, identification from handwriting
Iris	Verification	Access control
Voice	Recognition/Verification	Speaker verification, phone service, speaker verification, access control

# Biometrics in Banking



## Login with Fingerprint

- \* The fingerprint recognition is used as login in the notebook (Acer 730).



\* <http://www.zaobao.com/it/itweek.html>

## Internet Security

- \* NEC has developed a fingerprint system (800dpi /US\$330) for internet security.



\* <http://www.zaobao.com/it/itweek.html>

## Face Verification System

- \* A face verification system, called "Neo Face", is developed in NEC, which costs US\$22,000.



\* <http://www.zaobao.com/it/itweek.html>

## Other Biometrics Applications\*

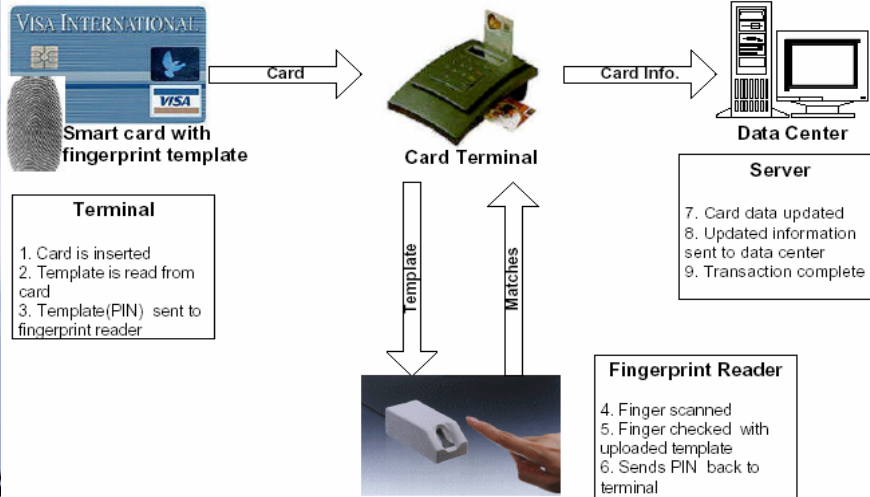
- NOKIA 6108: Login by Chinese characteristics
- NTT DoCoMo's mova F505i: Login by fingerprint
- HP iPAQ H5450: Login by fingerprint



\* <http://www.zaobao.com/it/itweek.html>

# Smart card

Application



**Terminal**

1. Card is inserted
2. Template is read from card
3. Template (PIN) sent to fingerprint reader

**Server**

7. Card data updated
8. Updated information sent to data center
9. Transaction complete

**Fingerprint Reader**

4. Finger scanned
5. Finger checked with uploaded template
6. Sends PIN back to terminal

<http://csrc.nist.gov/nissc/1999/proceeding/papers/t14.pdf>

# Citizen-facing Applications Applications

- EU visa system, the biggest biometric project in the world, 70 million datasets, fingerprints & faces (under proposed)
- UN tests iris recognition systems on refugee
- Biometric ID cards, Hong Kong/Malaysia, fingerprint & face
- Security in Casino, Foxwoods, facial recognition
- Border security, Germany, face
- Passport, UK government, fingerprint, face, iris (under discussion)



Face scan at airports

Hand Geometry for Immigration

\* All above projects have been reported in Biometric Technology Today.

# Forensic-facing Applications Applications

- Smart gun, Smith & Wesson, the world's largest handgun manufacturer, fingerprints
- Florida Supreme Court – Fingerprints
- Car Security, BMW, fingerprint
- School Security, National School Fitness Foundation, fingerprint.



\* All above projects have been reported in Biometric Technology Today.

# Employee-facing Applications Applications

- Mobile phone, Sagem, fingerprints
- New York State Office of Mental Health – Fingerprints
- St Vincent's Healthcare Trust – Fingerprints
- Microsoft .Net Authentication - Faces



\* Type ID  
\* Swipe ID  
\* Select payment -OR-  
\* Pay cashier  
Cred | Debit | EBT |

Fingerprint at check-out counter



Time & Attendance  
01 | 10 | 02  
07:57:34 A.M.  
Start | End | Xfer | Inq?



Fingerprint employee attendance system:  
<http://www.lucky-tech.com/figuard-videodemo.htm>  
<http://65.211.242.195/Admins/index.html>

# Customer-facing Applications

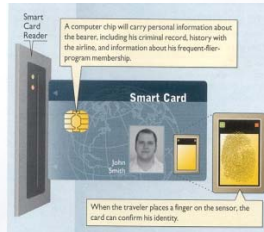


BioPay services

<http://www.tmcnet.com/usubmit/2003/Sep/1020276.htm>



Iris-based ATM



Smart card with fingerprints

## Application

**EXAMPLE 1:  
Access Control**



**EXAMPLE 2:  
Law Enforcement**



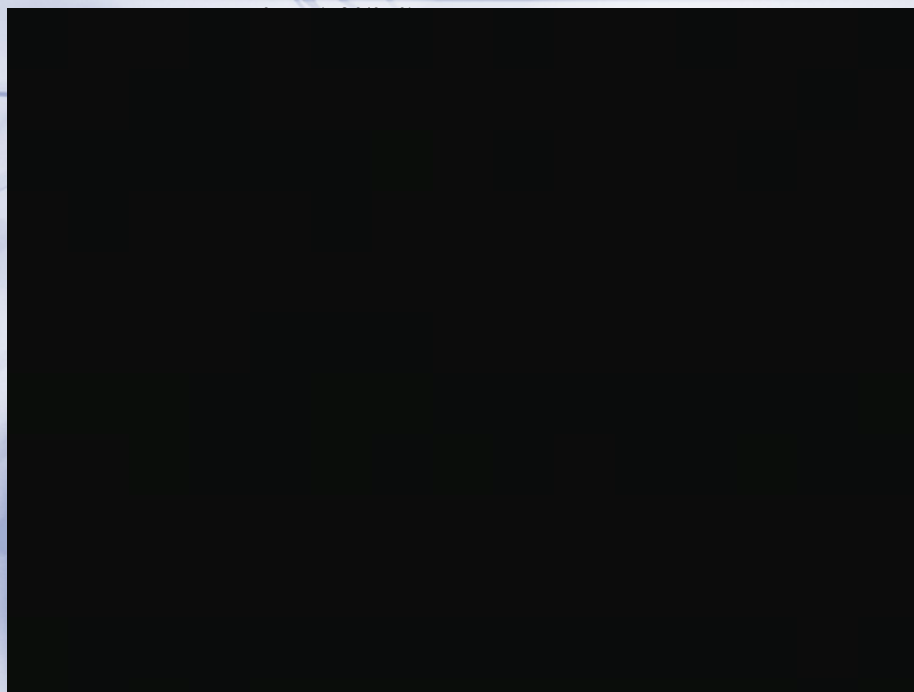
**EXAMPLE 3:  
Smart Card**



face\_card.swf

**EXAMPLE 4:  
Bio-Pay**

Fingerprint.wmv



## Popular Biometric Organizations

- Biometric consortium (USA) (<http://www.biometrics.org/>)
- Association for biometrics (UK) (<http://www.afb.org.uk/>)
- National Institute of Standards and Technology, Speech Group (USA) (<http://www.itl.nist.gov/iad/894.01/>)
- National Institute of Standards and Technology, Image Group, fingerprint (USA) ([http://www.itl.nist.gov/iad/894.03/databases/defs/nist\\_nfis.html](http://www.itl.nist.gov/iad/894.03/databases/defs/nist_nfis.html))
- National Institute Technical Authority for Information Assurance (UK) (<http://www.cesg.gov.uk/>)
- International Biometric Group (<http://www.biometricgroup.com/>)
- Biometric Digest (<http://www.biodigest.com/>)
- Japan Biometric Authentication Association (<http://www.biometrics.gr.jp/>)

## Some Biometric Conferences

- International Conf. on Biometric Authentication, 15-16 July 2004, Hong Kong (<http://www4.comp.polyu.edu.hk/~icba/>)
- Workshop on Multimodal User Authentication, Santa Barbara, CA, USA, Dec 11-12, 2003 (<http://mmua.cs.ucsb.edu/>)
- Biometric Technology for Human Identification (OR30), SPIE International Symposium on Defense and Security, 12-16 April, 2004, Orlando, USA ([http://biometrics.cse.msu.edu/DSS\\_CFP.pdf](http://biometrics.cse.msu.edu/DSS_CFP.pdf))
- The Speaker and Language Recognition Workshop, 31 May- 4 June, 2004, Toledo Spain (<http://www.odyssey04.org/home.asp>)
- The Government Security Expo and Conference, July 28-29, 2004 Washington, DC, USA (<http://www.govsecinfo.com/>)
- IEEE Symposium on Security and Privacy, May 9-12, 2004, California, USA (<http://www.cs.berkeley.edu/~daw/oakland04-cfp.html>)
- IEEE Conference on Technologies for Homeland Security, 21-22 April, 2004, Cambridge, MA, USA ([http://www.ieeeboston.org/homeland\\_2004.pdf](http://www.ieeeboston.org/homeland_2004.pdf))
- International Symposium on the Forensic Sciences, Wellington, New Zealand, 28 March-2 April 2004. ([http://www.anzffs2004.org.nz/main\\_page.htm](http://www.anzffs2004.org.nz/main_page.htm))

## Useful Links

### Researchers

<http://www.cse.msu.edu/~jain/>  
[http://bias.csr.unibo.it/research/biolab/bio\\_tree.html](http://bias.csr.unibo.it/research/biolab/bio_tree.html)  
<http://www.cl.cam.ac.uk/users/jgd1000/>  
<http://www.engr.sjsu.edu/biometrics/index.htm>  
<http://bias.csr.unibo.it/maio/>  
<http://www.citer.wvu.edu/research/index.php>  
<http://www.sinobiometrics.com/index.html>

### Researching Company

<http://www.biometricgroup.com/> or  
<http://www.ibgweb.com/>

### Biometric Glossary

<http://www.resonancepub.com/biometricgl.htm>  
<http://www.afb.org.uk/docs/glossary.htm>

### Public Domain

<http://directory.google.com/Top/Computers/Security/Biometrics/>  
<http://dmoz.org/Computers/Security/Biometrics/>  
<http://groups.yahoo.com/group/biometrics/messages>

## Useful Links

### BioAPI Consortium

<http://www.bioapi.org/>

### Biometric Identification (Online Resources)

<http://www.tml.hut.fi/Opinnot/Tik-110.501/1998/papers/12biometric/biometric.htm>

### Fake Fingerprint

<http://cryptome.org/fake-prints.htm>

### Face Recognition Vendor Tests

<http://www.frvt.org/>

### Fingerprint Verification Competitions

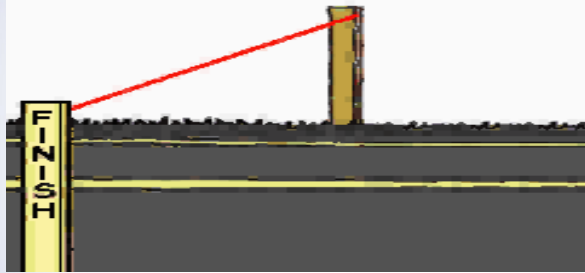
<http://bias.csr.unibo.it/fvc2000/>  
<http://bias.csr.unibo.it/fvc2002/>  
<http://bias.csr.unibo.it/fvc2004/>

### Signature Verification Competition

<http://www.cs.ust.hk/~dyyeung/>

## Useful Links

<http://www.crimescope.com/home.htm> (fingerprint and palmprint)  
<http://www.afix.net/> (fingerprint)  
<http://www.authentec.com/> (fingerprint)  
<http://www.biomet.ch/index.htm> (fingerprint)  
<http://www.timetrak.com/text/products/hardware/T016.htm> (fingerprint)  
<http://www.biometricaccess.com/> (fingerprint)  
<http://www.secugen.com/> (fingerprint)  
[http://www.sw.nec.co.jp/english/pid\\_e/mechanism.html](http://www.sw.nec.co.jp/english/pid_e/mechanism.html) (fingerprint matching mechanism)  
[http://www.identix.com/products/pro\\_livescan\\_TPpro.html](http://www.identix.com/products/pro_livescan_TPpro.html) (fingerprint/ palmprint)  
<http://www.necsolutions-am.com/idsolutions/products/Identification.cfm> (fingerprint/ palmprint)  
[http://www.crossmatch.net/products\\_livescan\\_id10.html](http://www.crossmatch.net/products_livescan_id10.html) (fingerprint/ palmprint)  
<http://www.printquest-apis.com/> (fingerprint/ palm)  
<http://www.iridiantech.com/> (iris)  
<http://www.sensar.com/> (iris)  
<http://www.eyenetwatch.com/iris/scanners.htm> (iris)  
<http://www.viisage.com/> (face)  
<http://www-white.media.mit.edu/vismod/demos/facerec/> (face)  
<http://www.cs.colostate.edu/evalfacerec/index.html> (face)  
[http://www.recogsys.com/products/personal\\_id.htm](http://www.recogsys.com/products/personal_id.htm) (hand)  
<http://pr.fujitsu.com/en/news/2003/03/31.html> (palm vein)  
<http://pr.fujitsu.com/en/news/2002/08/28.html> (palm vein)  
[http://www.mmigroup.net/en/index\\_en.php](http://www.mmigroup.net/en/index_en.php) (signature)  
<http://www.cybersign.com/> (signature)  
<http://www.topazsystems.com/> (signature)  
<http://www.nuance.com/> (speech)  
<http://www.buytel.com/> (voice)  
<http://www.verivoice.com/> (voice)  
<http://www.voice-security.com/Biomet.html> (voice)



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