Biometrics

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WHAT IS BIOMETRICS?

- refers to the identification of humans by their characteristics or traits.
- Many different aspects of human physiology, chemistry or behavior can be used for biometric identification and authentication.

Know
Be
Have
PIN
Rapid!
Biometrics can be sorted into two classes:

- **Physiological**
  
  *Examples: face, fingerprint, hand geometry and iris recognition*

- **Behavioral**
  
  *Examples: signature and voice*
BIOMETRIC IDENTIFIERS

Common:
- Fingerprint Recognition
- Face Recognition
- Speaker Recognition
- Iris Recognition
- Hand Geometry
- Signature verification

Others:
- DNA
- Retina recognition
- Thermograms
- Ear recognition
- Skin reflection
- Lip motion
- Body odor
- Brain Wave Pattern
- Footprint and Foot Dynamics
An extremely useful biometrics technology since fingerprints have long been recognized as a primary and accurate identification method.
Acquisition Devices

- Ink & paper – the oldest way
- Ink-less Methods - sense the ridges on a finger
  “Livescan” fingerprint scanners

- Optical methods (FTIR)
- CMOS capacitance
- Thermal sensing
- Ultrasound sensing
Identification, or 1-to-Many: identifies a person from the entire enrolled population.

Authentication, or 1-to-1: matches a person's claimed identity to his/her biometric and one or more other security technologies (password, PIN, Token).

(See http://www.biometrics.dod.mil/bio101/index.aspx)
MINUTIAE

- Uses the ridge endings and bifurcation's on a person's finger to plot points known as Minutiae.
- The number and locations of the minutiae vary from finger to finger in any particular person, and from person to person for any particular finger.
Fingerprint scanning (Minutiae based approach)
MATCHING APPROACHES

Two basic classes of matching techniques:

- **Image techniques**

  Use both optical and numerical image correlation techniques

- **Feature techniques**

  Extracts features and develop representations from these features

Combining the above two techniques:

- **Hybrid techniques**  (with improved accuracy)
2. **FACE RECOGNITION**

- Uses an image or series of images either from a camera or photograph to recognize a person.
- Principle: analysis of the unique shape, pattern and positioning of facial features.
FEATURES

- Passive biometrics and does not require a person's cooperation.
- Highly complex technology and largely software based.
- Primary advantage is that the biometric system is able to operate "hands-free" and a user's identity is confirmed by simply staring at the screen.
Source of data: Single image, video sequence, 3D image and Near Infrared

Models: weak models of the human face that model face shape in terms of facial texture

- Face appearance
- Face geometry
Vision and Modeling Group
Voice recognition is not the same as speech recognition, it is speaker recognition.

Considered both physiological and behavioral.

Popular and low-cost, but less accurate and sometimes lengthy enrollment.
APPLICATION CATEGORIES

- Fixed text
- Text dependent
- Text independent
- Conversational
Advantage

- Less requirements for users, such that they do not have to go through a separate process for verification
- Very little hardware is required, and ideally suited to telephone-based system for a remote identification

Disadvantage

- Acoustic features: 1. Misspoken or misread phrases; 2. The human voice's tremendous variability, due to colds, aging, and simple tiredness
- Can be captured surreptitiously by a third party and replayed
4. **IRIS RECOGNITION**

- Analysis of the iris of the eye, which is the colored ring of tissue that surrounds the pupil of the eye.
- Based on visible features.
- Widely regarded as the most safe, accurate biometrics technology.
- High speeds, High accuracy.
Example Iris Images
Iris recognition is a highly mature technology with a proven track record in a number of application areas.

Used very effectively all over the world.

Heathrow Airport (London) - Iris
• Hand geometry systems are commonly available in two main forms. Full hand geometry systems take an image of the entire hand for comparison while Two Finger readers only image two fingers of the hand.
• Hand recognition technology is currently one of the most deployed biometrics disciplines world wide
A camera captures an image of the hand, with the help of a mirror to get also the edge, and some geometrical characteristics stored.

\[
\sum_{j=1}^{d} |y_j - f_j| < \epsilon_a, \\
\sum_{j=1}^{d} \frac{|y_j - f_j|}{\sigma_j} < \epsilon_{wa}, \\
\sqrt{\sum_{j=1}^{d} (y_j - f_j)^2} < \epsilon_e, \text{ and} \\
\sqrt{\sum_{j=1}^{d} \frac{(y_j - f_j)^2}{\sigma_j^2}} < \epsilon_{we},
\]

where \(\sigma_j^2\) is the feature variance of the \(j\)th feature and \(\epsilon_a, \epsilon_{wa}, \epsilon_e,\) and \(\epsilon_{we}\) are threshold values for each respective distance metric.

(See Jain et al. A Prototype Hand Geometry-based Verification System)
APPLICATIONS

BenGurion Airport - Hand Geometry

INSPASS - Hand Geometry
see INSP Passenger
Accelerated Service System
6. SIGNATURE VERIFICATION

- Static/Off-line: the conventional way
- Dynamic/On-line: using electronically instrumented device
  - Principle: the movement of the pen during the signing process rather than the static image of the signature.
  - Many aspects of the signature in motion can be studied, such as pen pressure, the sound the pen makes
Applications

For more technical information:

- IBM online signature verification

Examples of Commercial products:

- Cyber-SIGN PenOp

- CIC Communication Intelligence Corp.
  "The power to sign online"
<table>
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<th>Retina recognition</th>
<th>Thermograms</th>
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<td>Gait</td>
<td>Keystroke</td>
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I. DNA

- DNA has been called the “ultimate identifier”
- Identify information from every cell in the body in a digital form
- Not yet fully automated, not fast and expensive
- Theoretical limitation: Identical twins have the same DNA
- Privacy issue – DNA contains information about race, paternity, and medical conditions for certain diseases
## COMPARISON CHART

<table>
<thead>
<tr>
<th>DNA</th>
<th>Conventional Biometrics</th>
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<tbody>
<tr>
<td>Requires an actual physical sample</td>
<td>Uses an impression, image, or recording</td>
</tr>
<tr>
<td>Not done in real-time; not all stages of comparison are automated</td>
<td>Done in real-time; automated process</td>
</tr>
<tr>
<td>Does a comparison of actual samples</td>
<td>Uses templates or feature extraction</td>
</tr>
</tbody>
</table>
II. RETINA RECOGNITION

- The pattern of blood vessels that comes from the optic nerve and disperse throughout the retina depends on individuals and never changes.
- No two retinas are the same, even in identical twins.
- Commercial products: Retinal Technologies
Thermograms requires an infrared camera to detect the heat patterns of parts of the body that are unique to every human being (such as the face).

Normally expensive because of the sensors.

Useful paper: Illumination Invariant Face Recognition Using Thermal Infrared Imagery (Solikinski & als)
The final objective: to recognize persons using standard cameras in any conditions.

Gait recognition is particularly studied as it may enable identification at distance.

Examples for measurements (from Georgia Institute of Technology)
The rhythms with which one types at a keyboard are sufficiently distinctive to form the basis of the biometric technology known as keystroke dynamics.

- 100% software-based, requiring no sensor more than a home computer.
VI. EAR RECOGNITION

- Ear geometry recognition uses the shape of the ear to perform identification
- Suggestions have been made that the shapes and characteristics of the human ear are widely different
- Might be recognized at a distance
Fig. 2. (a) Anatomy, (b) Measurements. (a) 1 Helix Rim, 2 Lobule, 3 Antihelix, 4 Concha, 5 Tragus, 6 Antitragus, 7 Crus of Helix, 8 Triangular Fossa, 9 Incisure Intertragica. (b) The locations of the anthropometric measurements used in the “Iannarelli System”. (Burge et al., 1998)
Lumidigm Inc. has established that the absorption spectrum of the skin depends on the individuals.

In a range of wavelengths over 6mm patch, several LEDs send light into the skin, and photodiodes read the scattered light, which is analyzed to perform the authentication.
 VIII. LIP MOTION

- Compares the characteristic lip motions of people while they speak.
- Identification needs associated with speaker recognition.
- Different imaging conditions: Infrared (high security & cost) and Near Infrared (cheap, normally used for active sensing)
CONCLUSION

Security = Biometrics
RESOURSE

1- Introduction to Biometric Authentication
   By Norman Poh
2- Types of Biometrics By Chang Jia
3- Wikipedia
4- Internet Sources
Any Question?

THANK YOU.