

朝陽科技大學資訊工程研究所專題演講-2009-12-15

機器臉型辨識

Face Recognition

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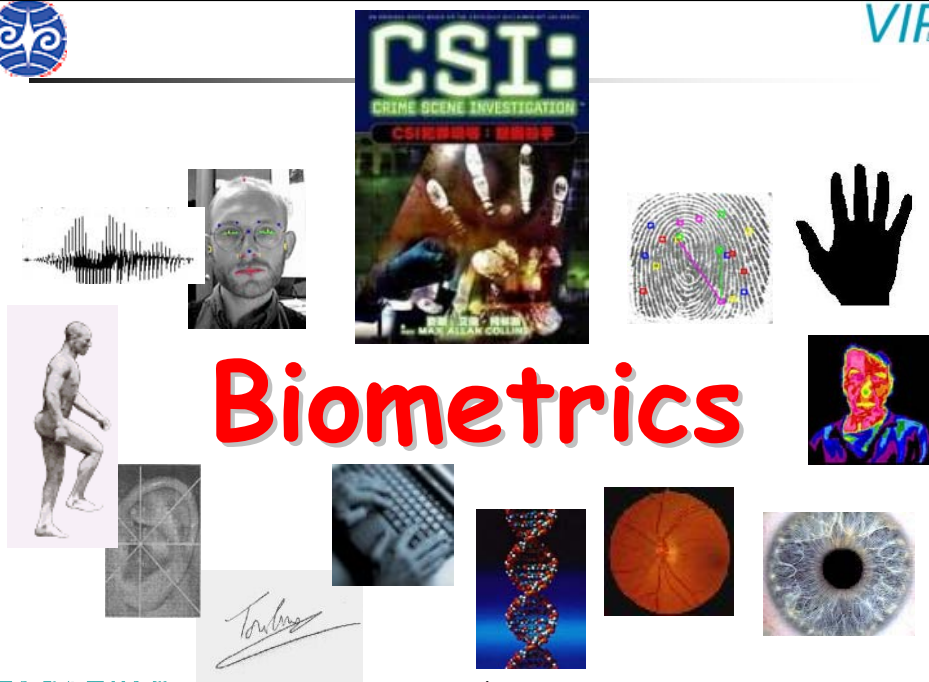
OUTLINE

VIP
Lab

- ☐ Introduction
- ☐ Biometric Recognition
- ☐ Face Recognition: Introduction
- ☐ Methods: Briefly
- ☐ Some New Applications
- ☐ Conclusion



概述 (Introduction)





Introduction

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- 個人身份認證(personal/identity authentication)
 - 個人身份認證是二十一世紀資訊網路時代所面臨到非常關鍵性的問題
 - 電子認證(e-authentication)是資訊時代人與電腦溝通時進行個人身份認證所必要的一項基本技術，是網路安全與電子商務實用化上的一項關鍵，可非常有效地維持整個資訊網路社會的安全與秩序
 - 例如
 - 罪犯比對(CSI; Forensics)
 - 門禁管制
 - 機場通關
 - ATM
 - 經過電腦進行股票的交易
 - 網路購物
 -



Introduction

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- Especially, after New York 911,.....



(COURTESY WABC)



Personal Identification Objects

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□ Token-based:

“Something that you have”

- Key, smart card, magnetic card, passport, USB token ..., etc.

□ Knowledge-based:

“Something that you know”

- Password, PIN, ..., etc.

□ Biometrics-based:

“Something that you are”

- Fingerprint, Face, Iris, Voiceprint, ..., etc.



Introduction

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□ 傳統個人身份認證方法: Token-based and Knowledge-based

- Key
- License or card
- Password
- so on

□ 缺點

- Lost
- Stolen
- Forgotten (too many, hard to memorize)
 - Easy to memorize, easy to guess!
- Misplaced

*Good Solution: **Biometrics!***



生物辨識 (Biometric Recognition)



Funny, But True

Boss, may I have your

Copyright 1996 by Randy Glasbergen.
www.glasbergen.com

My passwords are



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



生物測定學(Biometrics)

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Bio + metrics:

The statistical measurement of biological data.

Biometric Consortium definition:

Automatically recognizing a person using distinguishing traits.

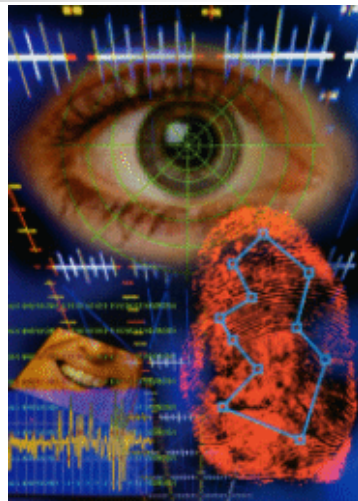


生物辨識(Biometric Recognition)

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■ **Biometrics**

- is the measurement and statistical analysis of biological data
- In IT, biometrics refers to technologies for measuring and analyzing human body characteristics for identity authentication purposes
- 利用人體固有的生物特徵作為個人身份認證之一門學問
- 屬型態辨識(Pattern Recognition)之一分支

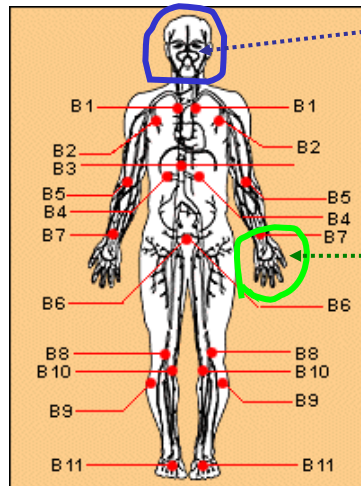


- 又稱為**生物辨識(Biometric Recognition)**



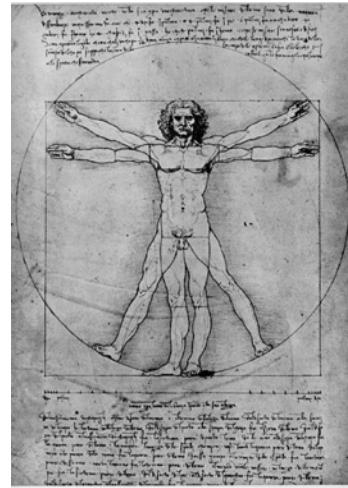
Where the Biometric Traits ?

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Head

Hand



Introduction

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生物辨識(biometric recognition)

- 利用人體固有的生物特徵作個人身份認證
- 與生俱來
- 攜帶方便
- 不易仿冒，安全性高

個人生物身份辨識技術的優點

- No need to remember passwords
- Unauthorized access to personal data can be prevented
- Fraudulent use of ATMs, credit cards can be prevented
- No need something to token based systems



生物特徵之分類

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- **生理性(Physiological/Static Characteristics)**
 - biometric methods – authentication based on a feature that is always present
 - 生理上之特徵一般皆是選取較不易隨著時間改變的特徵為基礎，故其通常不會有上述的問題
 - 特徵資料擷取常較困難
- **行為性(Behavioral/Dynamic Traits)**
 - biometric methods – authentication based on a certain behaviour pattern
 - 大多數行為性特徵皆會隨著時間而改變，故其必須時常更新資料
 - 特徵資料擷取較方便
 - 實作成本一般不高，故較易被大眾所接受



生物辨識技術之分類

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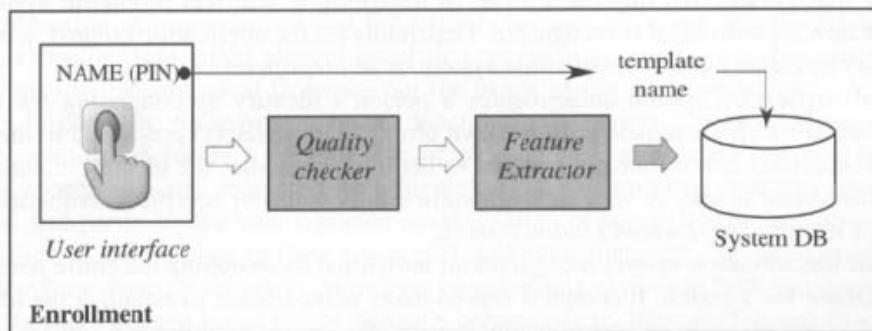
- **Biometric Systems**
 - 註冊(Enrollment)
 - 辨識(Recognition)或認證(Authentication)
- **生物辨識技術應用於個人身份認證可分為兩種不同型式**
 - Identification (Recognition)
 - Verification (Authentication)
- *Authentication* (認證)
- *Identification* (識別)
- *Verification* (確認) (鑑別)
- *Recognition* (辨識)



Enrollment

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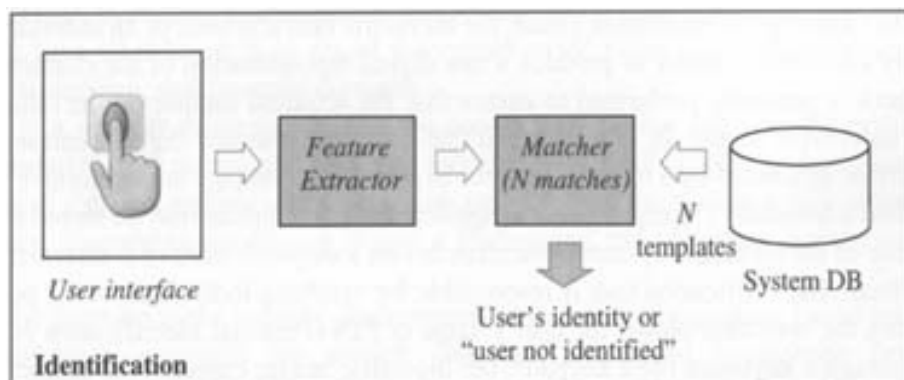
- Person entered into the database



Identification

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- Who am I ? or Who is this guy?
- 1-to-many mapping
- Example: FBI比對指紋找出罪犯

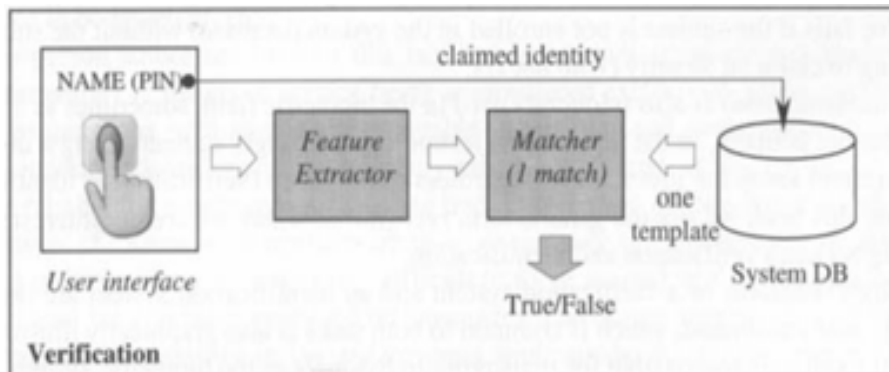




Verification

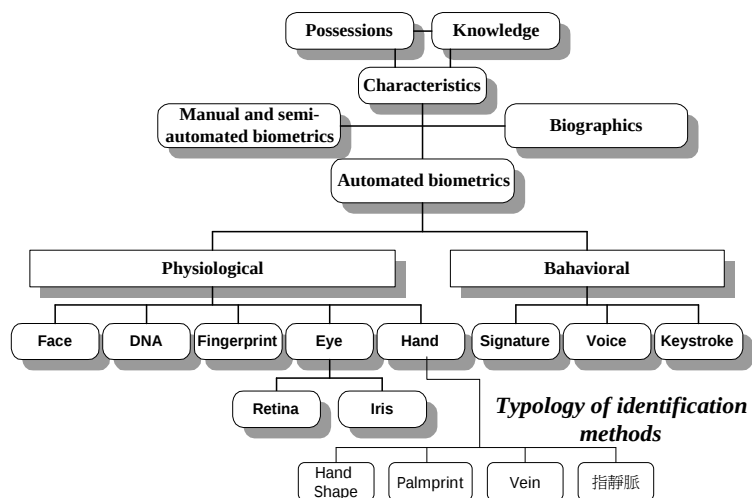
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- Am I who I claim to be?
- 1-to-1 comparison
- Confirms a claimed identity
 - Claim identity using name, user ID, ...
- Example: 門禁管制



常用之生物特徵分類

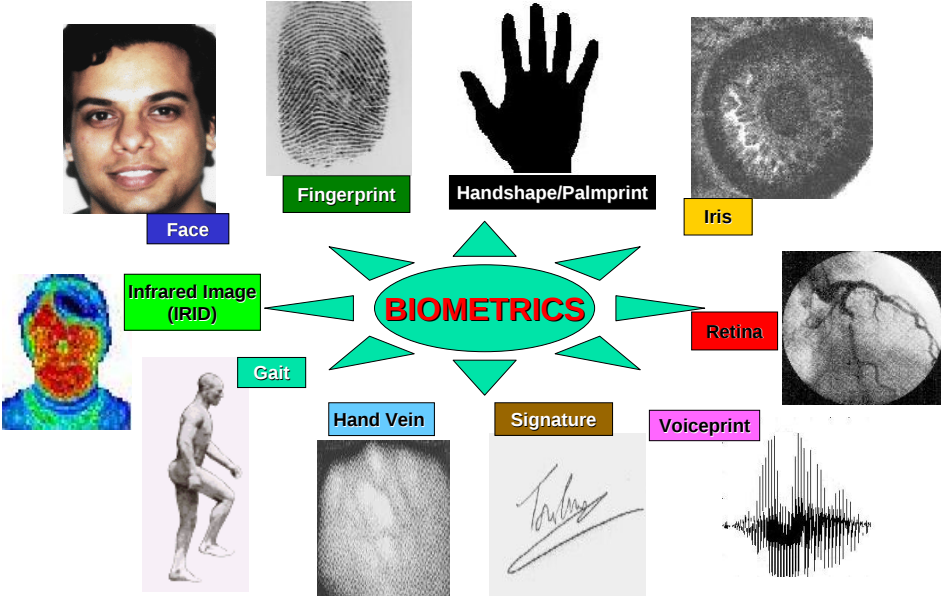
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重要的生物特徵





BIOMETRICS



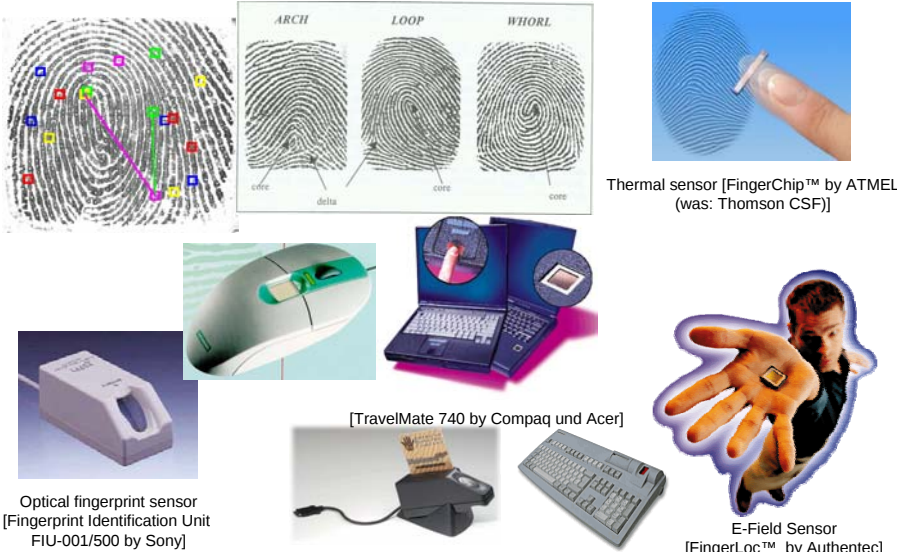
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Fingerprint Recognition







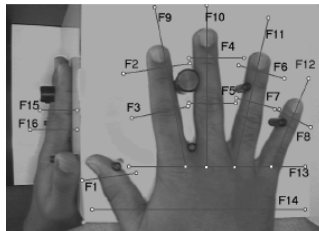
22

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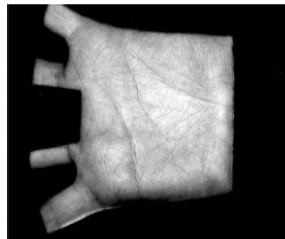
Hand Recognition

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Hand shape (掌形)

Palmpoint (掌紋)



Time & Attendance Terminal



Hand geometry reader by Recognition Systems

Hand geometry reader for two finger recognition by BioMet Partners

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National Chi Nan University

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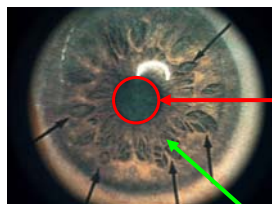
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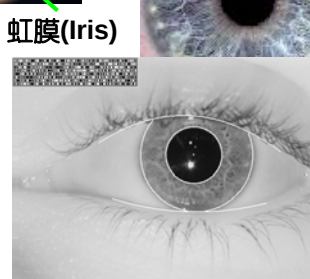
Iris Recognition

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- Iris (虹膜或虹彩)
- Feature : 利用iris的組織紋理分佈



瞳孔 (Pupil)



虹膜(Iris)

日本武富士消費金融公司於1999年發表一款虹彩辨識提款機 (ATM)



Stella : 英國NCR公司利用眼球虹膜辨識技術設計之自動提款機

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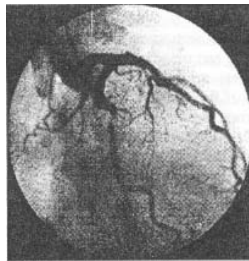
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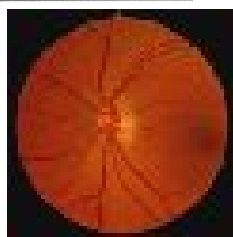
Retina Recognition

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- Retina (視網膜或眼底影像)
- Feature : 利用retina的血管分佈



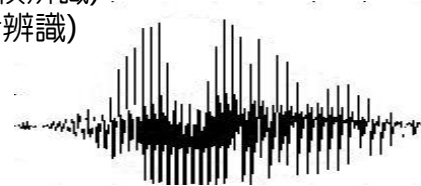
Retinal recognition system [Icam 2000]



Voiceprint Recognition

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- Voiceprint Recognition (聲紋辨識)
- Speaker Recognition (語者辨識)
 - Fixed text
 - Text dependent
 - Text independent
 - Conversational





Handwritten Recognition

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Handwritten or Signature (手寫簽字)

Static (off-line) Signature Recognition



Electronic pen [LCI-SmartPen]

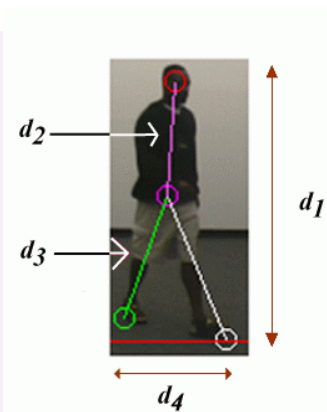
Dynamic (on-line) Signature Recognition (DSR)



Gait Recognition

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Gait (走路姿態)





DNA Recognition

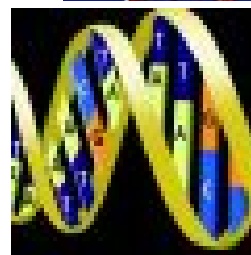
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- DNA辨識技術已被大部份法院所採用
- 存在一些爭議性問題(non-technical)
 - DNA有可能被破壞
 - 隱私的爭議 – DNA contains information about race, paternity, and medical conditions for certain disease

“Ultimate Identifier”



- Technical Problems
 - Not yet fully automated, not fast (not real-time) and expensive
 - Theoretical limitation: Identical twins have the same DNA



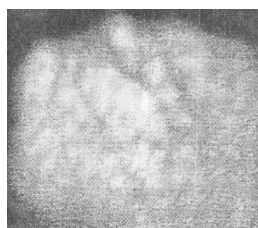
Infrared Thermogram Image

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Infrared Facial Thermograms



Identical twins have different thermograms



Hand Vein Thermograms



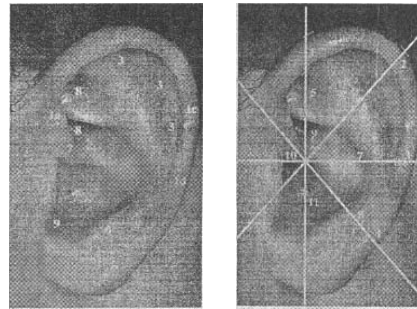
Ear Recognition

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Feature

- 由耳朵形狀及突出的軟骨組織，找出vector of distances of salient point

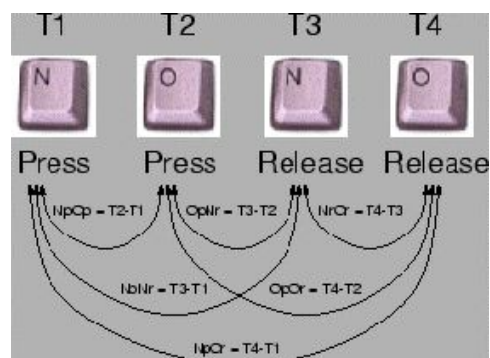
- Ear geometry recognition uses the shape of the ear to perform identification
- An infrared image can be used to eliminate hair
- Might be recognized at a distance



Keystroke Dynamics

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- 依敲擊鍵盤間距的時間
- 屬於行為性特徵





Face Recognition

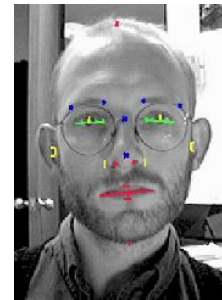
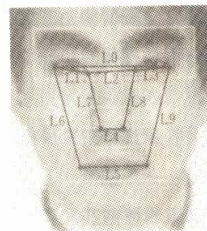
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- Analyzes some keypoints in human face, and relationship between them
- Analyzes color



Face recognition system
[TrueFace Engine by Miros]



Face recognition system
[One-to-One™ by Biometric Access Corporation]

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UCSD Biometric Soda Machine

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Face Recognition



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Video Surveillance (Airports)

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Face Recognition



New Passports

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Face Recognition

"ICAO TAG-MRTD/NTWG RESOLUTION N001 - Berlin, 28 June 2002

ICAO TAG-MRTD/NTWG endorses the use of **face recognition** as the globally interoperable biometric for machine assisted identity confirmation with machine readable travel documents.

ICAO TAG-MRTD/NTWG further recognizes that Member States may elect to use fingerprint and/or iris recognition as additional biometric technologies in support of machine assisted identity confirmation.

Endorsement: Unanimous"

<http://www.icao.int>



The new passports have an embedded contactless (ISO 14443) "smart-card" chip that stores personal information and a biometric template. Two problems: **reliability and privacy**



Access Control

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Hand-shape Recognition



Fingerprint System at Gas Stations

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- “Galp Energia SGPS SA of **Fingerprint Recognition** Lisbon won the technology innovation award for developing a payment system in which gasoline-station customers can settle their bills simply by pressing a thumb against a glass pad.
- Scanning technology identifies the thumbprint and sends the customer's identification information into Galp's back-offices system for payment authorization.”





Fingerprint System at Border Crossing

VIP

Fingerprint Recognition



Biometrics for Personalization

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Fingerprint Recognition

- Automatic **personalization** of vehicle settings:
 - Seat position
 - Steering wheel position
 - Mirror positions
 - Lighting
 - Radio station preferences
 - Climate control settings
- URLs at your fingertips



<http://www.visteon.com>





Iris Scans to Unlock Hotel Rooms

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Iris Recognition



The Nine Zero hotel

in Boston just installed a new system which uses digital photos of the irises of employees, vendors and VIP guests to admit them to certain areas, the same system used in high-security areas at airports such as New York's JFK



Want to Charge It?

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Voiceprint Recognition



Beepcard, a company in California, has designed a credit card that **works only when it recognizes the voice of its rightful owner**. Enclosed in the card is a tiny microphone, a loudspeaker and a speech recognition chip that compares the spoken password with a recorded sample. If the voices match, the card emits a set of beeps that authorize a transaction over the telephone or the Internet. If the voices do not match, the card will not beep.

The system **tolerates some variations in voice** to accommodate cold or background noise. But it might not work if there is a blaring music in the background.



Did You Vote?

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PAPER-BALLOT ERA

WING-POWANG



TOUCH-SCREEN ERA



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臉型辨識技術 (Face Recognition Technology)



Face Recognition

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Query: *Who is this guy?*

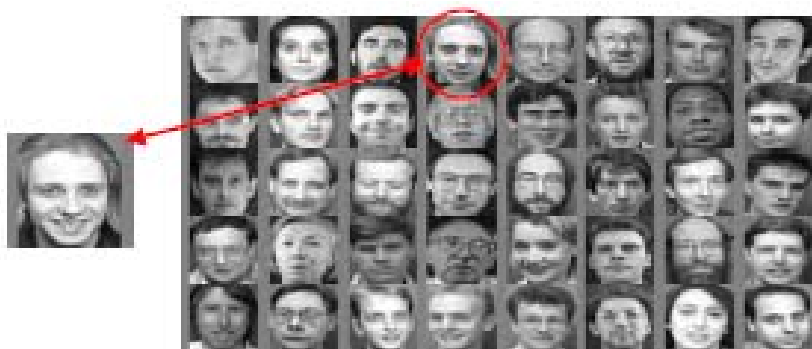
Ans: *Bill Clinton.* ✓

Ans: *Monica Lewinsky.* ✗



Example – Face Identification

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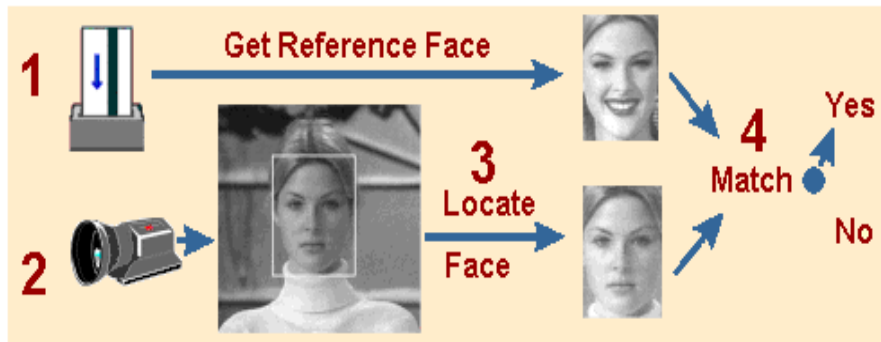


Is she in the database? **YES!**



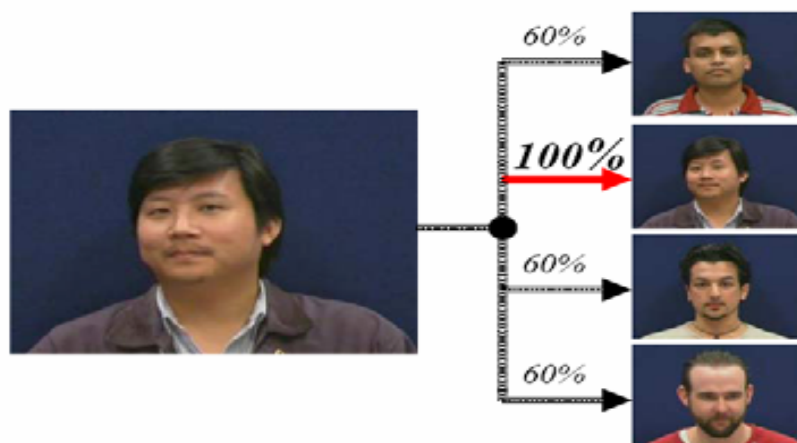
Face Recognition System

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Face Recognition: Correlation

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Introduction

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- Why Face Recognition?
 - Natural and easy to use
 - Many potential applications, such as person identification, human-computer interaction, security systems
- Stages of Face Recognition
 - Face location detection
 - Feature extraction
 - Facial image classification
- Approaches of Feature Extraction
 - Local features
 - Eyes, nose, mouth information
 - Easily affected by irrelevant information
 - Global features
 - Extract features from a whole image



Introduction

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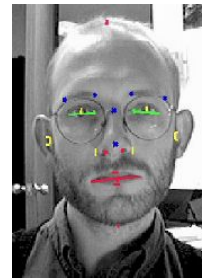
- Advantages
 - Most natural method: without user cooperation
 - Non-intrusive (非接觸式、非侵入式)
 - Low cost
 - Ability to operate covertly
- Disadvantages
 - Affected by appearance/environment
 - High false non-match rates
 - Identical twins attack
 - Potential for privacy abuse
 - 認知心理學目前對人類如何一眼看出並判斷此人是否認識的這種行為，至今尚無解答



Introduction

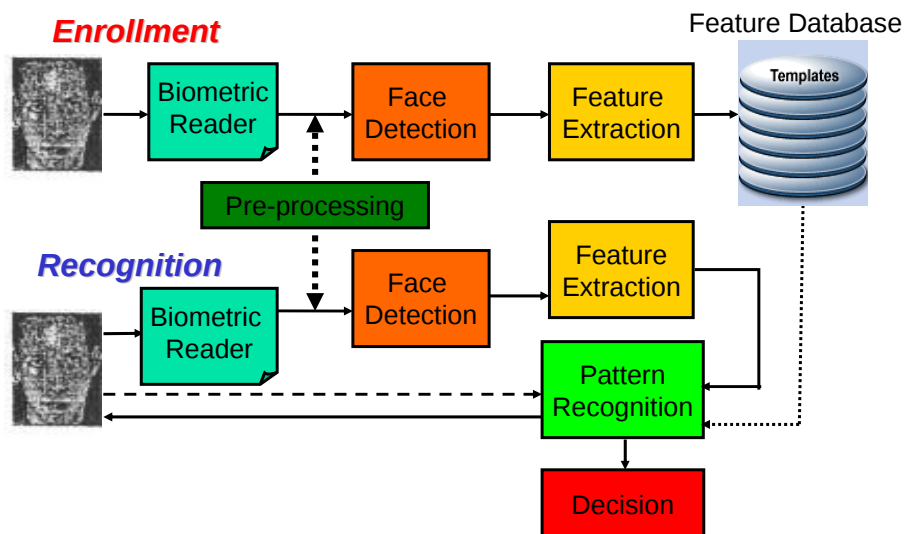
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- ❑ **Face recognition** from images is a sub-area of the general **object recognition** problem
- ❑ Approaches of Feature Extraction
 - Local features
 - Eyes, nose, mouth information
 - Easily affected by irrelevant information
 - Global features
 - Extract features from a whole image
- ❑ Applications
 - law enforcement
 - personal identification
 - driver's licenses
 - credit card
 - gateway of limited access areas
 - Some new applications on "multimedia"



人臉辨識系統之基本架構

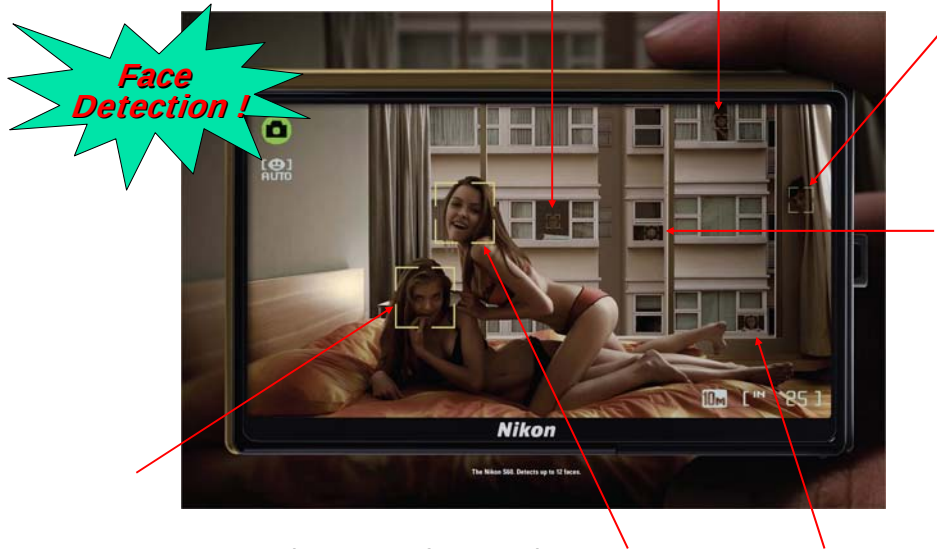
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Just Face Detection? Cool!

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So strong the power of camera is !



Face Detection

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*Camera tell us where the faces are !
How smart the camera !*

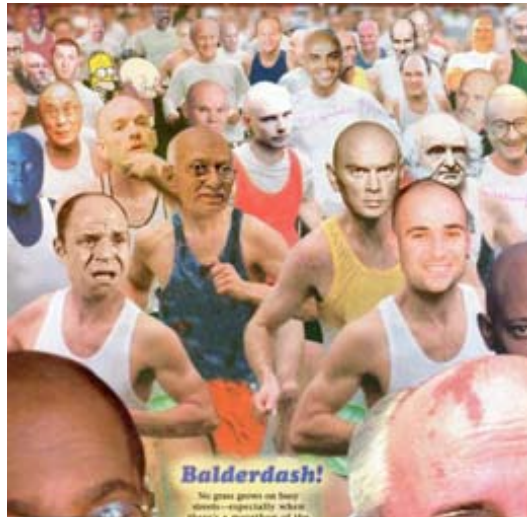
Ask the machine:

*Where are faces?
and
male or female?*



Locating Faces in a Crowd

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A difficult problem!

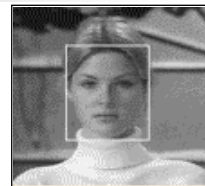


Face Detection

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□ Face Detection and Localization

- Facial image
- Arbitrary image



□ Problems

- Orientation of the face
- Causal and complex scene
- Illumination variation
- Computing

□ Methods

- Histogram: vertical and horizontal
- Brightness distribution
- Edge detection (point distribution model, PDM)
- Integral projection on color and edge information





Feature Extraction: Approaches

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□ Methods

- *Manually defining features* --- Feature-based
- *Automatically deriving features* --- Appearance-based

□ Feature-based

- Local model based on *Face Geometry (geometrical features)*
- The idea is to model a human face in terms of particular face features, such as eyes, nose, mouth, etc., and the geometry of the layout of these features
 - Local features: "Eigen-eyes" or "Eigen-noses," etc.

□ Appearance-based (or Template-based)

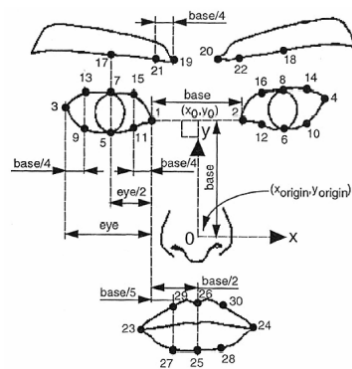
- Global model based on *Face Appearance or template*
- The underlying idea is to reduce a facial image containing thousands of pixels to a handful of numbers
- To capture the distinctiveness of the face without being overly sensitive to "noise" such as lighting variations
- A face image is transformed into a space that is spanned by basis image functions, e.g., Fourier transform, KLT, wavelet, ...
 - *Eigenfaces using KLT or PCA* (by Turk and Pentland, MIT)



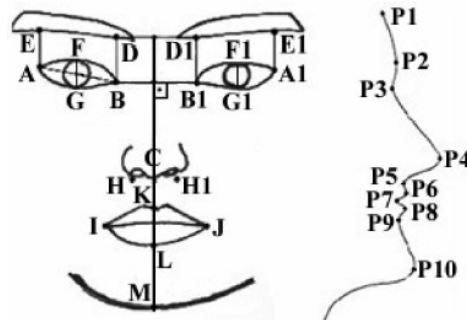
Face Data Extraction

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Static Images and Feature-Based Methods



FCPs : Facial Characteristic Points
- by Kobayashi



Facial Points of the frontal-view face model and the side-view face model
-by Pantic



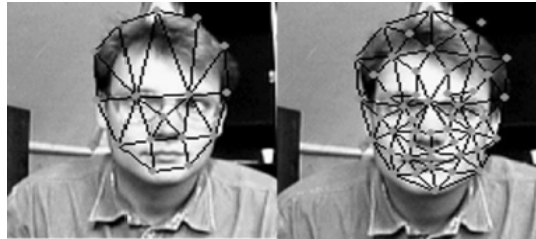
Face Data Extraction

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Static Images and Template-Based Methods

A small model-graph (small GFK) Dense model-graph (big GFK)

-by Hong



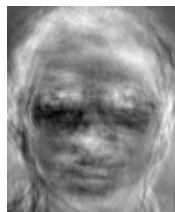
- Method :
1. "Gabor wavelet" extracted at a point of the input image
 2. GFK : General Face Knowledge
 3. Small GFK : find the exact face location in a facial image
 4. Big GFK : localize the facial feature
 5. Real-time process



特徵臉(Eigenfaces)

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- ❑ “特徵”是指明顯之處
 - 眼睛、鼻子、嘴、和頭髮
- ❑ 數學理論上，希望可以找到臉型影像的集合的特徵向量
- ❑ Math. Basis: Principal Component Analysis (PCA)
- ❑ 特徵臉(Eigenfaces)的方法
 - 特徵臉
 - 特徵臉的計算
 - 特徵臉分類
 - 辨識方法

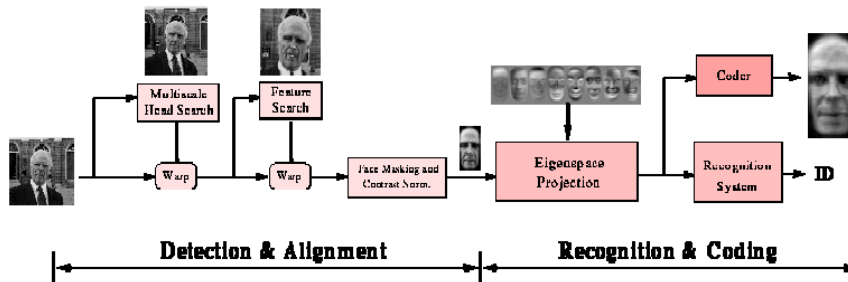




Eigenface Recognition System

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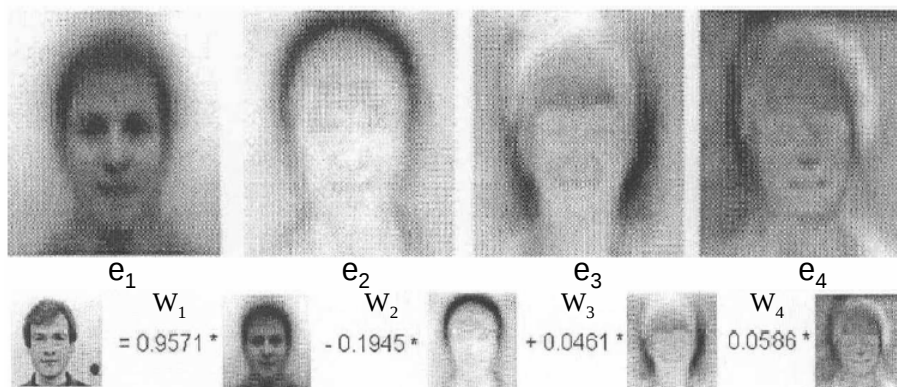
MIT Media Laboratory
Vision and Modeling Group



Eigenface: An Example

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A face image can be represented exactly as weighted combinations of the eigenface components





Problems and Challenges

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□ 人臉偵測的困難點

● 環境問題

- 複雜背景
- 光源位置
- 光源強度

● 人的問題

- 臉部的旋轉、傾斜、俯仰
- 眼睛的開合
- 表情的變化
- 化妝、飾品、髮型、鬍鬚、眼鏡
- 膚色的不同
- 距camera的遠近與camera的解析度影響臉部的大小

● Camera的參數

- 光圈
- 快門
- 解析度



Problems: Lighting Variability

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Indoor

Outdoor





Same person or different person?

VIP



Same person or different person?

VIP





Same person or different person?

VIP



Intra-Class Variability

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Inter-class similarity (Twins)

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Temporal Variations

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Time duration: 6 months



Time duration: 2 years





Applications: Issues of Recognition

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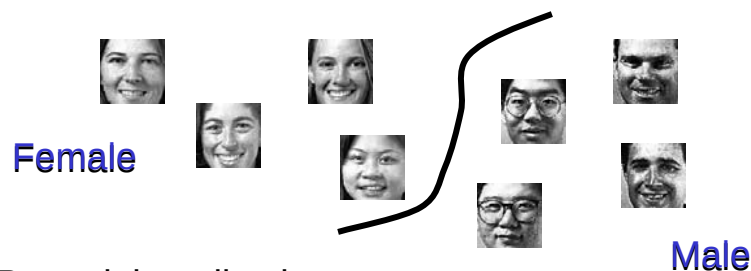
- Traditional Application Issues
 - **Identity Authentication**
 - Recognize a person who he or she is?
 - **Facial Expression**
 - **Others**: Hat, Glasses, Beard, Mustache, ...
- New Emerging Application Issues
 - **Gender Classification**
 - Recognize sex: male or female?
 - **Age Estimation and Classification**
 - Recognize a person how old one is?
 - **Ethnicity (Race) Classification**
 - Recognize race or skin color
 - **Genealogy Verification**
 - Recognize two faces with similar look
 - Father-son, mother-daughter, sibling, ...



Gender Classification

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- Problem statement
 - Determine the gender of a subject from facial images



- Potential applications
 - Face Recognition
 - Human-Computer Interaction (HCI)
- Challenges
 - Race, age, facial expression, hair style, etc.



Can You Tell?

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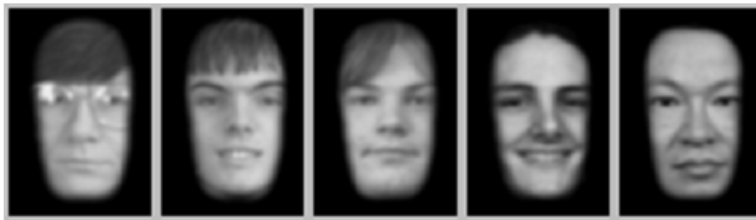


Not easy to do, even human eyes !



Can You Tell?

VIP Lab



Answer:

F - M - M - F - M

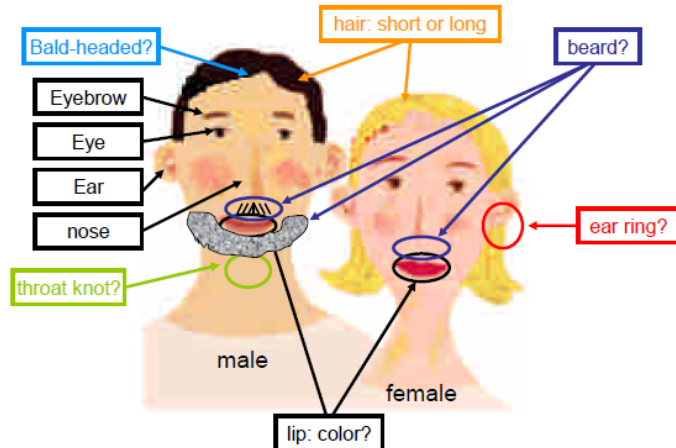
Not a easy problem!



Component-based Classification

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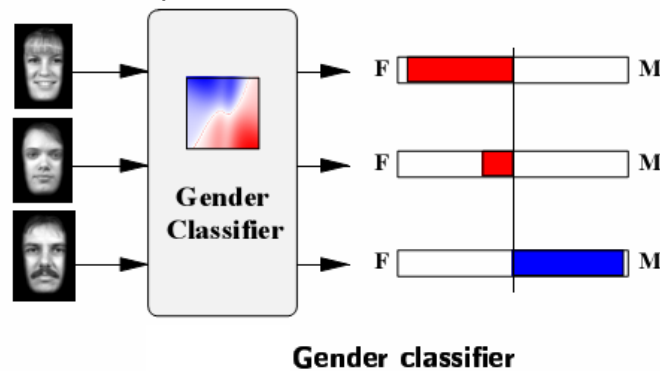
- Component-based gender classification
 - Local model based on *Face Geometry (geometrical features)*



Classification using SVM

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- Appearance-based gender classification
 - Global model based on *Face Templates*
- Learning to classify pictures according to their gender (Male/Female) when only the facial features appear (almost no hair)





Results

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Classifier	Error Rate		
	Overall	Male	Female
SVM with Gaussian RBF kernel	3.38%	2.05%	4.79%
SVM with cubic polynomial kernel	4.88%	4.21%	5.59%
Large ensemble-RBF	5.54%	4.59%	6.55%
Classical RBF	7.79%	6.89%	8.75%
Quadratic classifier	10.63%	9.44%	11.88%
Fisher linear discriminant	13.03%	12.31%	13.78%
Nearest neighbor	27.16%	26.53%	28.04%

Human error rates

Gender of human subject	Error Rate	
	High resolution	Low resolution
Male	7.02%	30.87%
Female	5.22%	30.31%
Combined	6.54%	30.65%



An Application on Multimedia

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NEC Eye flavor





NEC Eye Flavor

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NEC Eye Flavor

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Conclusion

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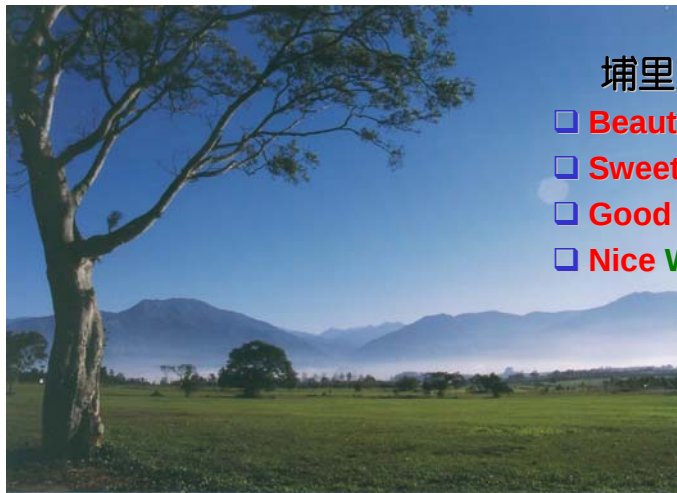
Just One Word:

Face Recognition
*is very Crucial and Valuable
from both Academic and Commercial Viewpoints !*



Thank You Very Much !

VIP Lab



埔里暨大4W

- ☐ Beautiful Women
- ☐ Sweet Water
- ☐ Good Wine
- ☐ Nice Weather



Q & A

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