人臉辨識

陳慶瀚
機器智慧與自動化技術(MIAT)實驗室
義守大學電機系
pierre@isu.edu.tw
2005年10月25日

人臉辨識的應用

- 生物辨識
- 改善人機介面
- 輔助駕駛
- 視訊內容擷取(video summarization)
- 虛擬實境模擬
- 家庭自動化/娛樂

人臉辨識作為生物辨識的優缺點

優點：

- 沒有隱私權問題(privacy)
- 資料擷取容易(ubiquitous)
- 無接觸式感測(contactless)
- 取像裝置成本低(low-cost)

缺點：

- 對環境變數變化非常敏感
- 容易被偽造誤判
- 不適用在大型資料庫的身分識別

人臉辨識技術的發展

- 1964, 1970, 1977: Facial feature-based recognition (Bledsoe, Kelly Kanade)
- 1984: WIZARD neural net approach (Stonham)
- 1991, 1994: Eigenface PCA (Pentland & Turk)
- 1997: Fisherface FLD + PCA (Belheumeur)
- 2000: FERET standard testing method & database
- 2002: Independent Component Analysis (ICA) captures higher-order statistics (Bartlett)
- 2003: Kernel, SVM, RBF (Liu, Er)
- 2004: Plenoptic light-fields (Gross), 2D-PCA (Yang)
- 2005: FERET color testing database

人臉辨識系統的設計目標

給一組人臉影像資料庫，訓練人臉辨識系統，使其能從一張新的人臉影像找出其在影像資料庫中符合的個人。人臉辨識系統設計的目標在於使辨識性能盡可能與環境條件無關，使正確接受率和錯誤拒絕率同時達到最大化。

人臉辨識主要步驟

1. 人臉影像擷取
2. 人臉偵測
3. 人臉特徵擷取
4. 特徵比對

人臉影像來源

- 2-D gray image
- Color image
- Infra-red image
- 3-D range image
- Time-varying image sequence

人臉影像來源

- 2-D灰階影像
- 2-D彩色影像
- 紅外線影像
- 3-D 深度影像(range image)
- 混合影像

影響人臉辨識的因素

- 相貌變化：鬍鬚、眼鏡、化妝、神態
- 影像比例/解析度變化
- 照明變化
- 取像角度變化

人臉偵測

人臉特徵

幾何特徵

eye comers, mouth extremities, nostrils and chin top為特徵點，再以這些特徵點之間的相對距離和方位角做為特徵向量

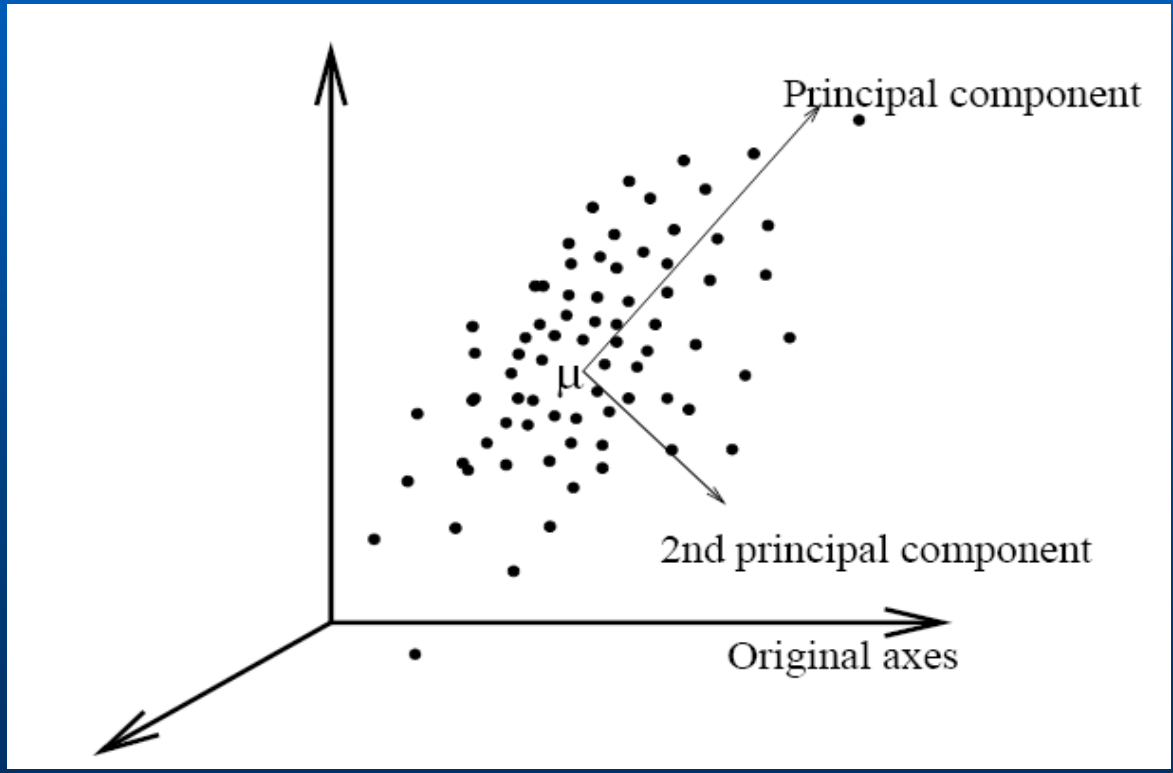
統計特徵

PCA

LDA

Eigenfaces

- MIT Media Lab 專利
- 使用PCA(主成分分析)方法找出一個對稱矩陣的特徵向量(Eigenvector)



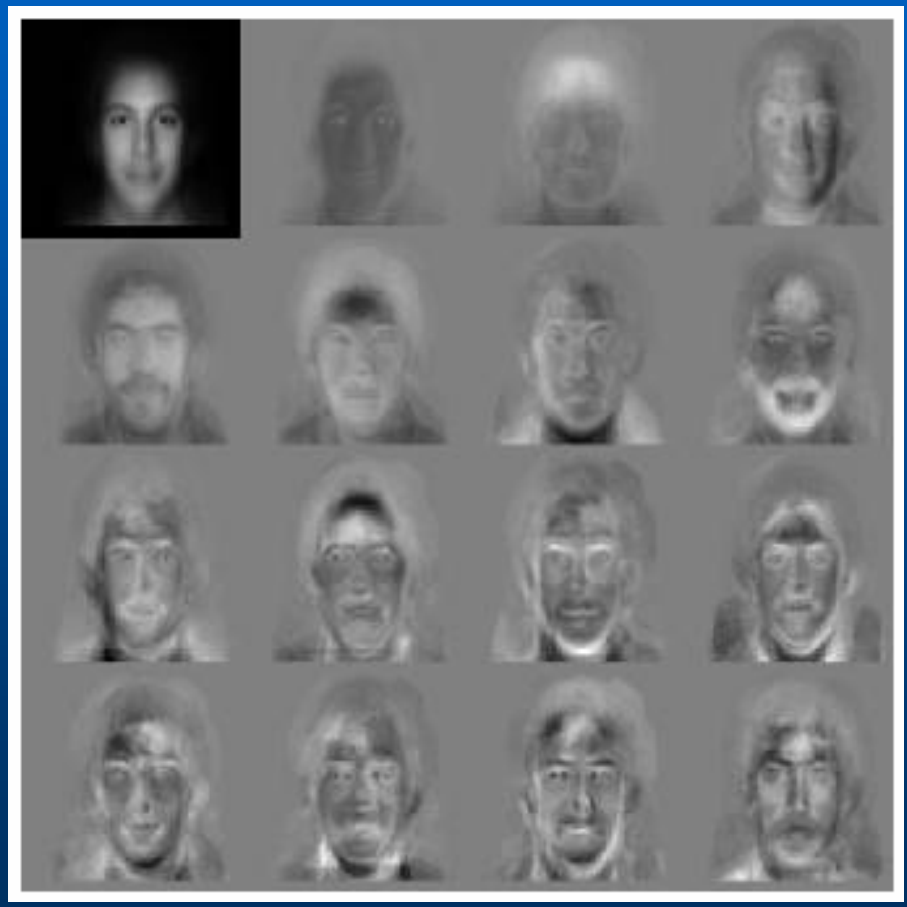
Eignface人臉特徵

- 前3個主成分通常與影像亮度有關
- 排序最後的主成分通常表示雜訊
- 將一張影像X映射至一些eigenvector(例如第15到第100個主成分)：

$$f_i = (\mathbf{x} - \mu).\mathbf{v}_i$$

- 以此eigenvector作為人臉特徵向量

Eignface人臉特徵

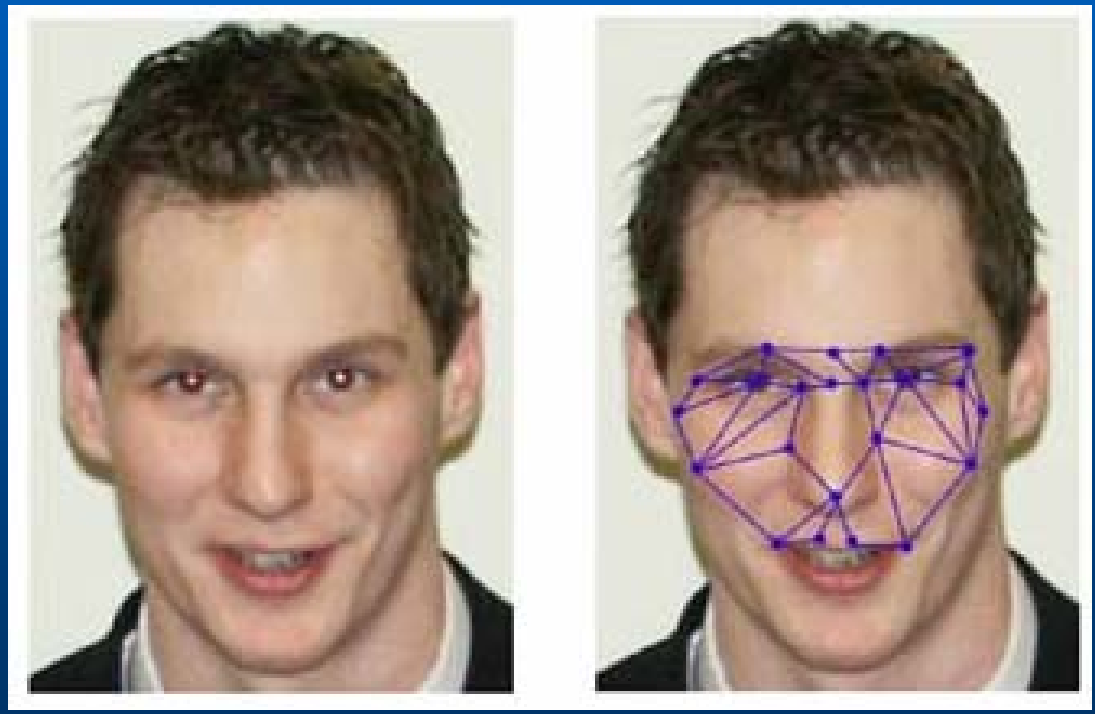


Local Feature Analysis

Dr. Joseph Atick, Dr. Paul Griffin, and Dr. Norman Redlich of the Visionics Corporation

The algorithm first locates the face from its surroundings. The reference points are then located by using the change in shading around each feature. Once a change in shade is found, it is defined as an anchor point. Once all the anchor points are found, the algorithm creates triangles that tie together the anchor points. The angles of the triangles from each anchor point are measured and a 672-bit template is generated.

Local Feature Analysis



Neual-based人臉辨識(1)

Kohonen demonstrated the use of a self-organizing map for face recollection applications. Even when the input images were very noisy or had portions missing, an accurate recall capability was achieved on a small set of face images.(T. Kohonen, *Self-Organization and Associative Memory*. Springer-Verlag, Berlin, 1988.)

Lawrence et al. used a 5-layer self-organization feature map for face recognition.(S. Lawrence, C. L. Giles, A. C. Tsoi, and A. D. Back, ‘‘Face recognition: A convolutional network approach,” *IEEE Trans. Neural Networks*, Vol. 8, No. 1, pp. 98-1 13, 1997.)

Neual-based人臉辨識(2)

Multilayer perceptron neural networks and radial basis function networks have also been used for face recognition. A back-propagation training algorithm for multi-layer perceptron may be sufficient for a low dimensionality feature vector with a small number of classes. For example, for face detection (a twoclass problem) used low resolution images and have successfully tested a multilayer feedforward network with back-propagation training with momentum.(H. A. Rowley, S. Baluja, and T. Kanade, “Neural network-based face detection,” *IEEE Trans. Pattern Analysis and Machine Intelligence*, Vol. *20*, No. 1, 23-38, 1998.)

Neual-based人臉辨識(3)

Cresceptron uses multilevel retinotopic layers of neurons to automatically determine the configuration of its network in the training phase. The network structure can be predesigned and fixed if only faces need to be recognized, which allows effective size control.

(J. Weng, N. Ahuja, and T. S. Huang, “Learning recognition and segmentation using the Cresceptron,” In *Proceedings International Conference on Computer Vision*, pp. 12 **1** - 128. Berlin, Germany, 1993.)

人臉辨識演算法的主要課題

- Face space
- The most discriminating feature space.
- PCA vs. LDA.
- Hierarchical spaces vs. a flat space.
- Incremental learning vs. batch learning.
- Built-in deformation models.