

Eigenfaces

Robert B. Fisher
School of Informatics
University of Edinburgh


PCA-based Face Recognition

- (Turk & Pentland 1991)
Representation of faces using PCA directly on image intensities
One of most famous uses of PCA in computer vision
Seminal reference for face recognition (but would work better if we modeled shape variation rather than lightness variation)

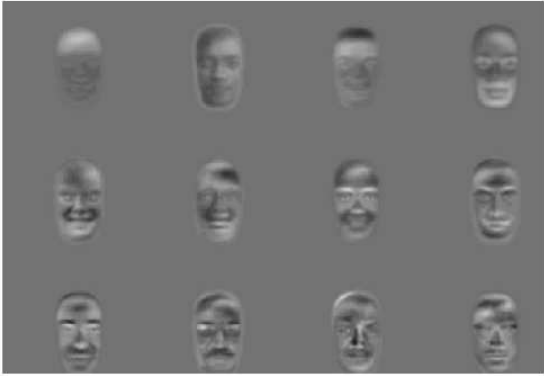
- **Key principle:**
Turn image array into long vector
Represent sample image (face) as weighted sum of eigenimages (eigenfaces)

Eigenfaces

1. Given set of K registered face images ($R \times C$) with varying capture conditions
2. Represent as $R \times C$ long vectors
3. Do (special trick for large matrices)



Mean face and subset of principle component axes/images [Morris '04]



4. Represent person i by projection weights \vec{w}_i

Eigenface Recognition

Given unknown face image F_u

1. Subtract mean face and project onto
 $\rightarrow \vec{w}_u$
2. Given database of projections $\{\vec{w}_i\}_{i=1}^K$, find class c with smallest Mahalanobis distance d_c to \vec{w}_u
3. If d_c small enough, return c as identity

Eigenface Results

2500 128×128 image database, varied lighting

- 96% successful recognition over variations
- 85% over orientation variations
- 64% over size variations

Eigenface Discussion

- in position, orientation, scale & occlusion cause problems
- Research topics
- 4-36% failure rate a problem at busy airports