Eigenfaces

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PCA-based Face Recognition

- Eigenfaces (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**:

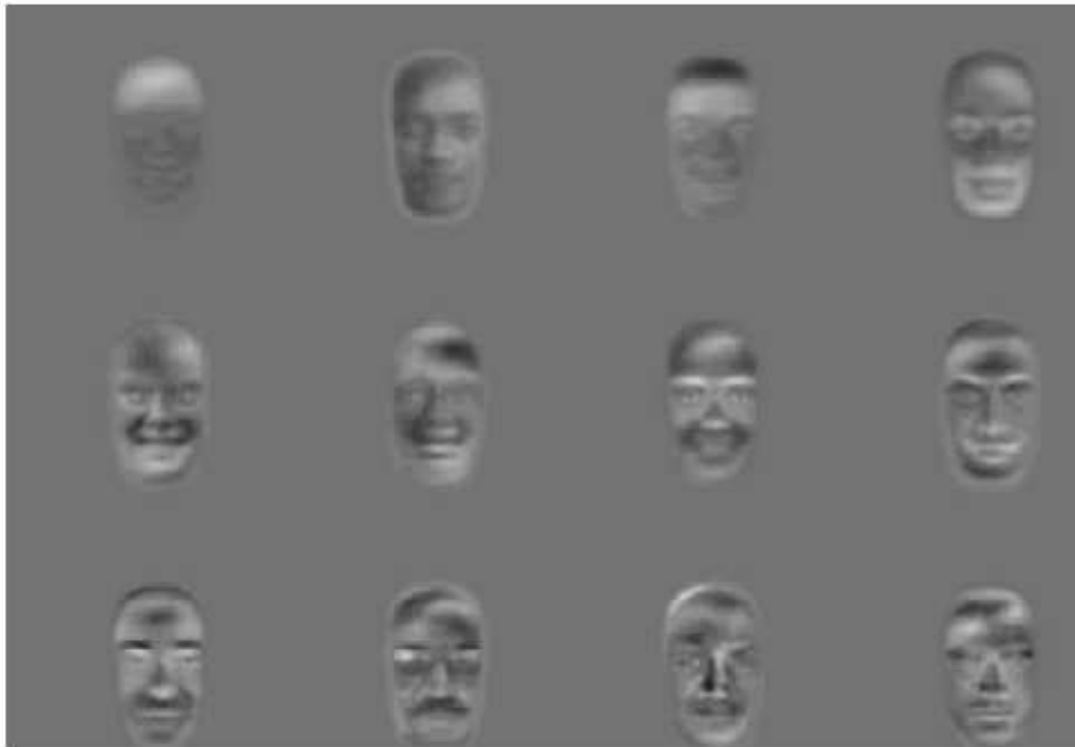 Turn image array into long vector

  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 PCA (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 eigenfaces $\rightarrow \vec{w}_u$

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 lighting variations

- 85% over orientation variations

- 64% over size variations

Eigenface Discussion

- Variations in position, orientation, scale & occlusion cause problems

- Research topics

- 4-36% failure rate a problem at busy airports