Facial Recognition and Detection With OpenCV

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Background

- Facial Detection
  - Not as difficult as recognition
  - Haar Cascades method (aka Viola-Jones method)
  - A pre-trained XML classifier is used in our method.
- Facial Recognition
  - More difficult, many different algorithms
  - Must match face within the input image with a face/person within the training set
  - We will use:
    - Eigenfaces
    - Fisherfaces
    - LBPH (Local Binary Patterns Histograms)

Facial Detection – Input and Output

- Haar Cascades
  - Input image is inspected for features according to the classifier.
  - Once our features are detected, our application draws an ellipse around the x,y coordinates of each feature.

Training Set for Facial Recognition

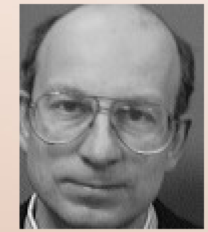
- AT&T Face Database
  - Collection of 40 classes (separate people)
    - 10 Images in each class (or 10 images per person)
  - All 400 total images are frontal view

- We will remove 1 image from our database (before training).
- This image will be used as the input image to be recognized.

Recognition Algorithm #1: Eigenfaces

- How it works
- The Eigenface method uses Principal Component Analysis (PCA) to linearly project the image space to a low dimensional feature space.
- We want to find vectors with the greatest variance within the data.
- This is easily done after each image is converted to grayscale; essentially turning each image into a vector within a vector space.
- After a PCA is performed on these vectors, we obtain the eigenvectors which make up the basis of the vector space.
- The eigenvectors we obtain are very important to us since they usually represent the most prominent features of the data in question (faces).
- We can decompose an unknown face and assess which eigenvectors most closely correlate to the image in question.

Recognition Algorithm #1: Eigenfaces



- Actual class (label) of input image = 37
- Predicted class = 37
- Eigenvalues are given
- 10 Eigenfaces
- 20 Reconstruction images
- 1 training set mean face

```
Predicted class = 37 / Actual class = 37.
Eigenvalue #0 = 2817234.89109
Eigenvalue #1 = 2065223.71308
Eigenvalue #2 = 1096613.63515
Eigenvalue #3 = 888103.94982
Eigenvalue #4 = 818941.86977
Eigenvalue #5 = 538914.47401
Eigenvalue #6 = 392433.54243
Eigenvalue #7 = 373805.54654
Eigenvalue #8 = 313921.17233
Eigenvalue #9 = 288902.01563
```

Recognition Algorithm #2: Fisherfaces

- How it works
- Eigenface method utilizes PCA to project the image space to a low dimensional subspace and maximize the total scatter across all classes (faces)
  - Fisherface method uses LDA (Linear Discriminant Analysis) to maximize the ratio of between-class scatter to that of within-class scatter.
- The Fisherfaces allows a reconstruction of the projected image, just like the Eigenfaces did.
  - But since we only identified the features to distinguish between subjects, you can't expect a nice reconstruction of the original image.
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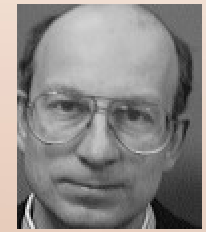
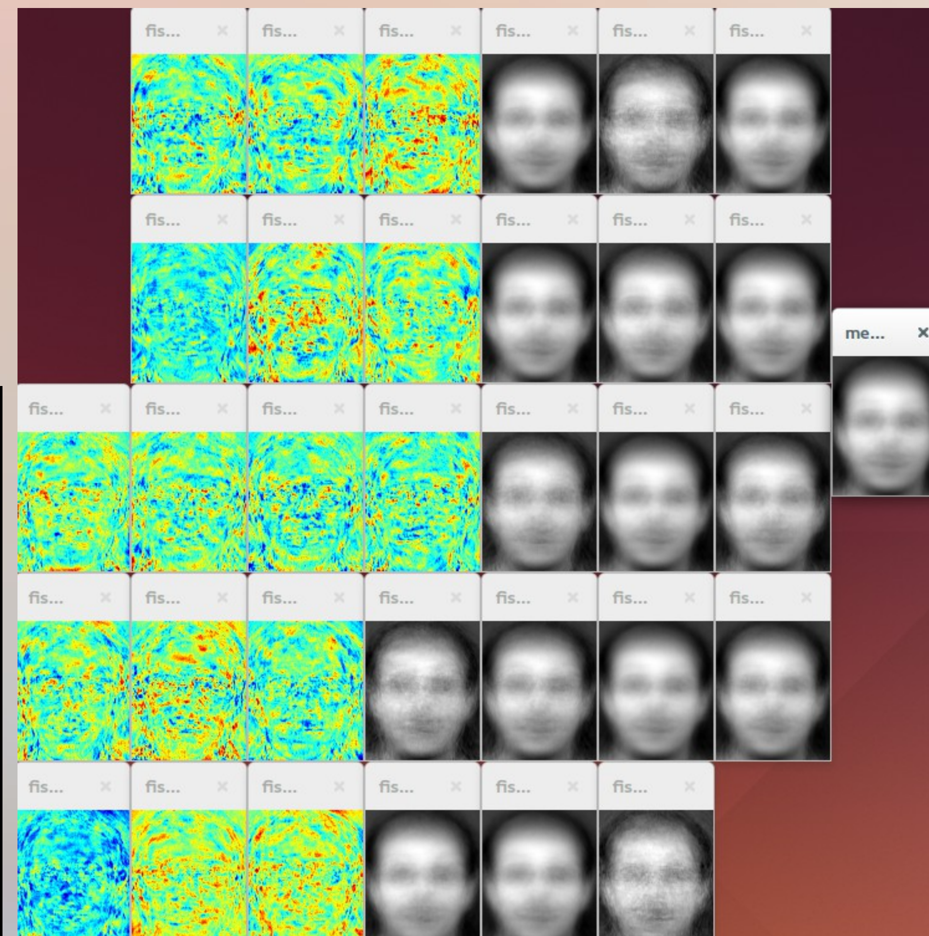
Recognition Algorithm #2: Fisherfaces



- Actual class (label) of input image = 37
- Predicted class = 37
- Eigenvalues are given
- 15 Eigenfaces
- Reconstruction is not as helpful
- 1 training set mean face

```
Predicted class = 37 / Actual class = 37.
Eigenvalue #0 = 473545.43068
Eigenvalue #1 = 10574.09452
Eigenvalue #2 = 1994.04279
Eigenvalue #3 = 1078.95203
Eigenvalue #4 = 722.94469
Eigenvalue #5 = 505.26909
Eigenvalue #6 = 240.57503
Eigenvalue #7 = 200.69655
Eigenvalue #8 = 168.09561
Eigenvalue #9 = 116.97400
Eigenvalue #10 = 83.17700
Eigenvalue #11 = 66.72139
Eigenvalue #12 = 46.44079
Eigenvalue #13 = 44.42637
Eigenvalue #14 = 36.04184
Eigenvalue #15 = 32.85056
```



Recognition Algorithm #3: LBPH (Local binary patterns histograms)

- How it works
- In contrast to the previous two methods, LBPH analyzes each image independently rather than inspecting the whole dataset.
- LBPH summarizes the local structure in an image by comparing each pixel with its neighborhood.
- When an unknown input image is provided, we perform the same analysis on it and compare the result to each of the images in the dataset.
- By characterizing the local patterns found in specific image locations, we can successfully analyze each image based on these results.

```
Predicted class = 37 / Actual class = 37.
Predicted class = -1
Model Information:
        LBPH(radius=1, neighbors=8, grid_x=8, grid_y=8, threshold=0.00)
Size of the histograms: 16384
```