A Realtime Face Recognition system using PCA and various Distance Classifiers

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Real time Face Recognition using PCA and various Distance Classifiers

Face recognition systems architecture broadly consists of the three following tasks:

1. Acquisition (Detection, Tracking of face-like images)
2. Feature extraction (Segmentation, alignment & normalization of the face image)
3. Recognition
Methodology

Real time Face Recognition using PCA and various Distance Classifiers

- Feature extraction was done using Principal component analysis
- The matching with the test image was done using three different distance classifiers.
- Manhattan Distance, Euclidean Distance, Mahalanobis Distance
Real time Face Recognition using PCA and various Distance Classifiers

- Mahalanobis distance is a distance measure introduced by P. C. Mahalanobis in 1936.
- It is based on correlations between variables by which different patterns can be identified and analyzed. It is a useful way of determining similarity of an unknown sample set to a known one.
- It differs from Euclidean distance in that it takes into account the correlations of the data set and is scale-invariant. In other words, it is a multivariate effect size.
Database

The ORL Database of Faces

- There are ten different images of each of 40 distinct subjects.
- For some subjects, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses).
- All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position (with tolerance for some side movement).
The ORL Database of Faces

- The files are in PGM format, and can conveniently be viewed on UNIX (TM) systems using the 'xv' program. The size of each image is 92x112 pixels, with 256 grey levels per pixel.
- The images are organised in 40 directories (one for each subject), which have names of the form sX, where X indicates the subject number (between 1 and 40).
- Each directory has ten different images of that subject, which have names of the form Y.pgm, where Y is the image number for that subject (between 1 and 10).
- Credit to AT&T Laboratories Cambridge.
The ORL Database of Faces

Sample images
Yale face database B

Sample images
Yale face database B

- TOTAL 1176 face images of 38 individuals.
- There are 31 images per subject
- One per different facial expression or configuration: center-light, with glasses, happy, left-light, with no glasses, normal, right-light, sad, sleepy, surprised, and wink.
- The image resolution is 168 x 192 pixels.
- The file names of the images in this database have been named in a special order mentioning the pose and illumination detail.
THE YALE B DATABASE OF FACES

TOTAL 320 face images of varying facial expression, illumination, orientation and occlusion (Spectacles)

<table>
<thead>
<tr>
<th>Method Used</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA + Eucledian distance</td>
<td>574</td>
<td>282</td>
<td>67.1%</td>
</tr>
<tr>
<td>PCA + Manhattan Distance</td>
<td>677</td>
<td>179</td>
<td>79.1%</td>
</tr>
<tr>
<td>PCA + Mahalanobis Distance</td>
<td>785</td>
<td>71</td>
<td>91.7%</td>
</tr>
</tbody>
</table>

Table: Results on The Yale Face Database B
Yale face database B

Figure: Recognition rate (in %) on Yale Face Database on total of 320 images
### RESULTS

#### The ORL Database of Faces

<table>
<thead>
<tr>
<th>Method Used</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Recognition%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA + Eucledian distance</td>
<td>286</td>
<td>34</td>
<td>89.4%</td>
</tr>
<tr>
<td>PCA + Manhattan Distance</td>
<td>284</td>
<td>36</td>
<td>88.8%</td>
</tr>
<tr>
<td>PCA + Mahalanobis Distance</td>
<td>301</td>
<td>19</td>
<td>94.1%</td>
</tr>
</tbody>
</table>

**Table:** Results on The ORL (AT&T) Face Database (ORL)
The ORL Database of Faces

**Figure:** Recognition rate (in %) on ORL (AT&T) Face Database on total of 320 images
Overall result

Figure: overall Recognition rate (in %) on total of 1176 face images
Results: A Realtime Application: Process time

- The processing time of the presented system was also measured.
- On a Linux based Ubuntu (10.04) operating system with Core 2 duo 2.4GHz Intel processor and 4GB memory,
- Running on a database of 1200 images containing images size 168 x 192 pixels from 78 subjects under various lightning conditions, facial expressions etc of the Yale B database,
- our OpenCV based C++ implementation of the proposed system using Mahalanobis distance takes 2 seconds for training on the face images and 3 seconds for testing all the images of the database in order to recognise the test subject.
- Once trained the system responds to single face recognition queries in less than 0.2 seconds.
- The system completed a query stream of 900 test images in 3 seconds, taking a per query time slot of just 3 milli-seconds.
In this project we have developed a PCA based face recognition system for feature extraction and matching using various distance classifiers.

The Distance classifiers used are Euclidean distance, Manhattan Distance and Mahalanobis distance.

The results for all three have been presented.

The results clearly show that a recognition system based on Mahalanobis distance performs far better than the conventional Euclidean distance based classifier.

The presented system is real time with a query response time of less than 0.2 seconds.
Thanks.

Thank You.