Real Time Face Recognition System

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Description

The project presents a unsupervised learning framework which can learn and recognize human faces. A face can be described using a set of 2D characterisitic views. The "*eigen faces*" or eigen vectors of the training images are used to define a face space. The images are projected onto this face space that also encodes the variation amongst the known faces.

Training

First the images (size = N$\times$N) are converted to a vector (size = $N^2 \times 1$) . The average vector of all the training images is then computed. Each image vector is then subtracted from this image vector and appended to a matrix ***A*** as a column. The covariance matrix of the images is computed as AA^T.

The eigen values and eigen vectors of the covariance matrix are computed. We choose the eigen vectors corresponding to the top *K* eigen values. These selected eigen vectors span the face space. Now we take the projections of each training image onto the face space and call each projection a weight vector.

Testing

The average image vector computed while training is subtracted from the test image. The resultant vector is then projected onto the face space and the corresponding weight vector is computed. The Euclidean distance between weight vector of each training image and weight vector of test image is computed. The test image is recognized as the image from which it has the minimum distance. Although it is done only if the min distance is less than a pre-decided threshold value.

Dataset Used

The database used is *"The ORL Database of Faces"*.[1]

The database has images of 40 different people. The images were taken at different times, with different lighting conditions and different facial expressions of the people. In all the images the background is dark. The position of the subject in each image is frontal and upright. The dataset makers have provided some tolerance for some side movements.

Size of each image : 92 $\times$ 112 pixels

Grey levels per pixel : 256

The organisation of the databse is as described below:

The images are organised in 40 directories (one for each person),. The directories are named as `si`, where `i` indicates the person number . The person number ranges from 1 till 40. In each of these directories, there are ten different images of that person, which have names of the form `X.pgm`, where `X` is the image number for that person. The image number for each person ranges from 1 till 10.

The test images have cropped face centered images. Hence there is no need for face detection.

Link to download database: http://www.cl.cam.ac.uk/Research/DTG/attarchive:pub/data/att_faces.tar.Z

Splitting of Dataset into Training and Testing Data

Total number of images : 400

Number of training images : 360

Number of testing images : 40

The first 9 images in each directory have been included in the tarining dataset. The 10^{th} image in each directory is included in the test dataset.

Hence there are 9 images of each person in the training dataset and there is a single image of each person in the testing dataset.

Output

Value of K = 20

Expected Output	Actual Output
s1	s1
s2	s2
s3	s3
s4	s4
s5	s5
s6	s6
s7	s7
s8	s8
s9	s9
s10	s3

Expected Output	Actual Output
s11	s11
s12	s12
s13	s13
s14	s14
s15	s15
s16	s16
s17	s17
s18	s18
s19	s19
s20	s20
s21	s21
s22	s22
s23	s23
s24	s24
s25	s25
s26	s26
s27	s27
s28	s28
s29	s29
s30	s30
s31	s31
s32	s32
s33	s33
s34	s34
s35	s40
s36	s36
s37	s37
s38	s38

Expected Output	Actual Output
s39	s39
s40	s40

As can been seen there are only two incorrect predictions:

- s10 is predicted as s3
- s35 is predicted as s40

The rest of the test images are recognized correctly. Hence the accuracy on the test set is 95%.

References

1. AT&T Laborartories Cambridge , https://www.cl.cam.ac.uk/research/dtg/attarchive/facedatabase.html
2. Face recognition using eigenfaces, M.A. Turk , A.P. Pentland , Proceedings. 1991 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, https://ieeexplore.ieee.org/document/139758/authors#authorsive
3. Eigenfaces for Recognition, M.A. Turk , A.P. Pentland, Journal of Cognitive Neuroscience, vol. 3, no. 1, pp. 71-86, 1991 http://didawiki.cli.di.unipi.it/lib/exe/fetch.php/mcl/1992_turk_eigenfaces_for_recognition.pdf