

Face Detection System.

Algorithm followed for the Training set Images

1. Read all the training images
2. Convert each image matrix (mxn) into a image vector (mxnx1)
3. Find average face image vector (sum of all image vectors by total no. of images) and subtracting it from each vector
4. Stacking all (the subtracted images formed in 3rd step) in a matrix form.
5. Calculate a covariance matrix of above matrix.
6. Find eigenvectors and eigenvalues of the above covariance matrix.
7. Pre-multiply the eigenvectors of transpose(A)*A with A to get eigenvectors of A*transpose(A).
8. Then choosing the best k eigenvectors.

Algorithm followed for the Test set Images

1. Normalize the test image by subtracting the average face image vector.
2. Find weights of the test image same as above.
3. Calculate error between the test image and weights of the images in the training set.
4. Display the images with the min error.

Note: The 10 frontal images are stored in the folder *CLab2/Task3/My_img*. The 10 images were converted to .png format, resized , aligned and converted to grayscale image manually.

Based on the alignment of the images, the key points are captured These key points or feature points are important to be aligned to generate an integrated reconstructed faces and detect the face.

Code

1. **readFiles.m** : This function will take all the images in the training set as input and output an image matrix. The columns are image matrix for each image, they are reshaped/resized into vector and stacked as columns of the matrix
2. **flatten_image.m** : The function converts image matrix into vector form
3. **display_image.m**: This function displays image by converting the vector to image matrix
4. **faceRecognition.m**: This function does the steps 3-8 mentioned in the training algorithm.
5. **weights_image_vector.m**: This function takes the image matrix, k best eigenvectors, train variable; if the train variable is 1 then weights matrix is where the columns are weights of each training image while for train variable is 0 then weights vector for the test image.
6. **main.m** : This the main function performing the face detection.



```
Error 6.344138e+06 --> Image No 13.  
Error 5.722533e+08 --> Image No 13.  
Error 7.193790e+08 --> Image No 13.  
Error 7.234446e+08 --> Image No 13.  
Error 7.773214e+08 --> Image No 13.  
Error 7.945021e+08 --> Image No 13.  
Error 7.947359e+08 --> Image No 13.  
Error 7.960728e+08 --> Image No 13.  
Error 8.187159e+08 --> Image No 13.  
Error 8.736483e+08 --> Image No 13.  
Error 9.148644e+08 --> Image No 13.  
Error 9.179596e+08 --> Image No 13.  
Error 9.179723e+08 --> Image No 13.  
Error 9.184557e+08 --> Image No 13.  
Error 9.186674e+08 --> Image No 13.
```

Fig 1 Showing results for subject01.glasses



```
Error 2.297964e+07 --> Image No 87.
Error 3.850131e+08 --> Image No 77.
Error 5.875011e+08 --> Image No 14.
Error 5.913879e+08 --> Image No 14.
Error 5.918241e+08 --> Image No 14.
Error 6.053663e+08 --> Image No 14.
Error 6.107224e+08 --> Image No 14.
Error 6.109540e+08 --> Image No 14.
Error 6.312218e+08 --> Image No 14.
Error 6.312242e+08 --> Image No 14.
Error 6.314424e+08 --> Image No 14.
Error 6.314847e+08 --> Image No 14.
Error 6.323879e+08 --> Image No 14.
Error 6.325635e+08 --> Image No 14.
Error 6.325643e+08 --> Image No 14.
```

Fig 2 Showing results for subject02.happy



```
Error 4.550324e+07 --> Image No 113.
Error 4.822973e+08 --> Image No 97.
Error 5.364704e+08 --> Image No 53.
Error 6.361259e+08 --> Image No 22.
Error 6.362338e+08 --> Image No 22.
Error 6.637531e+08 --> Image No 22.
Error 6.638267e+08 --> Image No 22.
Error 6.643332e+08 --> Image No 22.
Error 6.700278e+08 --> Image No 22.
Error 6.726048e+08 --> Image No 22.
Error 6.745865e+08 --> Image No 22.
Error 6.749532e+08 --> Image No 22.
Error 6.752076e+08 --> Image No 22.
Error 6.779264e+08 --> Image No 22.
Error 6.786015e+08 --> Image No 22.
```

Fig 3 Showing results for subject03.happy



```
Error 5.610395e+07 --> Image No 38.
Error 1.698664e+08 --> Image No 22.
Error 1.738120e+08 --> Image No 22.
Error 1.767294e+08 --> Image No 22.
Error 1.999513e+08 --> Image No 22.
Error 2.100418e+08 --> Image No 22.
Error 2.162978e+08 --> Image No 22.
Error 2.210012e+08 --> Image No 22.
Error 2.272750e+08 --> Image No 22.
Error 2.382893e+08 --> Image No 22.
Error 2.721516e+08 --> Image No 22.
Error 2.736027e+08 --> Image No 22.
Error 2.769997e+08 --> Image No 22.
Error 2.775712e+08 --> Image No 22.
Error 2.811730e+08 --> Image No 22.
```

Fig 4 Showing results for subject04.glasses



```
Error 5.247750e+07 --> Image No 133.
Error 2.248750e+08 --> Image No 32.
Error 2.668251e+08 --> Image No 32.
Error 2.717251e+08 --> Image No 32.
Error 2.769220e+08 --> Image No 32.
Error 2.785430e+08 --> Image No 32.
Error 2.860939e+08 --> Image No 32.
Error 2.862348e+08 --> Image No 32.
Error 2.990523e+08 --> Image No 32.
Error 2.993716e+08 --> Image No 32.
Error 3.083399e+08 --> Image No 32.
Error 3.092253e+08 --> Image No 32.
Error 3.105254e+08 --> Image No 32.
Error 3.105402e+08 --> Image No 32.
Error 3.116240e+08 --> Image No 32.
```

Fig 5 Showing results for subject05.happy



```
Error 3.482731e+08 --> Image No 120.
Error 1.412403e+09 --> Image No 117.
Error 1.866187e+09 --> Image No 126.
Error 2.025513e+09 --> Image No 106.
Error 2.025542e+09 --> Image No 106.
Error 2.047485e+09 --> Image No 106.
Error 2.056753e+09 --> Image No 106.
Error 2.070613e+09 --> Image No 106.
Error 2.073105e+09 --> Image No 106.
Error 2.077559e+09 --> Image No 101.
Error 2.078940e+09 --> Image No 101.
Error 2.080593e+09 --> Image No 101.
Error 2.080965e+09 --> Image No 101.
Error 2.081948e+09 --> Image No 101.
Error 2.083362e+09 --> Image No 101.
```

Fig 6 Showing results for subject06.happy



```
Error 3.047472e+06 --> Image No 53.
Error 6.925572e+08 --> Image No 115.
Error 8.597664e+08 --> Image No 115.
Error 8.704303e+08 --> Image No 115.
Error 9.734792e+08 --> Image No 115.
Error 9.745924e+08 --> Image No 115.
Error 9.761167e+08 --> Image No 115.
Error 9.782563e+08 --> Image No 115.
Error 1.025616e+09 --> Image No 115.
Error 1.031403e+09 --> Image No 115.
Error 1.070019e+09 --> Image No 115.
Error 1.072946e+09 --> Image No 115.
Error 1.080983e+09 --> Image No 115.
Error 1.088078e+09 --> Image No 115.
Error 1.090905e+09 --> Image No 115.
```

Fig 7 Showing results for subject07.glasses



```
Error 7.087004e+07 --> Image No 35.
Error 1.389702e+09 --> Image No 44.
Error 1.391233e+09 --> Image No 44.
Error 1.391239e+09 --> Image No 44.
Error 1.404319e+09 --> Image No 44.
Error 1.507118e+09 --> Image No 44.
Error 1.513323e+09 --> Image No 44.
Error 1.519617e+09 --> Image No 44.
Error 1.519629e+09 --> Image No 44.
Error 1.560271e+09 --> Image No 44.
Error 1.567110e+09 --> Image No 44.
Error 1.568527e+09 --> Image No 44.
Error 1.589654e+09 --> Image No 44.
Error 1.591984e+09 --> Image No 44.
Error 1.596069e+09 --> Image No 44.
```

Fig 8 Showing results for subject08.happy



```
Error 9.501435e+07 --> Image No 51.
Error 5.756406e+08 --> Image No 85.
Error 9.948605e+08 --> Image No 125.
Error 9.961470e+08 --> Image No 125.
Error 1.063280e+09 --> Image No 125.
Error 1.072535e+09 --> Image No 125.
Error 1.080877e+09 --> Image No 125.
Error 1.100302e+09 --> Image No 125.
Error 1.119805e+09 --> Image No 125.
Error 1.120629e+09 --> Image No 125.
Error 1.122317e+09 --> Image No 125.
Error 1.144599e+09 --> Image No 125.
Error 1.144606e+09 --> Image No 125.
Error 1.145526e+09 --> Image No 125.
Error 1.145560e+09 --> Image No 125.
```

Fig 9 Showing results for subject09.happy



```
Error 3.873566e+07 --> Image No 35.
Error 5.730992e+08 --> Image No 142.
Error 5.920028e+08 --> Image No 142.
Error 7.115631e+08 --> Image No 142.
Error 7.740784e+08 --> Image No 142.
Error 8.524220e+08 --> Image No 142.
Error 8.982272e+08 --> Image No 142.
Error 8.991557e+08 --> Image No 142.
Error 8.996877e+08 --> Image No 142.
Error 9.029974e+08 --> Image No 142.
Error 9.257022e+08 --> Image No 142.
Error 9.257549e+08 --> Image No 142.
Error 9.267930e+08 --> Image No 142.
Error 9.267981e+08 --> Image No 142.
Error 9.282498e+08 --> Image No 142.
```

Fig 10 Showing results for subject10.happy

The above figs 1- 10 shows the top 3 faces for each of the test image, here the top 3 detected images, except for *subject06.happy* and *subject08.happy*, are the same as shown in the error analysis for each one of them with the image no. for the same.

Fig 3.6 shows two different images that can be considered as the top 3 detected images for that subject while *subject08.happy* gives a wrong detection.

Note: The final 3 images are the same based on the minimum error values attained.

At $n \geq 10$ eigenvectors, image detected are correct and the error remains more or less the same, that is, it has hit convergence.