T0: 1.4e14 **T1: 2e8**

The PCA coefficients (Ω_i) for each training image.

	1	2	3	4	5	6	7	8
1	-7.5839e+07	8.5591e+07	6.7909e+07	1.5937e+08	-2.5701e+07	-3.0997e+08	-5.4804e+07	1.5344e+08
2	-9.8659e+07	5.3277e+07	-2.8610e+...	5.9898e+07	-5.3104e+07	1.0157e+08	-7.5618e+07	4.1246e+07
3	7.3531e+07	4.3582e+04	2.1198e+07	-3.6239e+07	-7.6740e+07	7.2328e+06	-4.0790e+07	5.1764e+07
4	2.0906e+07	7.2756e+07	-6.1447e+...	-2.9967e+07	2.1367e+07	-1.3816e+07	-9.9724e+06	1.7351e+05
5	-1.3469e+07	-2.3619e+07	3.3837e+06	-3.1166e+07	4.7916e+07	4.0189e+06	-2.9914e+07	4.2849e+07

8 eigenfaces:

mean face:

FIRST TRY

when we choose Top 5 eigen faces.

T0: 1.4e14 **T1: 2e8**

For pic13: we should not recognize it as any face. The distance is 8.09e7.

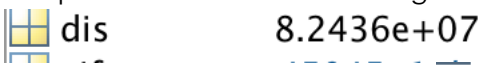
For apple: the distance0=8.98e11

For pic 6: the distance0=7.79e11

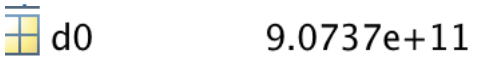
SECOND TRY

when we choose top 6 eigen faces.

For pic13: we should not recognize it as any face. The distance is 8.09e7.



For apple: the distance0=9e11



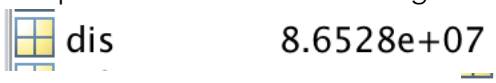
For pic 6: the distance0=7.8e11

Wrong answer number is 2.

THIRD TRY :

When we choose top 7 eigen faces:

For pic13: we should not recognize it as any face. The distance is 8.6e7.



For apple: the distance0=9.13e11

For pic 6: the distance0=7.8e11

For pic 1:

1	2	3	4	5	6	7
1.1159e+08	1.5524e+08	1.4668e+08	2.2959e+08	1.1971e+08	2.9287e+08	1.0795e+08

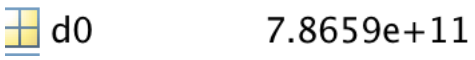
FORTH TRY

When we choose all

For pic13: we should not recognize it as any face. The distance is 8.6e7.

For apple: the distance0=9.13e11

For pic 6: the distance0=7.8e11



Conclusion: There is little differences between the four choices, we choose TOP 5 eigenvaluse to finish this project.

Code For Training the pics and get eigen face

```
clear   %calc xmean, sigma and its eigen decomposition
close all
train_all=[]; %Ri
trainpic=[01, 02, 03, 07, 10, 11, 14, 15];
T0=1.4e14;
T1=2e8;
for i=1:length(trainpic)
    if(trainpic(i)<10)
        pic_temp=imread(strcat('Face dataset/subject0',int2str(trainpic(i)),'.normal','.jpg'));
    else
        pic_temp=imread(strcat('Face dataset/subject',int2str(trainpic(i)),'.normal','.jpg'));
    end
    [r c]=size(pic_temp);
    pic_reshape=double(reshape(pic_temp,[r*c, 1]));
    train_all=[train_all pic_reshape]; %add column
end
train_mean=mean(train_all, 2);  %meanface m;
figure
imshow(mat2gray(reshape(train_mean, r, c)));

mean_reshape=reshape(train_mean, [r*c, 1]);
mean_all=repmat(mean_reshape, [1, length(trainpic)]);
train_A=train_all-mean_all; %compute Matrix A: R=Ri-m
train_L=train_A'*train_A; %cannot compute C: A*A', compute L
top=5;
[evect, eval]=eigs(train_L, top);
[vectorall, valueall]=eig(train_L);


train_V=evect; %put L into single matrix
%train_V=evect;
train_U=train_A*train_V; %eigen faces

%5 eigen face
figure;
for i=1:top
    eiface=train_U(:, i);
    subplot(1, top, i);
    imshow(mat2gray(reshape(eiface, r, c)));
end

%compute 8 projection
omg=[];
for i=1:length(trainpic)
    omg=[omg train_U'*train_A(:, i)]; %computer projection face omega
end
```

Code for recognizing:

```
%recongize
tall_omg=[];
temp_array=[];
dall0=[];
for i=1:18
    if(i<10)
        pic_temp=imread(strcat('test/subject0',int2str(i),'.jpg'));
    else
        pic_temp=imread(strcat('test/subject',int2str(i),'.jpg'));
    end
    pic_reshape=double(reshape(pic_temp,[r*c,1]));
    test_I=pic_reshape-train_mean; %compute I
    figure;
    imshow(mat2gray(reshape(test_I,r,c)));
     %string1=sprintf('%s%d','t',i,'.jpg');
     %imwrite(mat2gray(reshape(test_I,r,c)),string1);
    test_omg=train_U'*test_I;
    tall_omg=[tall_omg test_omg];
    test_IR=train_U*test_omg;
    figure;
     %string2=sprintf('%s%d','tIR',i,'.jpg');
    imshow(mat2gray(reshape(test_IR,r,c)));
     %imwrite(mat2gray(reshape(test_IR,r,c)),string2);
    d0=norm(test_IR-test_I,1);
    dall0=[dall0,d0];
    if(d0<T0)
        h=msgbox('This is not face');
    else
        dis=1e30;
        for j=1:length(trainpic)
            temp=norm(test_omg-omg(:,j),1);
            if(temp<dis)
                dis=temp;
                dect=j;
            end
            temp_array=[temp_array temp] %distance
        end
        if(dis<T1)
            msg=sprintf('%s%d%s','This is',trainpic(dect),'face');
            h=msgbox(msg);
        else
            h=msgbox('We can not recognize');
        end
    end
end
```

Notice that we use norm(,1) Manhattan distance instead of Euclid distance, which gives us more accurate results.

Test Pic 1: 

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	1.8844e+08	2.7828e+08	2.2333e+08	4.0638e+08	2.1085e+08	4.3711e+08	1.9832e+08	3.4858e+08

PCA coefficients (Ω_I)

	1
1	-4.1927e+07
2	-9.3344e+06
3	1.9689e+07
4	2.3336e+07
5	-4.5388e+06

Result:

Test Pic 2: 

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	1.0682e+08	3.4203e+08	2.6896e+08	4.7145e+08	2.1051e+08	5.5132e+08	1.8474e+08	3.7163e+08

PCA coefficients (Ω_I)

	1
1	-2.8423e+07
2	-6.2166e+07
3	5.5840e+07
4	2.3992e+07
5	-1.5604e+07

Result:

Test Pic 3:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	0	4.4885e+08	3.6534e+08	5.7210e+08	3.0781e+08	5.5286e+08	2.0572e+08	4.6801e+08

PCA coefficients (Ω_I)

	1
1	-7.5839e+07
2	-9.8659e+07
3	7.3531e+07
4	2.0906e+07
5	-1.3469e+07

Result:

Test Pic 4:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	4.4885e+08	0	2.8193e+08	2.2695e+08	4.1738e+08	5.6525e+08	3.9915e+08	2.7065e+08

PCA coefficients (Ω_I)

	1
1	8.5591e+07
2	5.3277e+07
3	4.3582e+04
4	7.2756e+07
5	-2.3619e+07

Result:

Test Pic 5:

subtract mean face

the reconstructed face image (I_R)

distance d_i

1	2	3	4	5	6	7	8
3.6534e+08	2.819...	0	3.0343e+08	3.4339e+08	5.7028e+08	3.1648e+08	2.8704e+08

PCA coefficients (Ω_I)

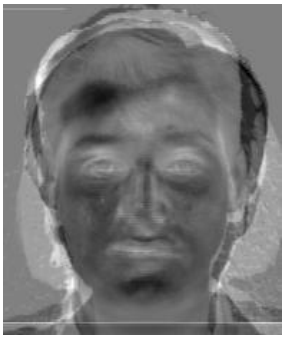
1
6.7909e+07
-2.8610e+07
2.1198e+07
-6.1447e+07
3.3837e+06

Result:

Test Pic 6:

subtract mean face

the reconstructed face image (I_R)



distance d_i

it is recognized as non-face, so we just have d0 data.

	1
1	1.2592e+14

PCA coefficients (Ω_I)

1	5.9428e+06
2	-1.0907e+07
3	-6.4439e+07
4	-1.8865e+06
5	-1.6001e+07

Result:

(Wrong Answer)

Because its d0 too small, which is less than the apple's d0, and less than T0, we recognize it as non-face pic.

Test Pic 7:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	4.1769e+08	1.8108e+08	1.8382e+08	1.7334e+08	3.2185e+08	5.5538e+08	2.9390e+08	2.0668e+08

PCA coefficients (Ω_I)

1
1.0389e+08
9.1560e+06
-2.3140e+07
-3.1026e+06
-4.0070e+06

Result:

Test Pic 8:

subtract mean face

the reconstructed face image (I_R)

distance d_i

1	2	3	4	5	6	7	8
5.7210e+08	2.2695e+08	3.0343e+08	0	4.6898e+08	6.0581e+08	3.7548e+08	2.1673e+08

PCA coefficients (Ω_I)

1
1.5937e+08
5.9898e+07
-3.6239e+07
-2.9967e+07
-3.1166e+07

Result:

Test Pic 9:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	3.0781e+08	4.1738e+08	3.4339e+08	4.6898e+08	0	6.0199e+08	1.9673e+08	4.2826e+08

PCA coefficients (Ω_I)

	1
1	-2.5701e+07
2	-5.3104e+07
3	-7.6740e+07
4	2.1367e+07
5	4.7916e+07

Result:

Test Pic 10:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	4.2037e+08	4.2618e+08	5.0896e+08	5.0752e+08	4.9457e+08	1.9096e+08	4.1217e+08	5.3305e+08

PCA coefficients (Ω_I)

	1
1	-1.8446e+08
2	1.2751e+08
3	3.9410e+06
4	6.5752e+06
5	-1.1807e+07

Result:

Test Pic 11:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	5.2798e+08	5.4206e+08	5.6766e+08	5.9256e+08	5.9238e+08	3.7711e+07	4.9721e+08	6.0978e+08

PCA coefficients (Ω_I)

1
-2.9128e+08
1.0798e+08
8.0798e+06
-8.8425e+06
-2.7743e+06

Result:

Test Pic 12:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	5.5286e+08	5.6525e+08	5.7028e+08	6.0581e+08	6.0199e+08	0	5.1815e+08	6.2108e+08

PCA coefficients (Ω_I)

	1
1	-3.0997e+08
2	1.0157e+08
3	7.2328e+06
4	-1.3816e+07
5	4.0189e+06

Result:

Test Pic 13:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	1.7869e+08	3.1235e+08	2.9361e+08	4.3591e+08	2.2326e+08	4.2603e+08	1.7277e+08	4.4819e+08

PCA coefficients (Ω_I)

	1
1	-8.4815e+07
2	-2.3998e+07
3	-9.2469e+06
4	3.0354e+07
5	-1.0642e+07

Result:

Wrong answer:

Because we don't train Face 12 sample, so the right answer is "we cannot recognize this face", it min(di) should more than T1, but if we set T1 according to this di(1.72e8), more other pics will have wrong answer like PIC10, because its min(di) is 1.9e8. So for better results, we ignore this one.

Test Pic 14:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	2.0894e+08	3.6064e+08	2.7457e+08	3.6333e+08	1.9959e+08	5.1144e+08	4.4588e+07	4.6206e+08

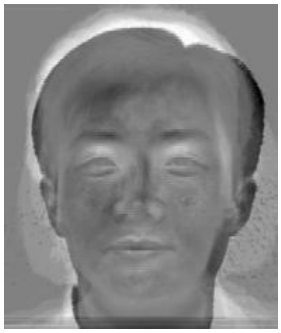
PCA coefficients (Ω_I)

	1
1	-3.7200e+07
2	-7.2355e+07
3	-2.0107e+07
4	-1.1675e+07
5	-3.1250e+07

Result:

Test Pic 15:

subtract mean face



the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	2.0572e+08	3.9915e+08	3.1648e+08	3.7548e+08	1.9673e+08	5.1815e+08	0	5.0057e+08

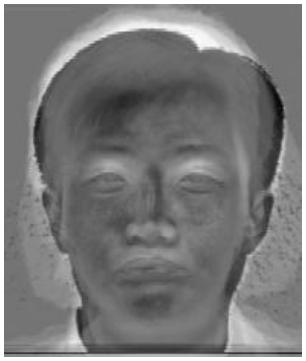
PCA coefficients (Ω_I)

	1
1	-5.4804e+07
2	-7.5618e+07
3	-4.0790e+07
4	-9.9724e+06
5	-2.9914e+07

Result:

Test Pic 16:

subtract mean face



the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	2.4285e+08	3.6163e+08	2.8067e+08	3.3902e+08	1.5854e+08	5.3003e+08	3.8834e+07	4.6306e+08

PCA coefficients (Ω_I)

	1
1	-3.0956e+07
2	-6.2142e+07
3	-4.1128e+07
4	-9.1219e+06
5	-3.0236e+07

Result:

Test Pic 17:

subtract mean face

the reconstructed face image (I_R)

distance d_i

	1	2	3	4	5	6	7	8
1	4.6801e+08	2.7065e+08	2.8704e+08	2.1673e+08	4.2826e+08	6.2108e+08	5.0057e+08	0

PCA coefficients (Ω_I)

1	1.5344e+08
2	4.1246e+07
3	5.1764e+07
4	1.7351e+05
5	4.2849e+07

Result:

Test Pic 18:

subtract mean face

the reconstructed face image (I_R)

distance d_i

Because it is not a face, we do not calculate its distance with the sample training pictures, we just have d0;

	1
1	1.3987e+14

PCA coefficients (Ω_I)

	1
1	-2.4068e+07
2	-2.3397e+07
3	5.1898e+07
4	-2.5942e+06
5	-3.6246e+07

Result: