ECE 515
IMAGE ANALYSIS & COMPUTER VISION II
MID-TERM PROJECT

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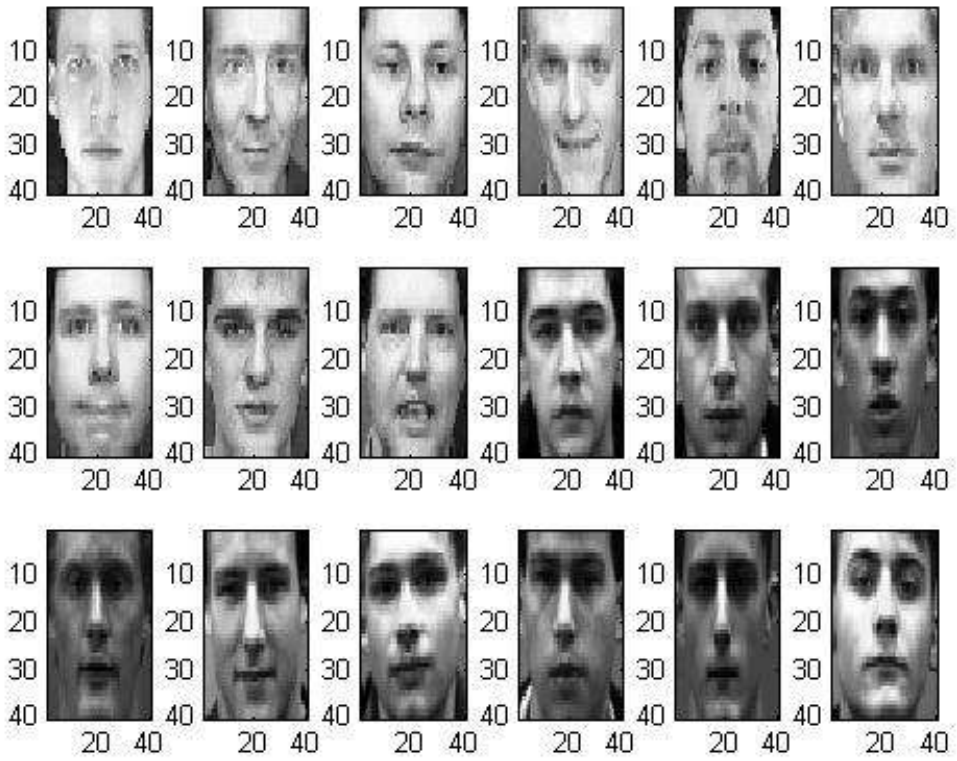
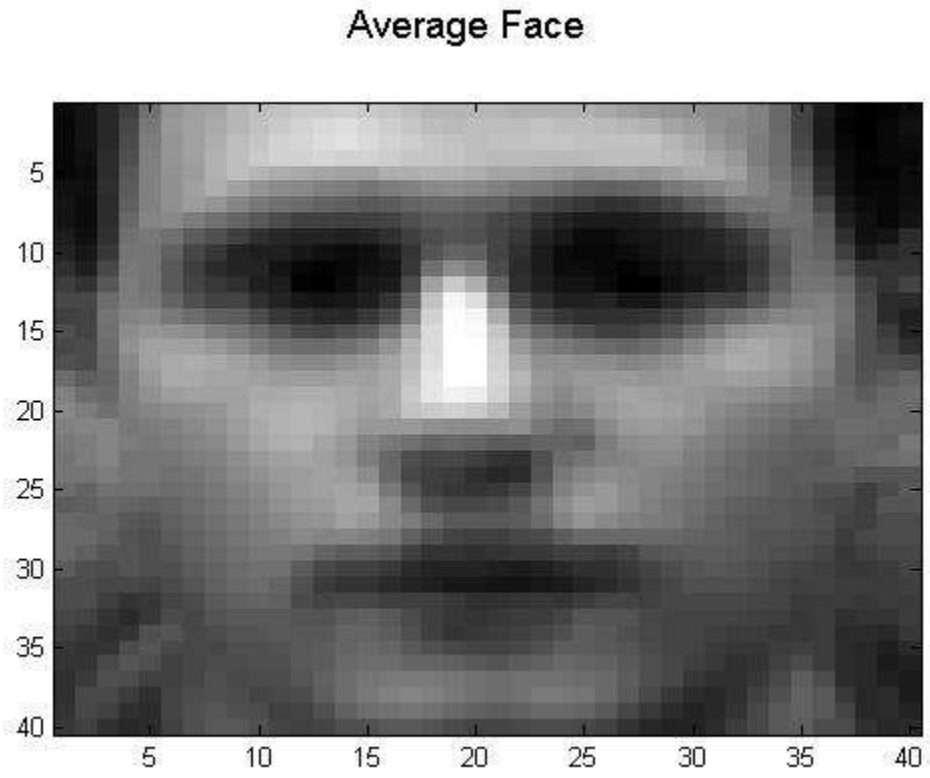
Display and print 18 face images.

```
clc;
close all;
clear all;
B = load('KL_norm_train.dat');
C = load('KL_norm_train_2.dat');
Z = load('Test_image.dat');
A = [B,C];
%Initialized the Temp variables to zero%
temp5=0;
distvector=0;
temp6=0;
temp7=0;
temp9=0;
m=0;
c=0;
figure;
   a = reshape(A,40,40,18); %Reshaping the original Image in
 40x40 format for display
for n= 1:18
   subplot(3,6,n);
   imagesc(a(:,:,n));
   colormap(gray); %This function is used to convert the colored imaged into
grayscale image
end
```



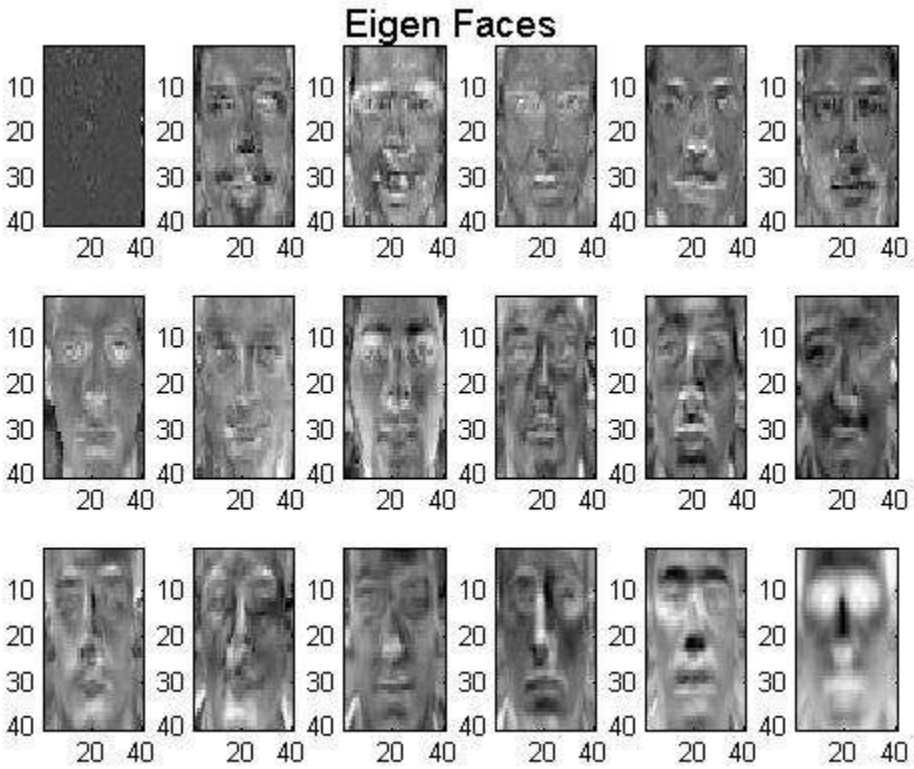
Finding the Average Image.

```
for n=1:18
  m=m+A(:,n);
end
%Displaying Average Faces%
avg = m/18;
figure;
suptitle('Average Face');
imagesc(reshape(avg,40,40));
colormap(gray);
%This function is used to convert the colored imaged into grayscale image
```



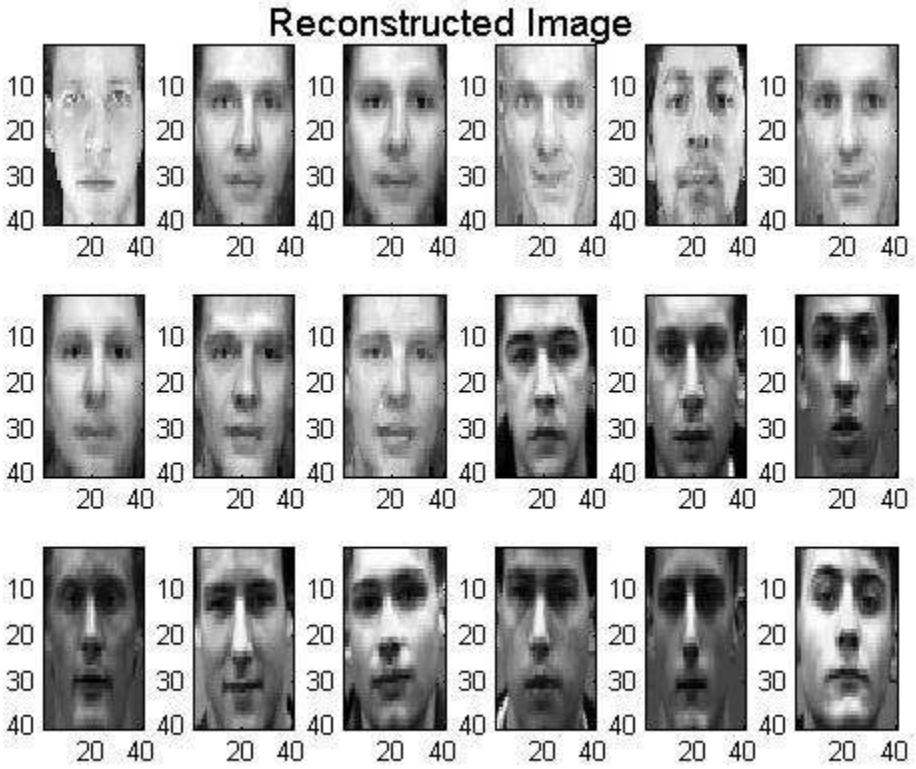
Displaying and printing the 9 Eigenvectors as Eigen Images

```
for n=1:18
    cov=(A(:,n)-avg)*(A(:,n)-avg)';
    c=c+cov;
end
[eigenvector,eigenvalue] = eig(c);
for n=1:18
    temp(:,n)=eigenvector(:,1582+n);
end
figure;
suptitle('Eigen Faces');
temp1 = reshape(temp(:,(1:18)),40,40,18);
for n= 1:18
       subplot(3,6,n);
       imagesc(temp1(:,:,n));
       colormap(gray);
%This function is used to convert the colored imaged into grayscale image
end
```



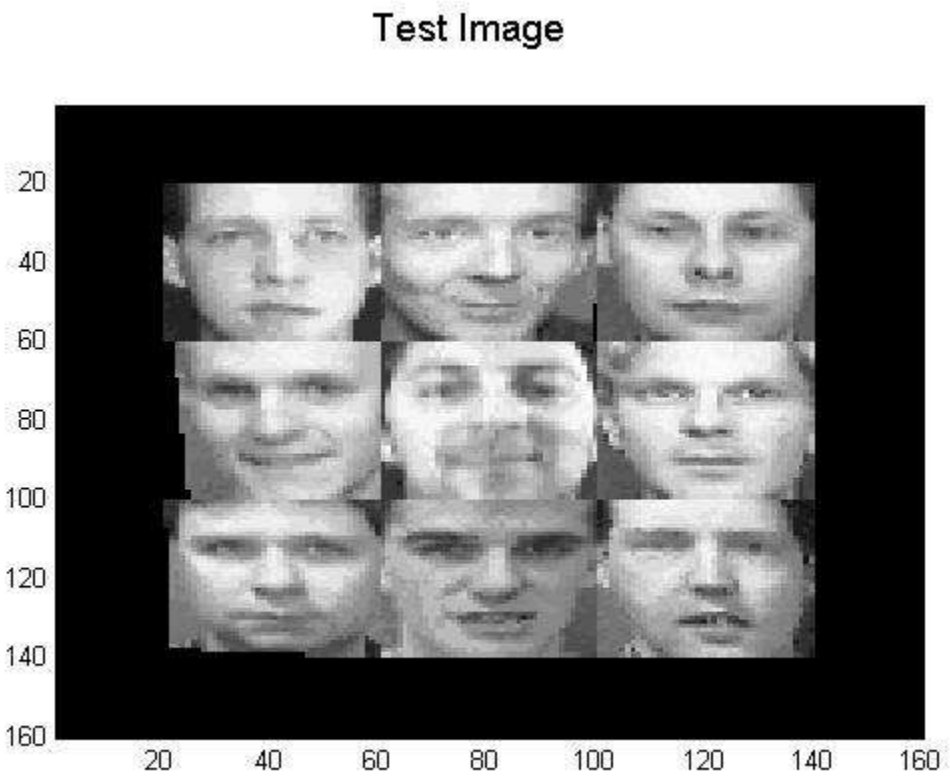
Reconstructing all the 9 training images with 6 eigenvectors

```
flip = fliplr(eigenvector(:,1589:1600));
for n=1:18
   weight(:,n)=(flip'*(A(:,n)-avg));
   recimg(:,n)=((flip*weight(:,n))+avg);
end
figure;
suptitle('Reconstructed Image');
temp2 = reshape(recimg(:,(1:18)),40,40,18);
 %Reconstructed Image is stored in temp2 just to reshape it while displaying
for n= 1:18
       subplot(3,6,n);
       imagesc(temp2(:,:,n));
       colormap(gray); %This function is used to convert the colored imaged
into grayscale image
end
```



Displaying Test Image

```
figure;
suptitle('Test Image');
imagesc(Z);
colormap(gray);
%This function is used to convert the colored imaged into grayscale image
```



In processing the test image, you need to scan the image with a 40 × 40 window. The part of the image within the window is first normalized by making it zero mean and unit variance to match the statistics of the test image.
Is this necessary? Why or why not? Please provide a well-thought out argument based on the methods used for detection and recognition.

A. Yes, It is necessary. The main reason is that in detection and recognition, we have to compare the test images. The dimensions of the image should match up with that of the average image and respective Eigen vector. It is impossible to recognize and detect the image if the image is not normalized or scaled.

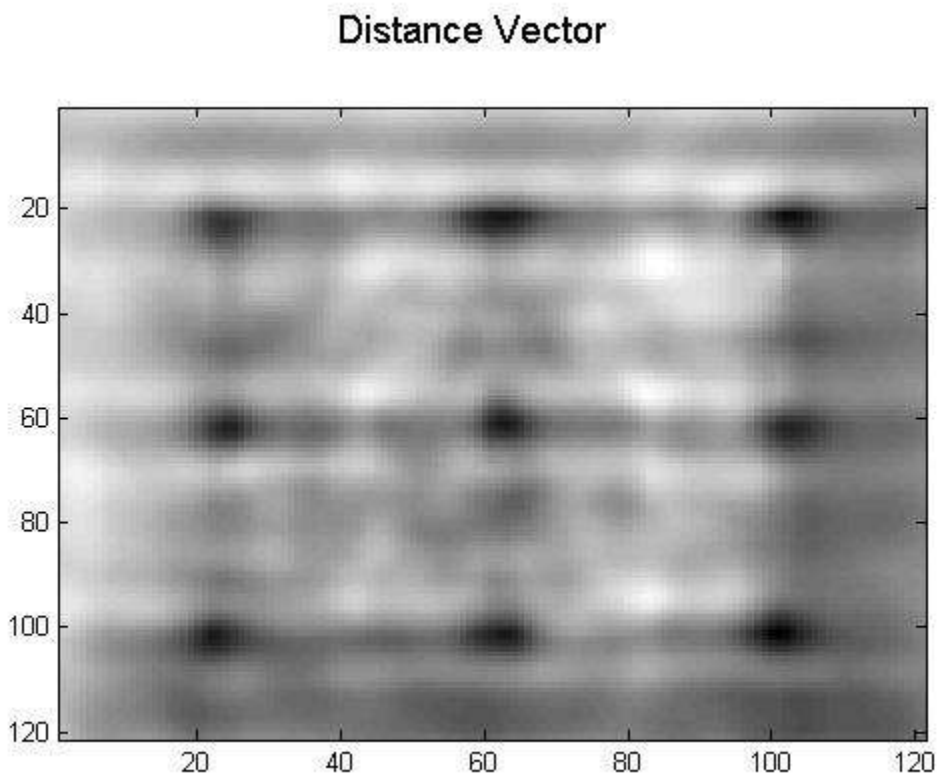
Why is it necessary to subtract I_{av} from W?

A. It is necessary since we are given different images to construct Eigen-vectors. Each image is unique and unlike each other and hecn we need subtract the average image to get correct coefficient matrix.

Source code for the detection algorithm

```
for i=1:121 %for1
    for j=1:121 %for2
window(:,:)=Z(i:i+39,j:j+39); %Window%
M = mean(mean(window)); %Mean of the window
diff=window-M;
SD = sqrt(sum(sum(diff.^2)));
NW = diff/SD;
%Normalized Window will have DC Value of 0 and variance of 1
output=(reshape(NW,1600,1)-avg);
%y
for k=1:12
y(i,j,k)=dot(flip(:,k),output);
end
%error square
temp8=zeros(1,12);
for k=1:12
temp8(:,k)=(y(i,j,k).^2);
end
temp9=sum(temp8); %temp9 is the sumation of y(i)^2 of 12 values
errorsq=((norm(output).^2)-temp9);
%Lamba i for 12 values
temp3=eigenvalue(1583:1600,1583:1600);
temp4=zeros(1,18);
for i1=1:18
    for j1=1:18
        if i1 == j1
           temp7(:,i1)=temp3(i1,j1); %Lambda i
        end
    end
end
temp5=sum(temp7(:,13:18)); %Summation Lambda i for last 6 values
rho=(1/6)*(temp5);
%distance vector
temp12=(y(i,j,:).^2);
for k=1:12
    temp11(i,j)=sum((temp12)/fliplr(temp7(:,k)));
end
distvector(i,j)=abs(temp11(i,j)+(errorsq/rho));
    end% for1 ends
end% for2 ends
figure;
suptitle('Distance Vector');
imagesc(distvector);
colormap(gray);
%This function is used to convert the colored imaged into grayscale image
```

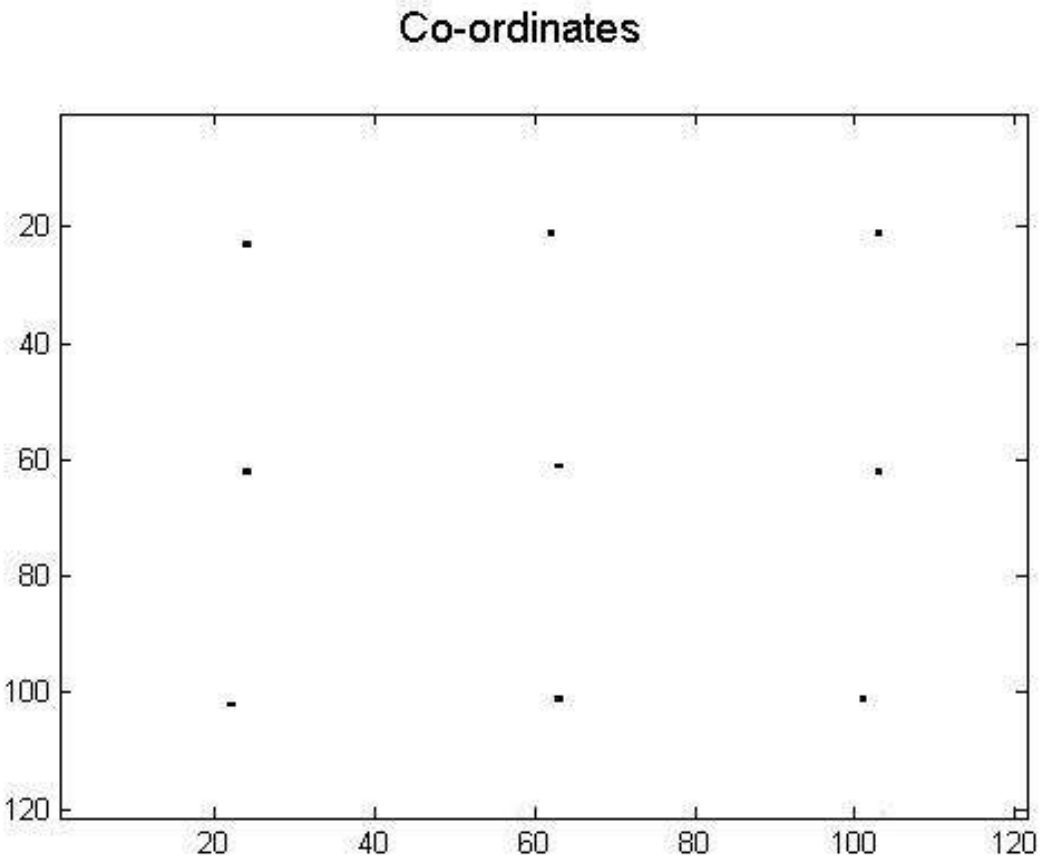
Display and print the distance image.



Detection Algorithm

```
n=20; %Window
for i=1:121-n+1 %for1
    for j=1:121-n+1 %for2
window1(:,:)=distvector(i:i+n-1,j:j+n-1);
M1 = min(min(window1)); %Mean of the window
for i1=i:i+n-1
    for j1=j:j+n-1
        if (distvector(i1,j1)>M1)
            distvector(i1,j1)=255;
        end
    end
end
   end
end
figure;
suptitle('Co-ordinates');
imagesc(distvector);
colormap(gray); %This function is used to convert the colored imaged into
grayscale image
```

Co-ordinates of the detected faces



Co-ordinates:

P1 = 23,24
P2 = 21,62
P3 = 21,103
P4 = 62,24
P5 = 61,63
P6 = 62,103
P7 = 102,22
P8 = 101,63
P9 = 101,101

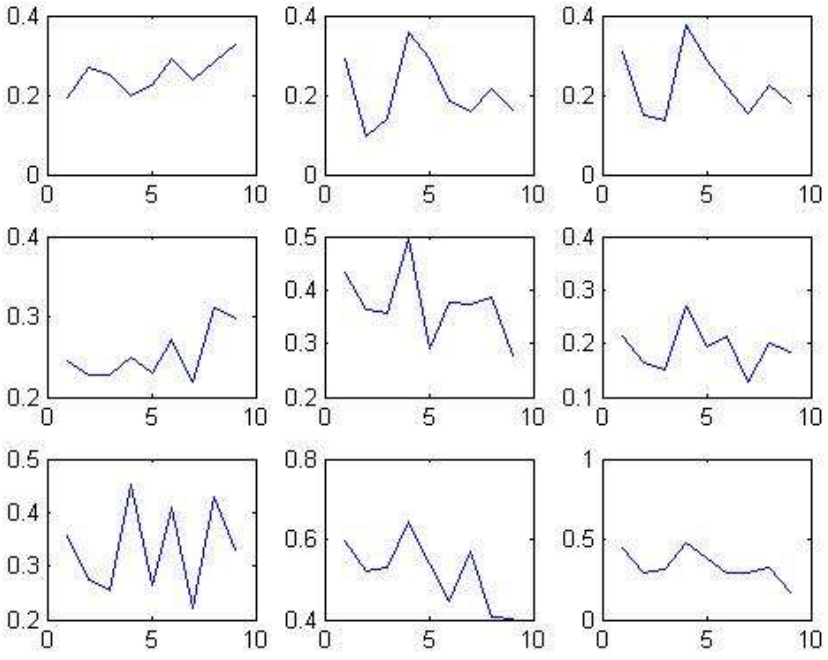
KL – Coefficient Matrix

16.0497	-0.3805	0.4844	-0.4585	0.0243	0.0259
15.9163	-0.4762	0.3803	-0.2159	0.0313	-0.0847
15.8759	-0.4245	0.4058	-0.2374	0.0363	-0.0323
15.9649	-0.4207	0.5163	-0.4237	-0.0582	-0.0374
15.9165	-0.2815	0.6086	-0.1330	-0.0537	-0.0710
15.9813	-0.3586	0.4183	-0.3216	0.0639	-0.0211
15.9377	-0.3023	0.2934	-0.2326	-0.1541	-0.1069
15.9188	-0.3942	0.6932	0.0381	0.2263	0.0001
15.8103	-0.3400	0.4393	-0.1700	0.1259	-0.1299

Distance of test faces versus training faces in the file

0.1930	0.2682	0.2502	0.1989	0.2260	0.2923	0.2389	0.2830	0.3265
0.2902	0.0967	0.1416	0.3564	0.2912	0.1840	0.1559	0.2145	0.1624
0.3103	0.1473	0.1365	0.3758	0.2863	0.2204	0.1551	0.225	0.1778
0.2445	0.2280	0.2272	0.2184	0.2295	0.2723	0.2502	0.3117	0.2969
0.4309	0.3619	0.3576	0.4936	0.2781	0.3758	0.3730	0.3872	0.2892
0.2132	0.1654	0.1524	0.2707	0.1938	0.1281	0.2142	0.2003	0.1841
0.3576	0.2728	0.2531	0.4528	0.2647	0.4095	0.2224	0.4306	0.3287
0.5955	0.5228	0.5313	0.6429	0.5403	0.4470	0.5712	0.4083	0.4002
0.4436	0.2885	0.3140	0.4776	0.3779	0.2881	0.2914	0.3200	0.1681

Ploting the distance of Test Image with Training Image



```
clc;
close all;
clear all;
B = load('C:\Users\Shreyas\Desktop\Image 2\KL_norm_train.dat');
C = load('C:\Users\Shreyas\Desktop\Image 2\KL_norm_train_2.dat');
Z = load('C:\Users\Shreyas\Desktop\Image 2\Test_image.dat');
A = [B,C];
%Initialized the Temp variables to zero%
temp5=0;
distvector=0;
temp6=0;
temp7=0;
temp9=0;
m=0;
c=0;
figure;
   a = reshape(A,40,40,18); %Reshaping the original Image in 40x40 format for
display
for n= 1:18
   subplot(3,6,n);
   imagesc(a(:,:,n));
   colormap(gray); %This function is used to convert the colored imaged into
grayscale image
end
for n=1:18
  m=m+A(:,n);
end
%Displaying Average Faces%
avg = m/18;
figure;
suptitle('Average Face');
imagesc(reshape(avg,40,40));
colormap(gray); %This function is used to convert the colored imaged into
grayscale image
for n=1:18
    cov=(A(:,n)-avg)*(A(:,n)-avg)';
    c=c+cov;
end
[eigenvector,eigenvalue] = eig(c);
for n=1:18
    temp(:,n)=eigenvector(:,1582+n);
end
figure;
suptitle('Eigen Faces');
temp1 = reshape(temp(:,(1:18)),40,40,18);
for n= 1:18
       subplot(3,6,n);
       imagesc(temp1(:,:,n));
       colormap(gray); %This function is used to convert the colored imaged
into grayscale image
end
flip = fliplr(eigenvector(:,1589:1600));
for n=1:18
```

```
   weight(:,n)=(flip'*(A(:,n)-avg));
   recimg(:,n)=((flip*weight(:,n))+avg);
   end
figure;
suptitle('Reconstructed Image');
temp2 = reshape(recimg(:,(1:18)),40,40,18); %Reconstructed Image is stored in
temp2 just to reshape it while displaying
for n= 1:18
       subplot(3,6,n);
       imagesc(temp2(:,:,n));
       colormap(gray);
%This function is used to convert the colored imaged into grayscale image
end
figure;
suptitle('Test Image');
imagesc(Z);
colormap(gray); %This function is used to convert the colored imaged into
grayscale image
for i=1:121 %for1
    for j=1:121 %for2
%Window%
window(:,:)=Z(i:i+39,j:j+39);
M = mean(mean(window)); %Mean of the window
diff=window-M;
SD = sqrt(sum(sum(diff.^2)));
NW = diff/SD;
%Normalized Window will have DC Value of 0 and variance of 1
output=(reshape(NW,1600,1)-avg);
%y
for k=1:12
y(i,j,k)=dot(flip(:,k),output);
end
%error square
temp8=zeros(1,12);
for k=1:12
temp8(:,k)=(y(i,j,k).^2);
end
 temp9=sum(temp8); %temp9 is the sumation of y(i)^2 of 12 values
errorsq=((norm(output).^2)-temp9);
%Lamba i for 12 values
temp3=eigenvalue(1583:1600,1583:1600);
temp4=zeros(1,18);
for i1=1:18
    for j1=1:18
        if i1 == j1
           temp7(:,i1)=temp3(i1,j1); %Lambda i
        end
    end
end
temp5=sum(temp7(:,13:18)); %Summation Lambda i for last 6 values
rho=(1/6)*(temp5);
%distance vector
temp12=(y(i,j,:).^2);
for k=1:12
    temp11(i,j)=sum((temp12)/fliplr(temp7(:,k)));
end
```

```
distvector(i,j)=abs(temp11(i,j)+(errorsq/rho));
    end% for1 ends
end% for2 ends
figure;
suptitle('Distance Vector');
imagesc(distvector);
colormap(gray); %This function is used to convert the colored imaged into
grayscale image
n=20;
for i=1:121-n+1 %for1
    for j=1:121-n+1 %for2
window1(:,:)=distvector(i:i+n-1,j:j+n-1);
M1 = min(min(window1)); %Mean of the window
for i1=i:i+n-1
    for j1=j:j+n-1
        if (distvector(i1,j1)>M1)
            distvector(i1,j1)=255;
        end
    end
end
   end
end
figure;
suptitle('Co-ordinates');
imagesc(distvector);
colormap(gray); %This function is used to convert the colored imaged into
grayscale image
[row, col] = find(distvector<255);
rowcol=[row,col];
rowarranged=[23;21;21;62;61;62;102;101;101];
colarranged=[24;62;103;24;63;103;22;63;101];
rowcolarrange=[rowarranged,colarranged];
for i=1:9
img=Z(rowarranged(i):rowarranged(i)+39,colarranged(i):colarranged(i)+39);
M2=mean(mean(img));
diff1=img(:,:)-M2;
SD2=sqrt(sum(sum(diff1.^2)));
NW2(:,:,i)=diff1/SD2;
subplot(3,3,i);
imagesc(NW2(:,:,i));
colormap(gray);
end
for j2=1:9
oldweight(:,:,j2) = (A(:,j2)-avg)'*(fliplr(eigenvector(:,1595:1600)));
end
oldweight=squeeze(oldweight);
for j2=1:9
    newweight(j2,:)=((reshape(NW2(:,:,j2),1600,1))-
avg)'*(fliplr(eigenvector(:,1595:1600)));
    for k2=1:9
            final(j2,k2)=norm(newweight(j2,:)-(oldweight(:,k2))');
    end

end
disp(newweight);
```

```
disp(final);
figure;

for i1=1:9
    for j1=1:9
        subplot(3,3,i1);
        plot(final(i1,:)); %Distance of Test Image with Training Image
    end
end
```
