# ECE 311 Lab 6

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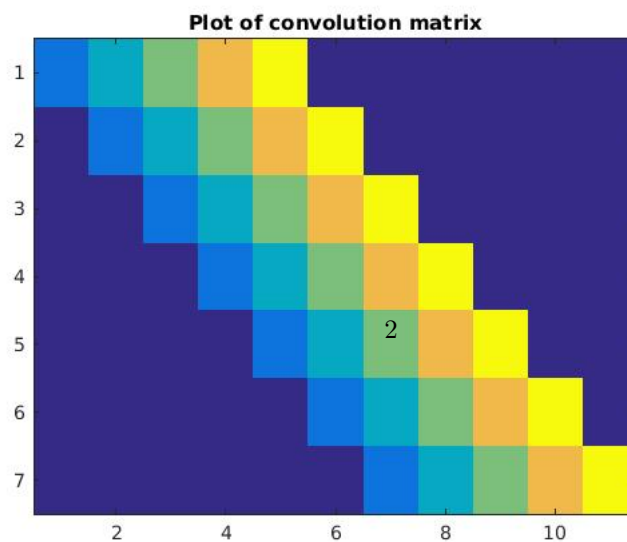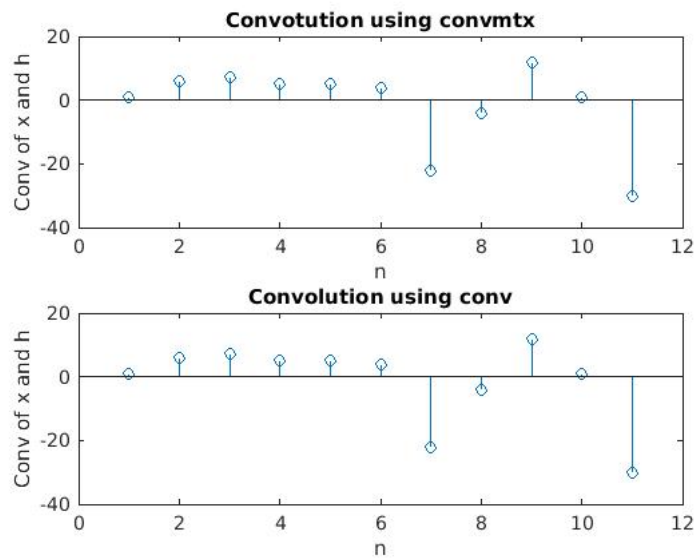
```matlab
x = [ 1 4 -4 -3 2 5 -6];
h = [1 2 3 4 5];
a = convmtx(h,length(x));
figure;
imagesc(a);
title('Plot of convolution matrix');

cx = x*a;
c = conv(x,h);

figure;
subplot(211);
stem(cx);
title('Convotution using convmtx');
ylabel('Conv of x and h');
xlabel('n');
subplot(212);
stem(c);
title('Convolution using conv');
ylabel('Conv of x and h');
xlabel('n');
```

report1.m



Convotution using convmtx

Convolution using conv



Plot of convolution matrix

$$A = U\Sigma V^H$$
$$A^H A = V\Sigma^H U^H U\Sigma V^H$$
$$= V\Sigma^H \Sigma V^H$$
$$A^H AV = V\Sigma^H \Sigma = V\Sigma^2$$

```matlab
clear all;
clc;
A = [1,4,-2; 3,11,5; 7,7,7];
AH = A';
AHA = AH*A;
AAH = A*AH;

[V1,D1] = eig(AAH);
[V2,D2] = eig(AHA);

[U3,S3,V3] = svd(A);

A*AH*U3 - U3*S3^2 % formula given, gives zero matrix

AH*A*V3 - V3*S3^2 % zero matrix returned
```

report2.m

```
ans =

   1.0e-12 *

   -0.0142   -0.0107   -0.0009
    0.0853    0.0018   -0.0027
    0.1137    0.0178    0.0036


ans =

   1.0e-13 *

    0.9948    0.0888    0.0355
    0.8527   -0.2132    0.1171
    0.8527        0    0.0222
```
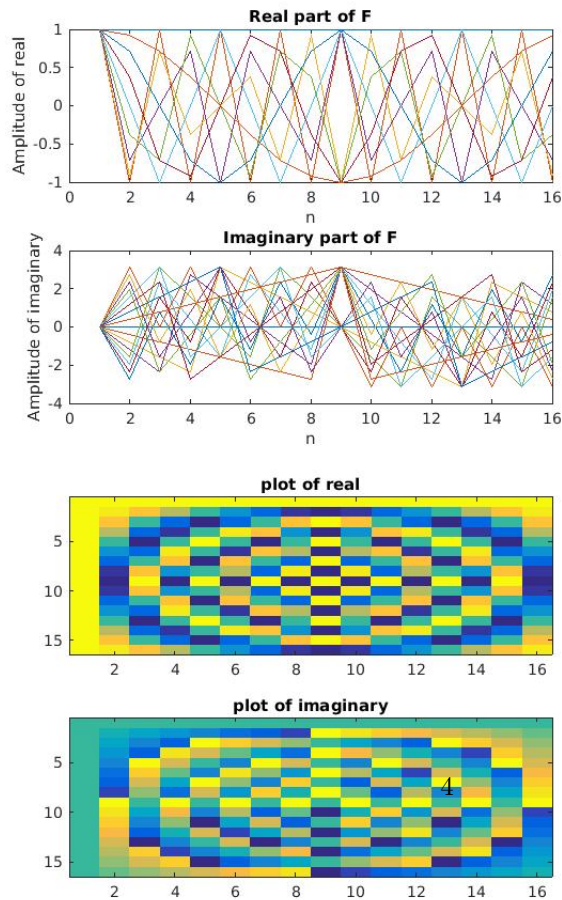
```matlab
clc;
clear all;
x = [1 1 4 -4 -3 2 5 -6 3 2 4 -2 5 9 -8 4]';
F = dftmtx(length(x));
X = F*x;
r = real(F);
a = angle(F);
figure;
subplot(211);
plot(r);
title('Real part of F');
ylabel('Amplitude of real');
xlabel('n');
subplot(212);
plot(a);
title('Imaginary part of F');
xlabel('n');
ylabel('Amplitude of imaginary');

figure;
subplot(211);
imagesc(r);
title('plot of real');
subplot(212);
imagesc(a);
title('plot of imaginary');
```
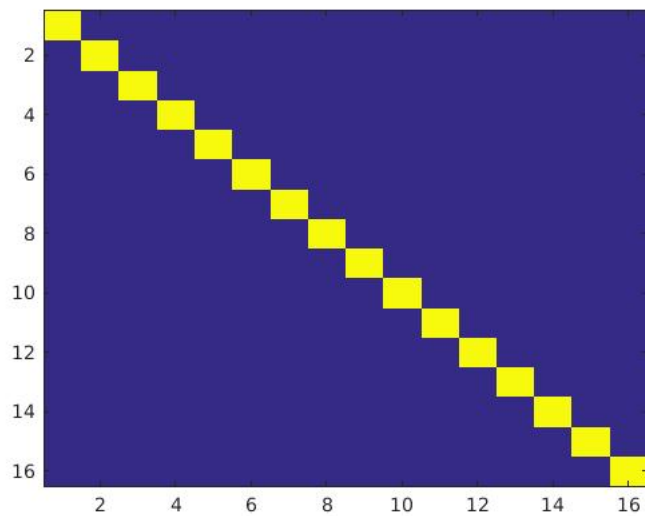
report4.m

```matlab
clc;
clear all;
x = [1 1 4 -4 -3 2 5 -6 3 2 4 -2 5 9 -8 4]';
F = dftmtx(length(x));
Fh = (1/length(x))*F';
A = Fh*F;
figure;
subplot(211);
plot(abs(A));
subplot(212);
plot(angle(A));

figure;
imagesc(abs(A));
```

report5.m

```matlab
clc;
clear all;
X = loadImages('yalefaces');
Y = compMeanVec(X);
Z = reshape(Y,[60,80]);
imagesc(Z);
colormap gray
```
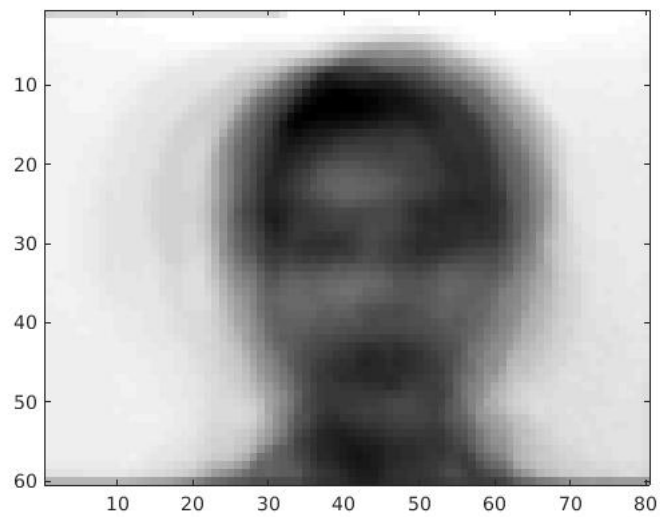
report6.m

```matlab
function [ Y ] = compMeanVec( X )
[height, width] = size(X);
sum = zeros(1,width);
for i=1:height
    sum = sum + X(i,:);
end
sum = sum/height;
Y = sum;
end
```
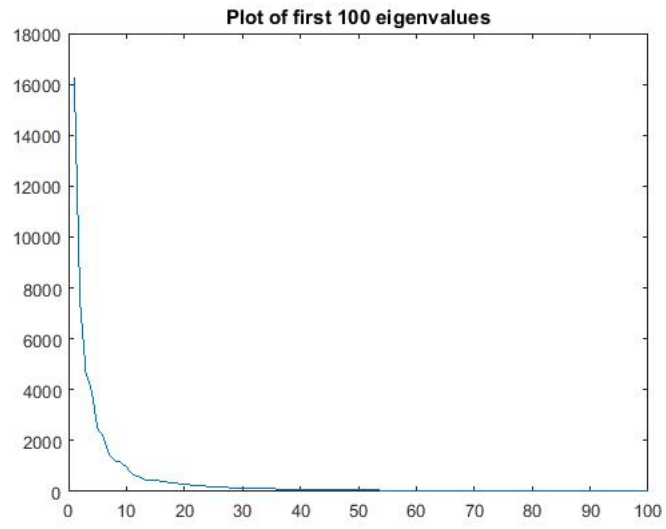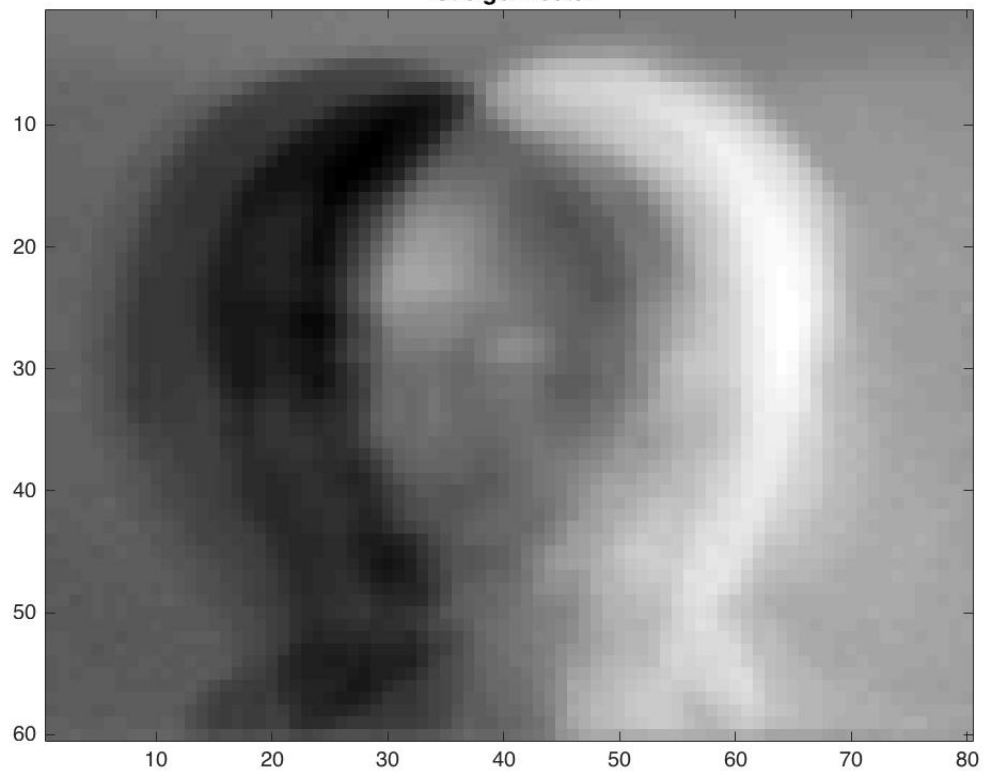
compMeanVec.m

```matlab
clc;
clear all;
X= loadImages('yalefaces');
Y = compMeanVec(X);
X_hat = zeros(165,4800);
for i=1:165
    X_hat(i,:) = X(i,:) - Y;
end
R = (X_hat')*(X_hat);
[U,S,V] = svd(R);
s = svd(R);
figure;
s = s(1:100,1);
plot(s);
title('Plot of first 100 eigenvalues');


figure;
imagesc(reshape(U(:,1),[60,80]));
colormap gray
title('1st eigenvector');

figure;
imagesc(reshape(U(:,2),[60,80]));
colormap gray
title('2nd eigenvector');

figure;
imagesc(reshape(U(:,3),[60,80]));
colormap gray
title('3rd eigenvector');

figure;
imagesc(reshape(U(:,4),[60,80]));
colormap gray
title('4th eigenvector');

figure;
imagesc(reshape(U(:,50),[60,80]));
colormap gray
title('50th eigenvector');

figure;
imagesc(reshape(U(:,100),[60,80]));
colormap gray
title('100th eigenvector');
```

report7.m
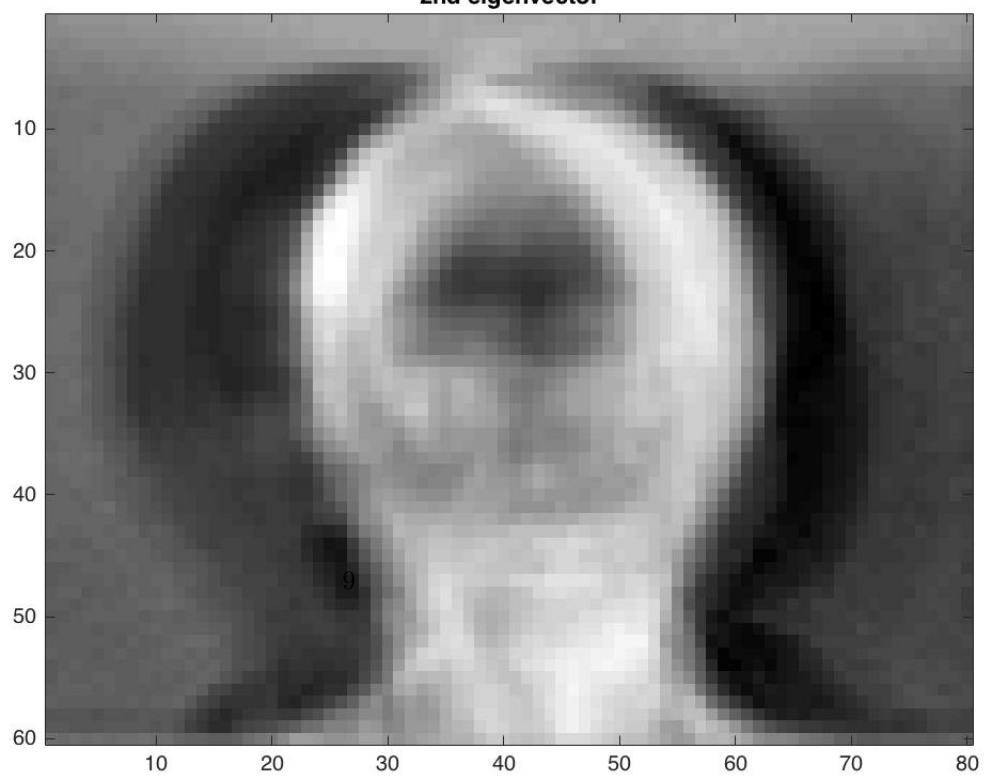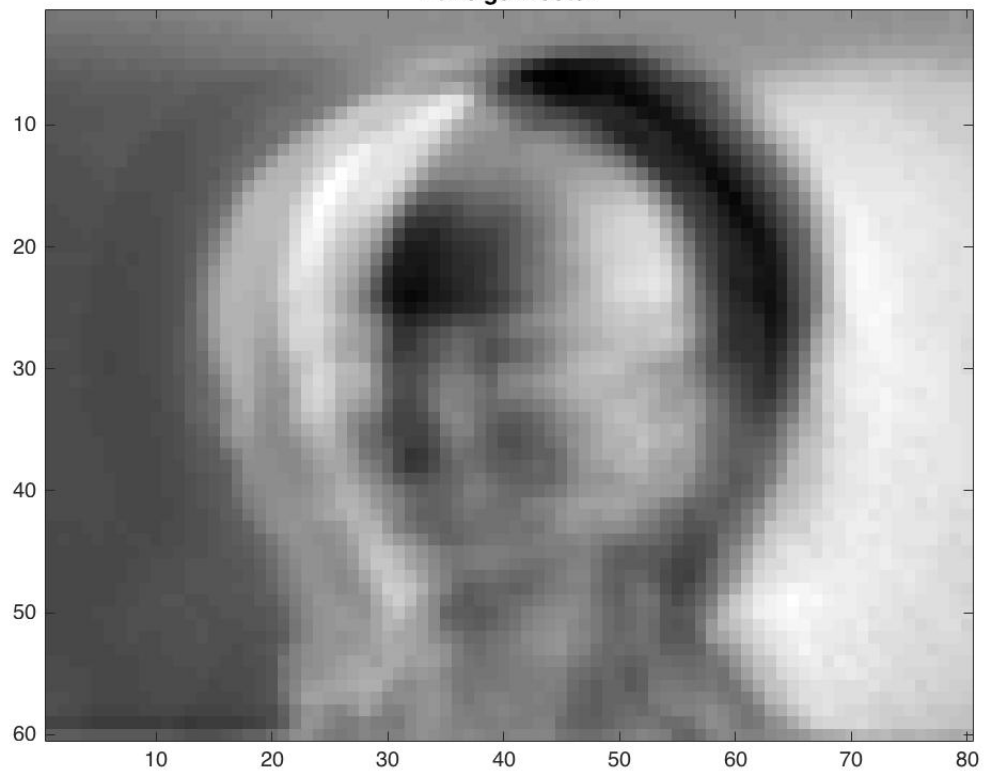
**Plot of first 100 eigenvalues**
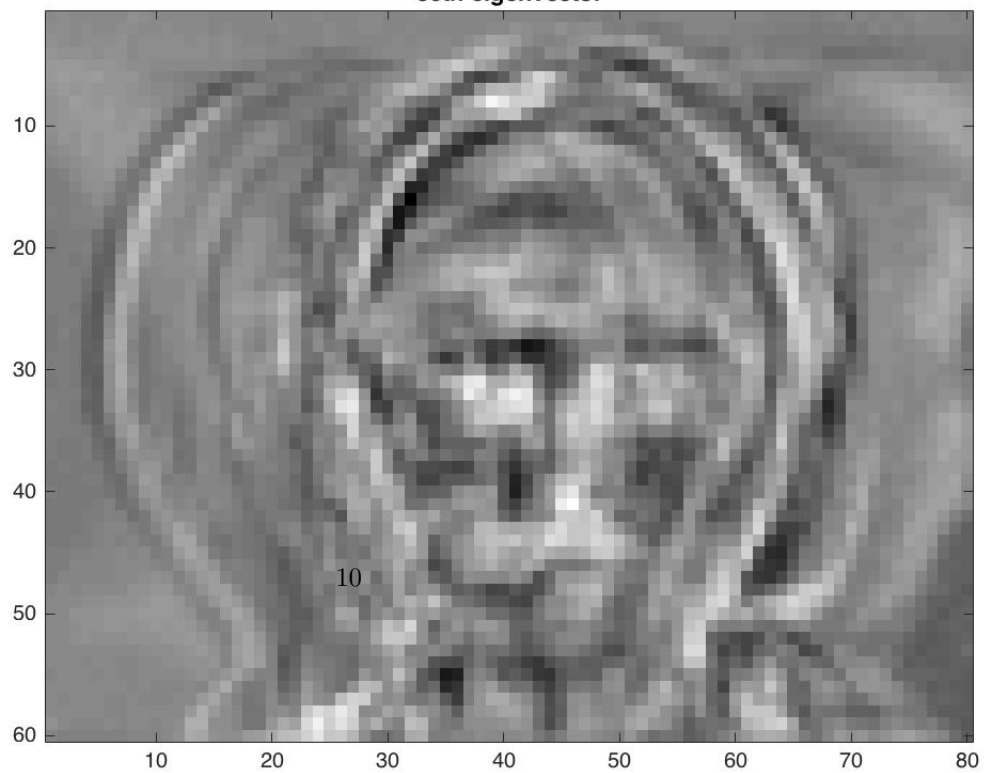
**1st eigenvector**



**2nd eigenvector**

**4th eigenvector**



**50th eigenvector**

```matlab
function [ x_pca ] = PCAtransform( Ux, V, x_orig )
    %[height,width] = size(x_orig);
    x_hat = x_orig - Ux;

    %{ for i=1:height
    %    x_hat(i,:) = x_orig(i,:) - Ux;
    %end
    x_pca =  inv(V) * x_hat';
end
```

PCAtransform.m

```matlab
function [ x_orig ] = invPCAtransform( Ux, V, x_pca )


x_orig = x_pca * V';
x_orig = x_orig + Ux;


end
```

invPCAtransform.m

```matlab
1
  clc ;
3 clear all ;
  X = loadImages('yalefaces');
5 Y = compMeanVec(X);
  Ux = Y;
7 X_hat = zeros(165,4800);
  for i=1:165
9     X_hat(i,:) = X(i,:) − Y;
  end
11 R = (X_hat')*(X_hat);
  [U,S,V] = svd(R);
13
  %%%%%%% get U and Ux
15 A = imread('noisy_face.png');
  A = im2double(A); % convert integer precision to double precision
      for mean
17 A = reshape(A,[1,4800]);

19 % start of PCA transform
  A_pca = PCAtransform(Ux,U,A);
21 % end of PCA transform

23 A_pca(1,100:4800) = 0; % limit noise

25 %%%%%%%%%%obtained pca version%%%%%%%%%%
  %start of inv PCA transform
27 A_orig = invPCAtransform(Ux,U,A_pca);
  %end of inv PCA transform
29 figure;
  imagesc(reshape(A_orig,[60,80]));
31 colormap gray
```

report8.m