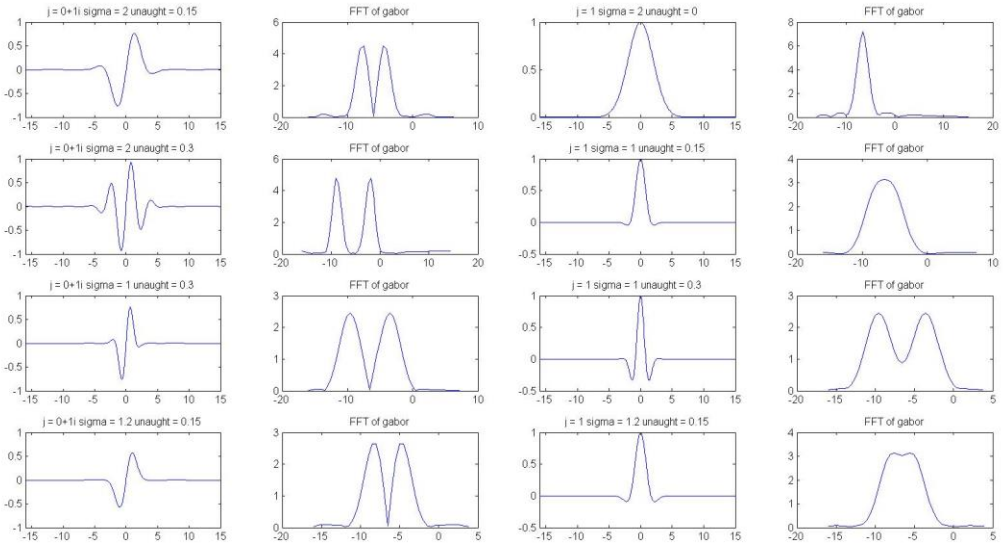
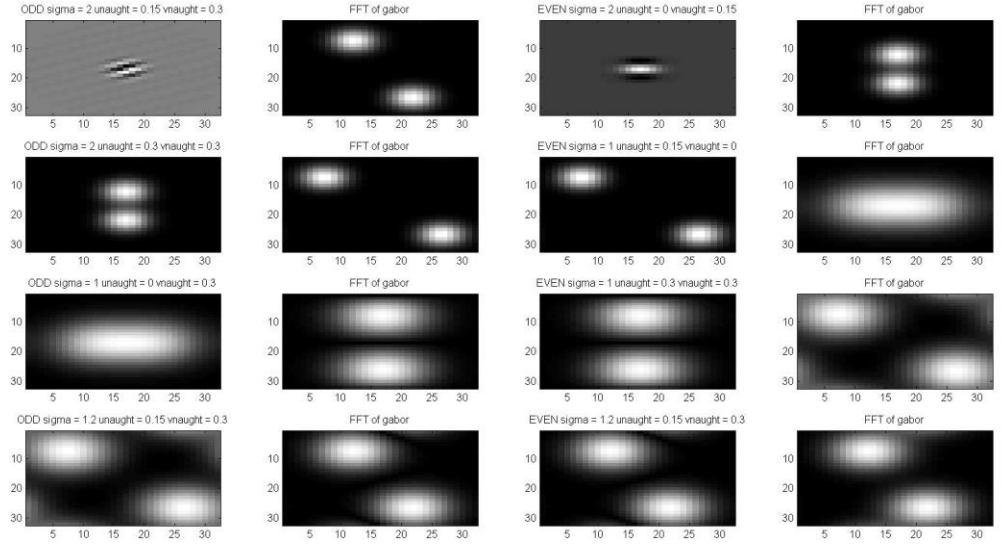
Programming Questions

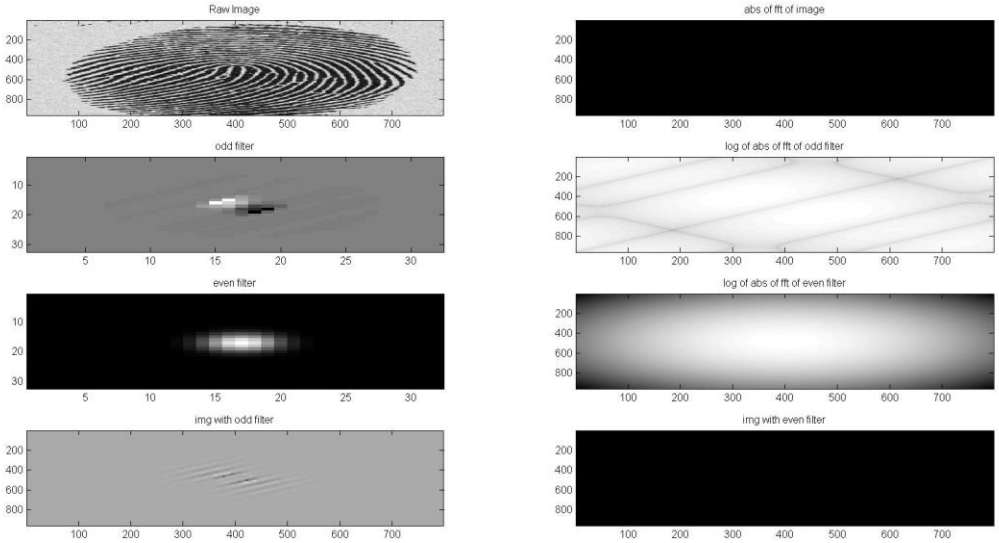
1a.



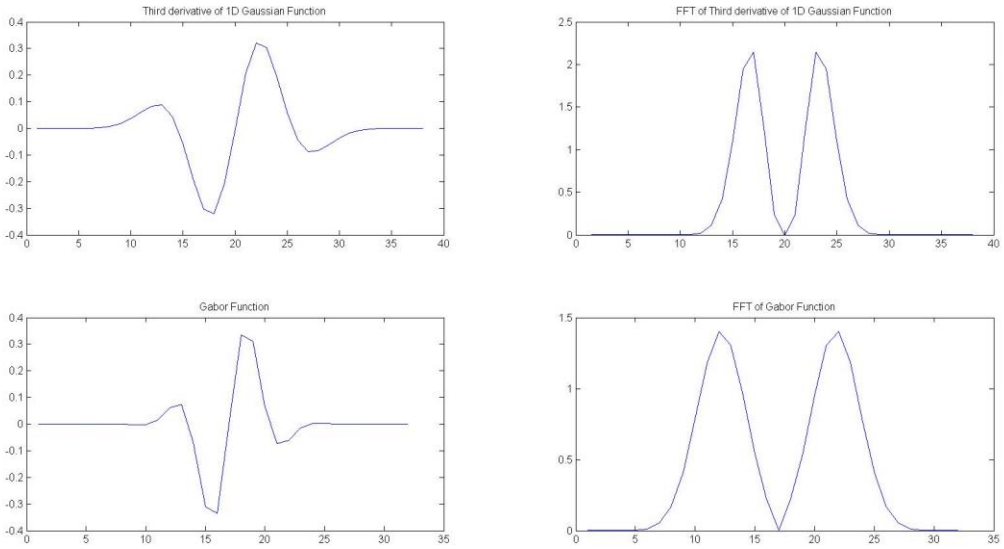
1b.



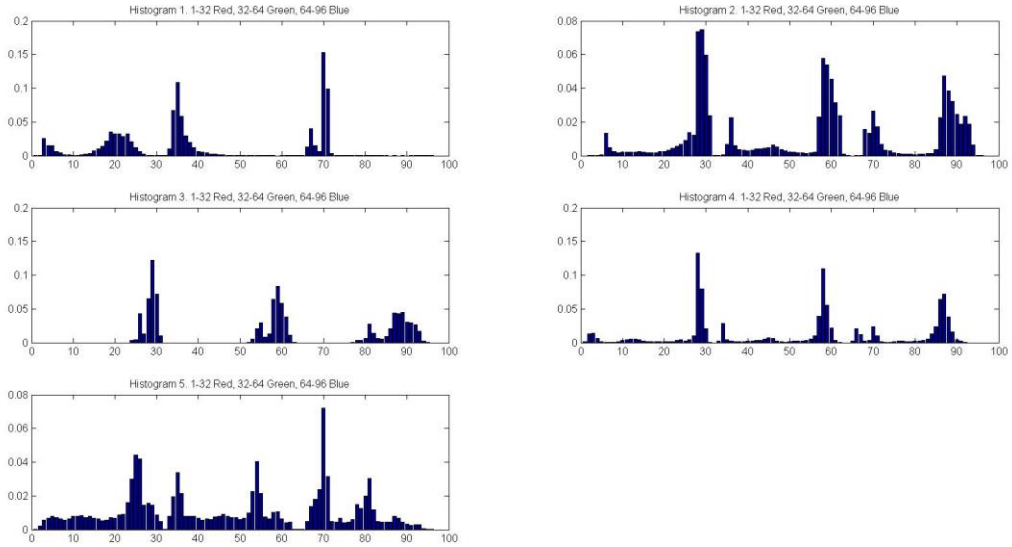
1c.


Raw Image
abs of fft of image
odd filter
log of abs of fft of odd filter
even filter
log of abs of fft of even filter
img with odd filter
img with even filter

2ab.


Third derivative of 1D Gaussian Function
FFT of Third derivative of 1D Gaussian Function
Gabor Function
FFT of Gabor Function

3b.



The peaks represent that there are a significant amount of pixels that fall within the range of a specific bin in a certain r, g, or b color space.

3c.

histd =

NaN	0.6873	0.9664	0.6999	0.3760
0.6873	NaN	NaN	0.2275	0.4009
0.9664	NaN	NaN	NaN	0.5769
0.6999	0.2275	NaN	NaN	0.4520
0.3760	0.4009	0.5769	0.4520	0

For entry 2,1: 0.6873, we compute the x^2 distance between histogram 2 and 1. It's somewhat high compared to the other values because they both share peaks for bins near x = 70 and 35.

For entry 3,1: 0.9664, we compute the x^2 distance between histogram 3 and 1. It's really high compared to the other values because they don't share any peak locations.

For entry 5,1: 0.3760, we compute the x^2 distance between histogram 3 and 1. It's really low compared to the other values because they both have peaks at the same locations.

```
function hw4q1a
j = 1i;
sigma = 2;
unaught = 0.15;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
figure;
subplot(4,4,1);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,2);
plot(x, ffty);
title('FFT of gabor');

j = 1;
sigma = 2;
unaught = 0.0;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,3);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,4);
plot(x, ffty);
title('FFT of gabor');

j = 1i;
sigma = 2;
unaught = 0.3;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,5);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,6);
plot(x, ffty);
title('FFT of gabor');

j = 1;
```

```
sigma = 1;
unaught = 0.15;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,7);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,8);
plot(x, ffty);
title('FFT of gabor');

j = 1i;
sigma = 1;
unaught = 0.3;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,9);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,10);
plot(x, ffty);
title('FFT of gabor');

j = 1;
sigma = 1;
unaught = 0.3;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,11);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,12);
plot(x, ffty);
title('FFT of gabor');

j = 1i;
sigma = 1.2;
unaught = 0.15;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
```

```
subplot(4,4,13);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = (fftshift(abs(fft(y))));
subplot(4,4,14);
plot(x, ffty);
title('FFT of gabor');

j = 1;
sigma = 1.2;
unaught = 0.15;
gabor1d = @(x)(gabor1dfun(x,sigma,unaught, j));
subplot(4,4,15);
fplot(gabor1d, [-16 15]);
title(['j = ', num2str(j), ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught)]);

[x y] = fplot(gabor1d, [-16 15]);
x = x(1:8:end);
y = y(1:8:end);
ffty = fftshift(abs(fft(y)));
subplot(4,4,16);
plot(x, ffty);
title('FFT of gabor');
end

function Y=gabor1dfun(x,sigma,unaught, j)
   if(j == 1)
      Y = exp(-(x^2)/(2*sigma^2)) * cos(2*pi*unaught*x);
   else
      Y = exp(-(x^2)/(2*sigma^2)) * sin(2*pi*unaught*x);
   end
end
```

```
function hw4p1b
evenorodd = 1i;
sigma = 2;
unaught = 0.15;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

figure;
```

```
subplot(4,4,1);
imagesc(gab);
colormap('gray');
title(['ODD', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,2);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1;
sigma = 2;
unaught = 0.0;
vnaught = 0.15;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

subplot(4,4,3);
imagesc(gab);
colormap('gray');
title(['EVEN', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,4);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1i;
sigma = 2;
unaught = 0.3;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

subplot(4,4,5);
```

```
imagesc(ffty);
colormap('gray');
title(['ODD', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,6);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1;
sigma = 1;
unaught = 0.15;
vnaught = 0.0;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

subplot(4,4,7);
imagesc(ffty);
colormap('gray');
title(['EVEN', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = real(fftshift(abs(fft2(gab))));
subplot(4,4,8);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1i;
sigma = 1;
unaught = 0.0;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

subplot(4,4,9);
imagesc(ffty);
```

```
colormap('gray');
title(['ODD', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = real(fftshift(abs(fft2(gab))));
subplot(4,4,10);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1;
sigma = 1;
unaught = 0.3;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
    for j=1:size(gab,2)
        gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
    end
end

subplot(4,4,11);
imagesc(ffty);
colormap('gray');
title(['EVEN', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,12);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1i;
sigma = 1.2;
unaught = 0.15;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
    for j=1:size(gab,2)
        gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
    end
end

subplot(4,4,13);
imagesc(ffty);
colormap('gray');
```

```
title(['ODD', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,14);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
evenorodd = 1;
sigma = 1.2;
unaught = 0.15;
vnaught = 0.3;
[x,y] = meshgrid(-16:1:15);
gab = zeros(size(x));

for i=1:size(gab,1)
   for j=1:size(gab,2)
      gab(i,j) = gabor2dfun(x(i,j), y(i,j), sigma, unaught, vnaught, evenorodd);
   end
end

subplot(4,4,15);
imagesc(ffty);
colormap('gray');
title(['EVEN', ' sigma = ', num2str(sigma), ' unaught = ', num2str(unaught), ' vnaught = ',
num2str(vnaught)]);

ffty = (fftshift(abs(fft2(gab))));
subplot(4,4,16);
imagesc(ffty);
colormap('gray');
title('FFT of gabor');
end

function Y=gabor2dfun(x, y ,sigma,unaught, vnaught, j)
   if(j == 1)
      Y = exp(-(sqrt(((x^2) + (y^2))^2))/(2*sigma^2)) * cos(2*pi*(unaught*x + vnaught*y));
   else
      Y = exp(-(sqrt(((x^2) + (y^2))^2))/(2*sigma^2)) * sin(2*pi*(unaught*x + vnaught*y));
   end
end
```

```
function hw4p2a
sigma = 3;

cfd = [1 0 -1];
dgauss = zeros(1,32);
for x=-16:1:15
   dgauss(x+17) = exp(-(x^2)/(2*sigma^2));
end
```

```
res = conv2(cfd, dgauss);
res = conv2(cfd, res);
res = conv2(cfd, res);

figure;
subplot(2,2,1);
plot(res);
title('Third derivative of 1D Gaussian Function');
subplot(2,2,2);
plot(abs(fftshift(fft2(res))));
title('FFT of Third derivative of 1D Gaussian Function');
dgab = zeros(1,32);
sigma = 2.5;
unaught = .15;
for x=-16:1:15
   dgab(x+17) = exp(-(x^2)/(2*sigma^2)) * sin(2*pi*unaught*x) * .45;
end
subplot(2,2,3);
plot(dgab);
title('Gabor Function');
subplot(2,2,4);
plot(abs(fftshift(fft2(dgab))));
title('FFT of Gabor Function');
end
```

```
function res = getHist(imgname)
%get rect from image
img = imread(imgname);
imshow(img);
rect = getrect;
xmin = floor(rect(1));
width = floor(rect(3));
ymin = floor(rect(2));
height = floor(rect(4));
%compute histogram
[rcount, rhist] = imhist(img(ymin:ymin+height,xmin:xmin+width,1), 32);
[gcount, ghist] = imhist(img(ymin:ymin+height,xmin:xmin+width,2), 32);
[bcount, bhist] = imhist(img(ymin:ymin+height,xmin:xmin+width,3), 32);
hist = [rcount; gcount; bcount];
totsum = 0;

for i=1:size(hist,1)
   for j=1:size(hist,2)
      totsum = totsum + hist(i,j);
   end
end

hist = hist ./ totsum;
res = hist;
end

function res = histdist(hist1, hist2)
```

```
csum = 0;
for k=1:size(hist1,1)
   temp = (hist1(k,1) - hist2(k,1))^2;
   temp = temp / (hist1(k,1) + hist2(k,1));
   csum = csum + temp;
end
res = csum/2;
end

function hw4p3b
hist1 = getHist('Fig0630(01)(strawberries_fullcolor).tif');
hist2 = getHist('Fig0630(01)(strawberries_fullcolor).tif');
hist3 = getHist('Fig0630(01)(strawberries_fullcolor).tif');
hist4 = getHist('Fig0630(01)(strawberries_fullcolor).tif');
hist5 = getHist('Fig0630(01)(strawberries_fullcolor).tif');

subplot(3,2,1);
bar(hist1);
title('Histogram 1. 1-32 Red, 32-64 Green, 64-96 Blue');
subplot(3,2,2);
bar(hist2);
title('Histogram 2. 1-32 Red, 32-64 Green, 64-96 Blue');
subplot(3,2,3);
bar(hist3);
title('Histogram 3. 1-32 Red, 32-64 Green, 64-96 Blue');
subplot(3,2,4);
bar(hist4);
title('Histogram 4. 1-32 Red, 32-64 Green, 64-96 Blue');
subplot(3,2,5);
bar(hist5);
title('Histogram 5. 1-32 Red, 32-64 Green, 64-96 Blue');

hists = [hist1 hist2 hist3 hist4 hist5];
histd = zeros(5,5);

for i=1:size(histd,1)
   for j=1:size(histd,2)
      histd(i,j) = histdist(hists(:,i),hists(:,j));
   end
end
histd
end
```