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EEU44C08

4C8 DIGITAL IMAGE AND VIDEO PROCESSING

LAB 2 – 2D Signal Processing

Submitted By

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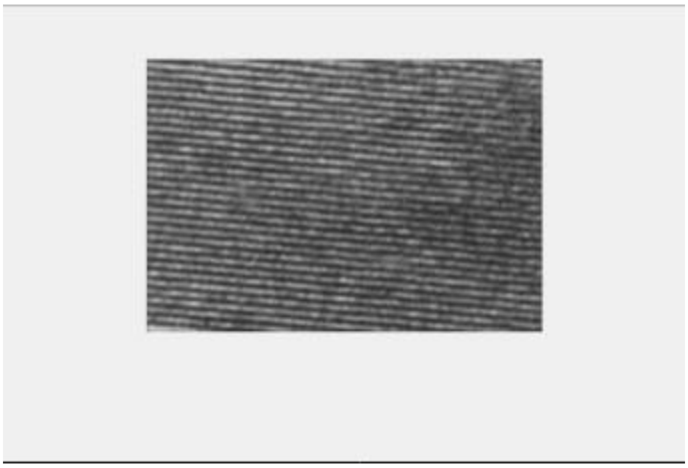
Q1 Low Pass Filter / Separable Filter

Q 1.1 Write the 2D convolution mask for this transfer function.

ANS - h0 = [1 3 1;3 9 3;1 3 1]/25;

Q 1.2 Use conv2 to apply this 2D lter to I and obtain I0. Show the results.

ANS -



(a)

Q 1.3 Show that H0 is separable and write down the two 1D convolutions masks.

ANS – h0 can be separable and its separated in
a = [1; 3; 1]/5;
b = [1 3 1]/5;

Q 1.4 Show how you can apply conv2 twice using these lters to obtain an image identical to I

ANS -

(b)

By observation From above we can see that a and b are identical

Q 1.5 Show that the output is numerically identical to I0 by computing the Mean Absolute Error between the two images.

ANS – The mean absolute error is calculated using mae function and is calculated as
Mean_Absolute_Error = mae(I0, I1);
The result is 2.906866089689699e-17
So we can conclude that since the Mean absolute error is very small and approaches zero I1 and I0 are numerically identical

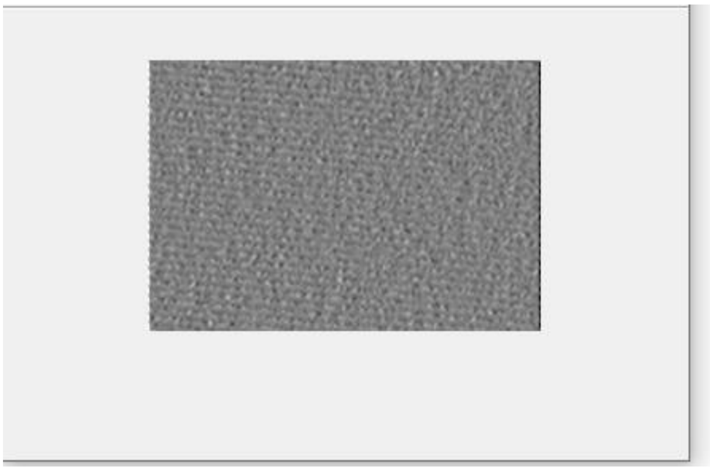
```
I = double(imread("atoms1.png"))/255;
figure('Name','atoms1.png');
imshow(I);

%q1.1

h0 = [1 3 1;3 9 3;1 3 1]/25;

% q1.2

I0 = conv2(I,h0, 'same');
figure('Name','1');
imshow(I0);

% q1.3

a = [1; 3; 1]/5;
b = [1 3 1]/5;
h0_1D = a * b;

% q1.4

I1 =  conv2(conv2(I,a,'same'),b,'same');
figure('Name','2');
imshow(I1);

% q1.5

Mean_Absolute_Error = mae(I0, I1);
% mae is a network performance function which measures mean absolute error.
```

(C) – CODE FOR Q1

Q 2 Computing the Image Gradient

Q 2.1 The horizontal derivative Ix will be given by Hx(z1, z2) = z2 − z −1 2 . Write the convolution mask for this transfer function and apply the lter for this 2D mask to I0 and save the results in Ix. Show (Ix + 0.5).

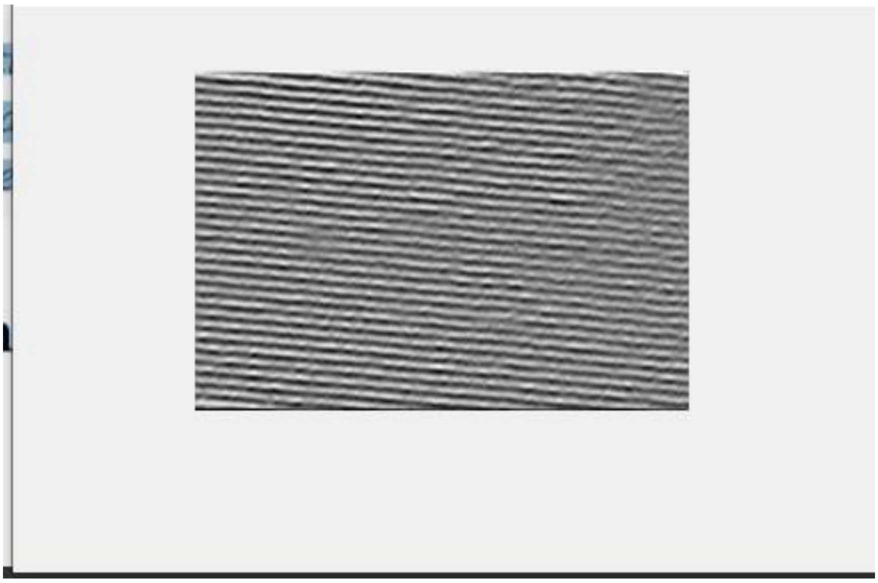
Ans-



(d) ix + 0.5

Q 2.2 The vertical derivative Iy will be given by Hy(z1, z2) = z1 − z −1 1 . Write the convolution mask for this transfer function and apply the lter for this 2D mask to I0 and save the results in Iy. Show (Iy + 0.5).

Ans-



(e) iy + 0.5

```
% q2.1
hx = [1 0 -1];
ix = conv2(I0, hx, 'same');
figure('Name','3');
imshow(ix+0.5);

% q2.2
hy = [1;0;-1];
iy = conv2(I0, hy, 'same');
figure('Name','4');
imshow(iy+0.5);

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```
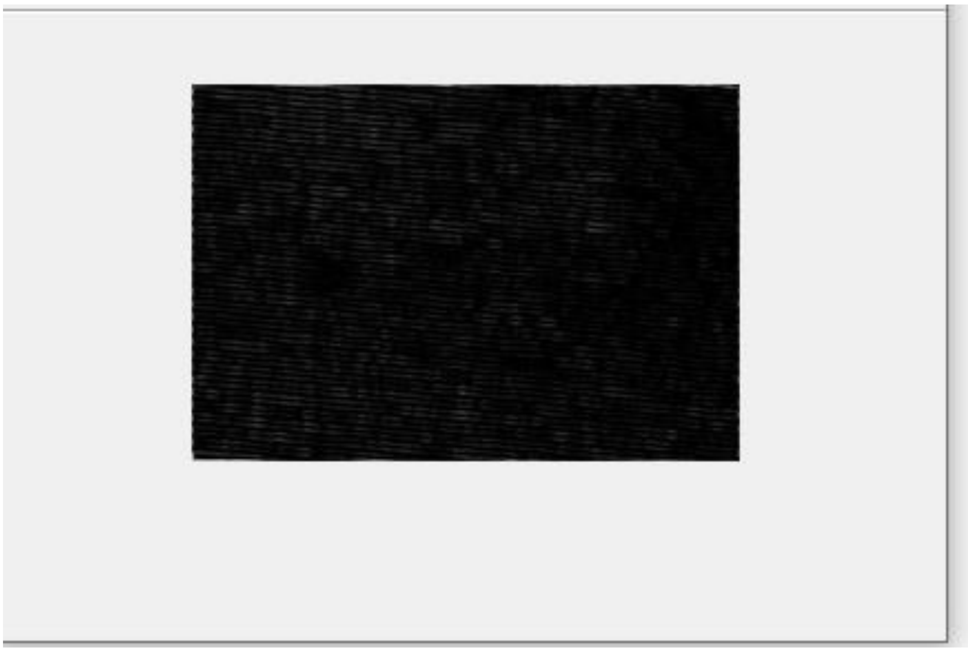

(f) CODE FOR Q2

Q 3 Gradient Magnitude and Angle Map

Q3.1 Combine both Ix and Iy to form the image gradient magnitude I 2 x + I 2 y . Save the output to grad_mag and show it.

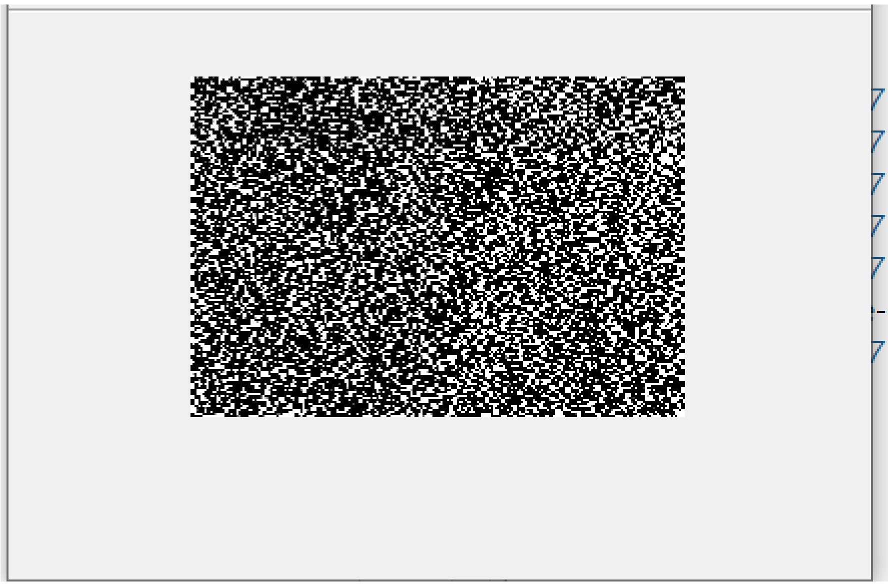
Ans –



(g) grad_mag

Q 3.2 Combine both Ix and Iy to form a map of the image edges angle in degrees $\theta = atan(Ix/Iy) \times 180/\pi$. Save the output to theta and show it.

Ans –



(h) theta

```
% q3.1

grad_mag = (Ix).^2 + (Iy).^2;
figure('Name','5');
imshow(grad_mag);

% q3.2

theta = atan(Ix ./ Iy) * 180 / pi;
figure('Name','6');
imshow(theta);

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```
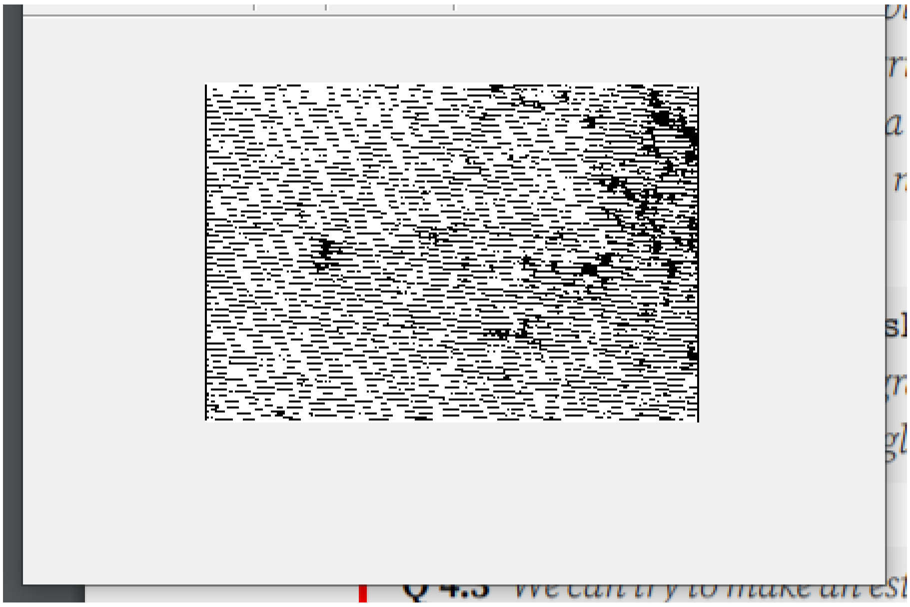

(i) CODE FOR Q3

Q 4 Orientation Measurement

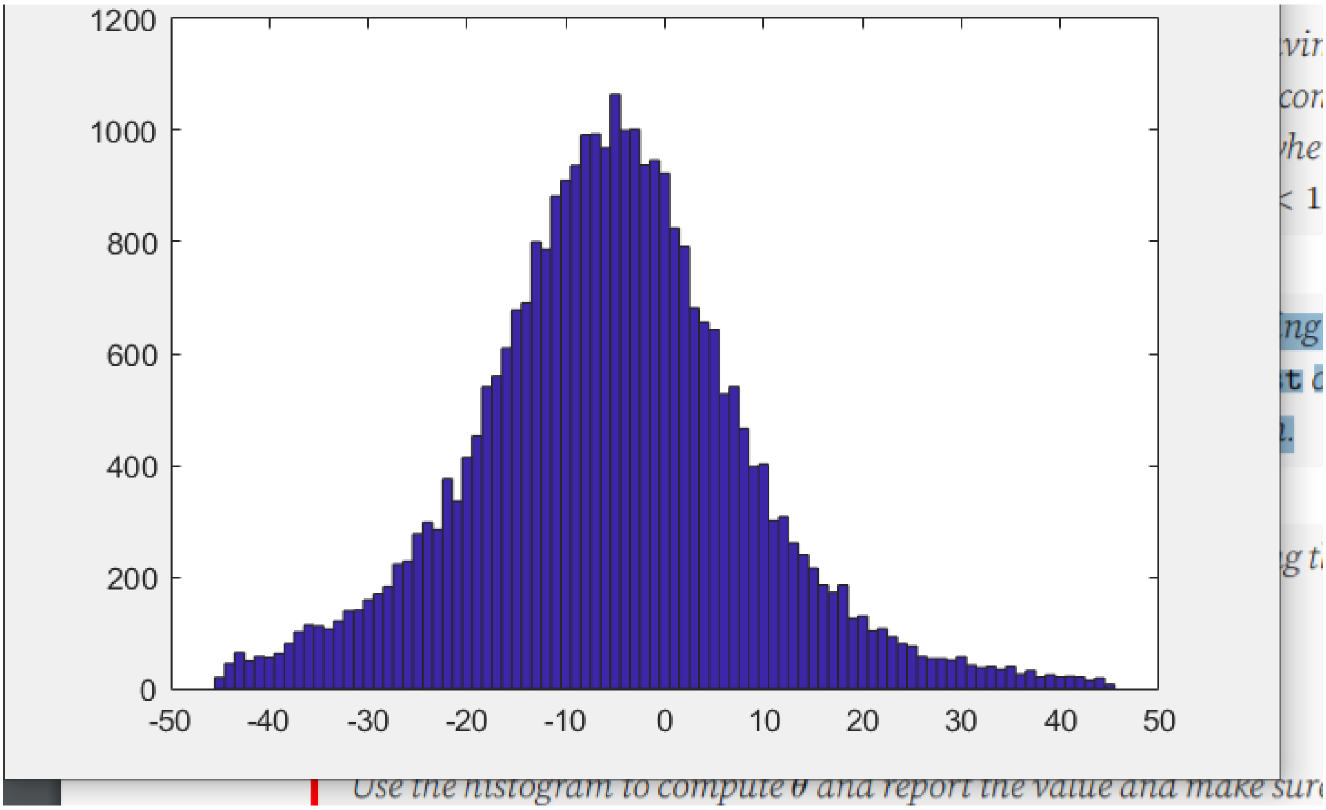
Q 4.1 Build a boolean mask (mask) which is 1 where $I_x^2 + I_y^2 > 0.01$ & $\theta < 45^\circ$ & $\theta > -45^\circ$ and 0 elsewhere. Show the mask

ANS-



(j) Boolean mask

Q 4.2 At this point theta(mask) will give you a vector containing all the valid angle measures. Compute the histogram of these angles using the hist command and use as bin centres the vector of angles $-45^\circ:1:45^\circ$. Plot the histogram.



(k) histogram theta(mask) – Atoms1.png

Q4.3 Use the histogram to compute ˆθ and report the value and make sure it is near enough to the actual orientation of θ = −5 ◦ .

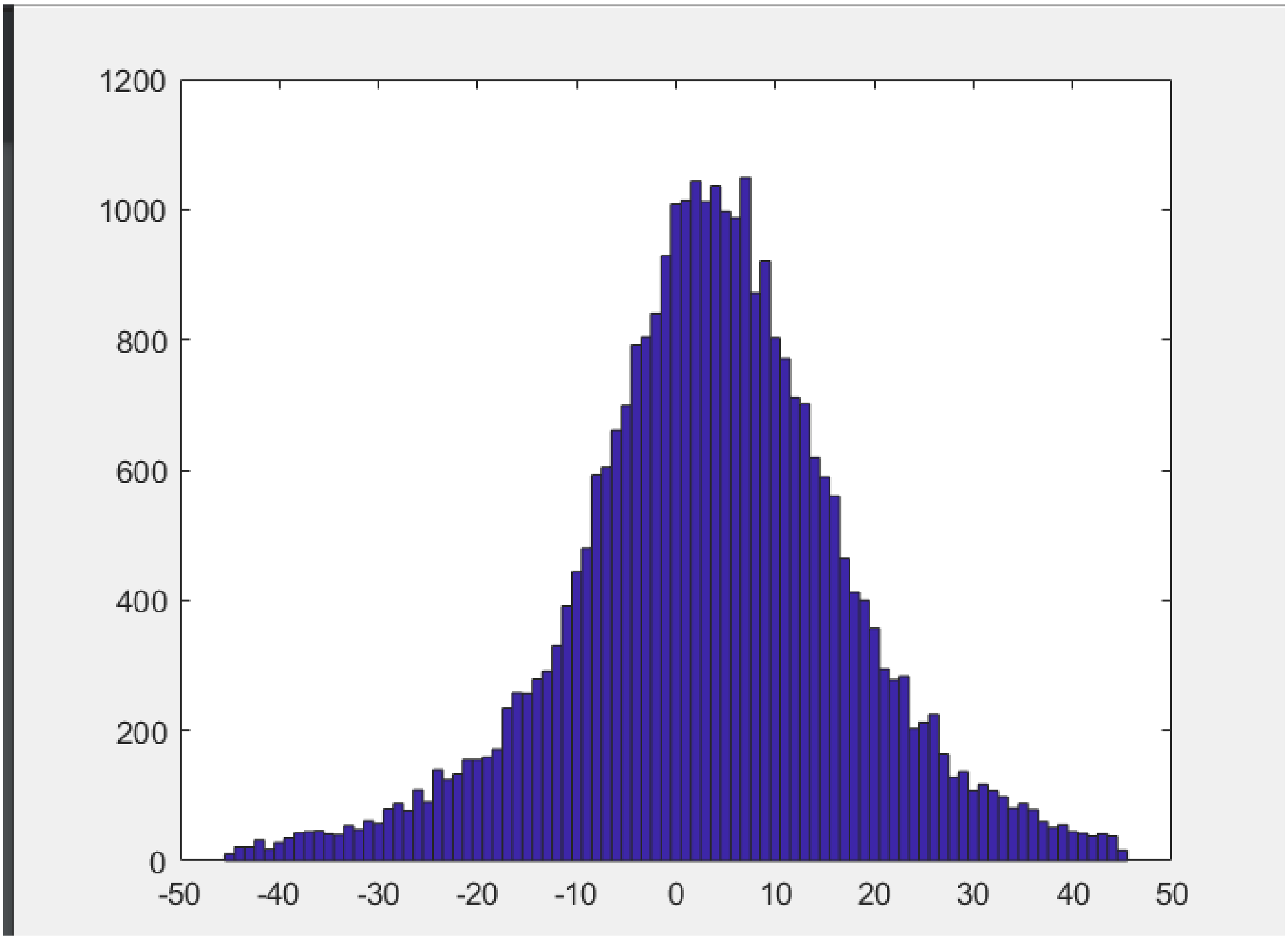
Ans – The value is computed from -

```
%q4.3

[x, y] = hist(theta(mask), -45:1:45);
angle = sum(x .* y) / sum(x);
```

And the expected angle for atom1.png comes out to be -5.4730

Q4.4 Repeat the process for the other two images atoms2.png and atoms3.png. Report their angle histograms and estimated orientations

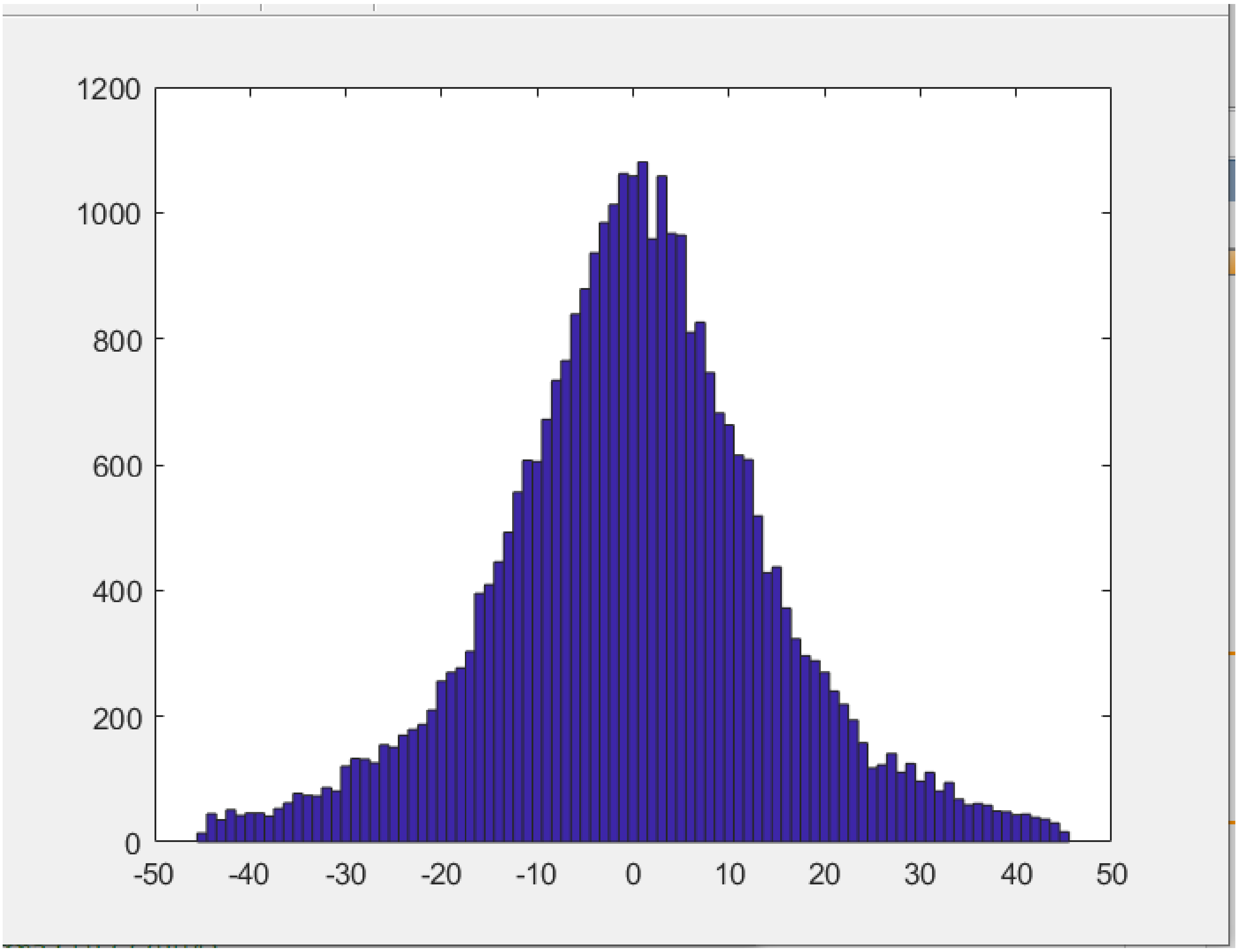
Ans- **ATOM2.PNG**



(l) Histogram Atom2.png

ANGLE – 3.3926

ATOM3.PNG



(m) Angle Histogram Atoms3.png

ANGLE – 0.0819

```
%q4.1

mask = ((grad_mag > 0.01) & (theta < 45) & (theta > -45));
figure('Name','7');
imshow(mask);

%q4.2

figure('Name','8');
hist(theta(mask), -45:1:45);

%q4.3

[x, y] = hist(theta(mask), -45:1:45);
angle = sum(x .* y) / sum(x);

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```

(n) Code Q4