Fundamentals of Computer Vision

Project Assignment 1

Image Filtering and Hough Transform

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Q1)

1.1)

In the image space let us consider a point on the line as x and y, this in Hough transform is defined by

$$\varrho = x * \cos(\theta) + y * \sin(\theta)$$

Divide the equation by it distance from the origin on both the direction which is,

$$sqrt(x^2 + y^2)$$

And also using the trigonometric property on the equation, I.e

$$sin(\alpha) = (x)/sqrt(x^2 + y^2)$$

$$cos(\alpha) = (y)/sqrt(x^2 + y^2)$$

Therefore,

$$\rho = sqrt(x^2 + y^2)(sin(\alpha) * cos(\theta) + cos(\alpha) * sin(\theta)$$

Using sinusoidal trigonometry identity this can be simplified to,

$$\rho = sqrt(x^2 + y^2)(sin(\alpha + \theta))$$

So, sqrt(x^2 + y^2) is the amplitude of the sine wave and α is the phase shift.

1.2)

Parameterizing a line in image space as slope and intercept in hough transform will result in a large accumulator array as the slope can also be negative and positive with values ranging between negative infinity to positive infinity.

Secondly,

A vertical line in image space when parameterized in hough transform will have infinite slope which practically makes it impossible.

$$\rho = xcos(\theta) + ysin(\theta)$$

Slope intercept form,

$$y = mx + c$$

Therefore comparing equations,

$$m = -cos(\theta)/sin(\theta)$$

$$c = \rho/sin(\theta)$$

1.3)

The maximum absolute value for ϱ is $sqrt(W2 + H2)$ and the range for theta is [0;360].

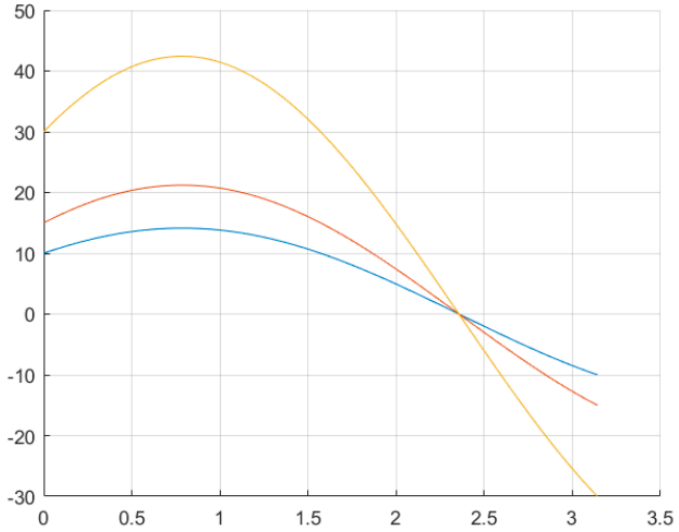
1.4)

All these point will have 3 different sign wave in hough transfer but will intersect at same point

Code:

```
a=[10 20 30];
b=[10 20 30];
for i=1:length(a)
 x = linspace(0,2*pi,100);
 y=(a(i)*cos(x))+(b(i)*sin(x));
 plot(x,y);
 hold on;
 grid on;
 grid minor;
 xlabel('Theta')
 ylabel('Rho')
 title('Hough Transform space (Theta vs Rho)')
end
```

Matlab image:



ϱ=0 , θ=2.356 , m=0.9998 , c=0

Q3)

Input image:

Object detection:

Threshold:

Hough space:

Detected Edge line from Hough voting:

The given set of parameters did the work perfectly for entire set of data set, it was able to detect edges of images that was vertical or horizontal and diagonal most of the times, but it was not possible to detect edges of circular objects in an image.

Sigma: on increasing the value of sigma the noise in the image is removed so edge detection can be improved but highly increasing the value could lure the edges and could result in failure of edge detection. So sigma value till 5 resulted in improving detection.

Threshold: higher the threshold the edges with thick line gets detected but if the threshold is less noise gets detected, so the optimal value is 0.1

rhoRes and thetaRes:

If the resolution is increased the edge detection becomes better but the compution complexity increases as well, this increase the time of obtaining result and energy some time. The optimal value is 3 and pi/90 respectively.

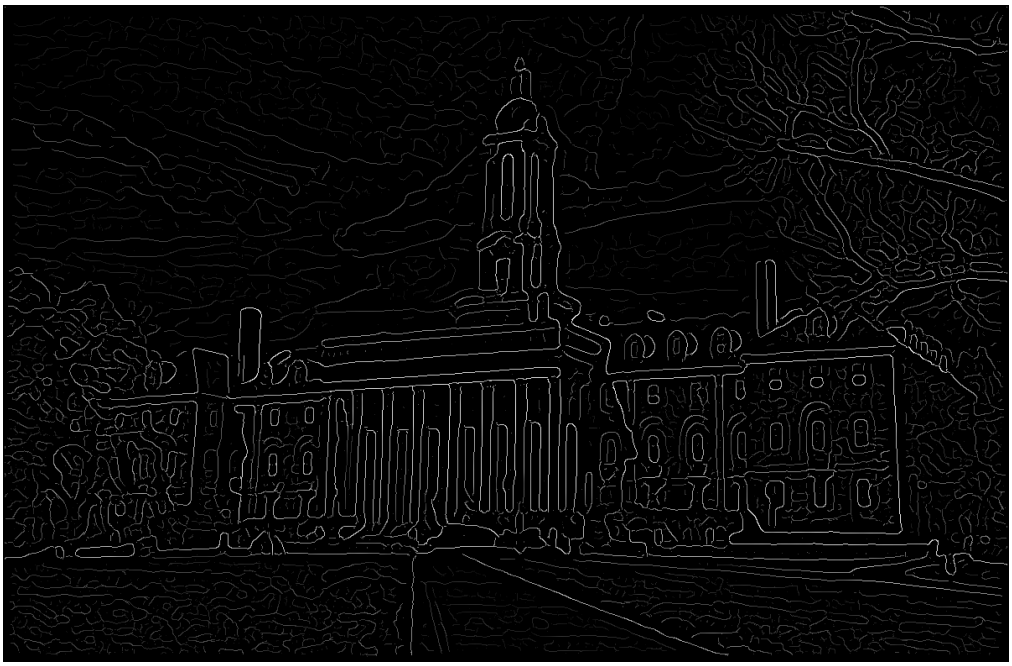
nLines:

The value of nLines depends on the resolution of theta and rho. If the value of rho and theta are high then nLine needs to be high to display all the lines in output. So optimal value is 50.

Q4)

Original Image:

Edge detection:



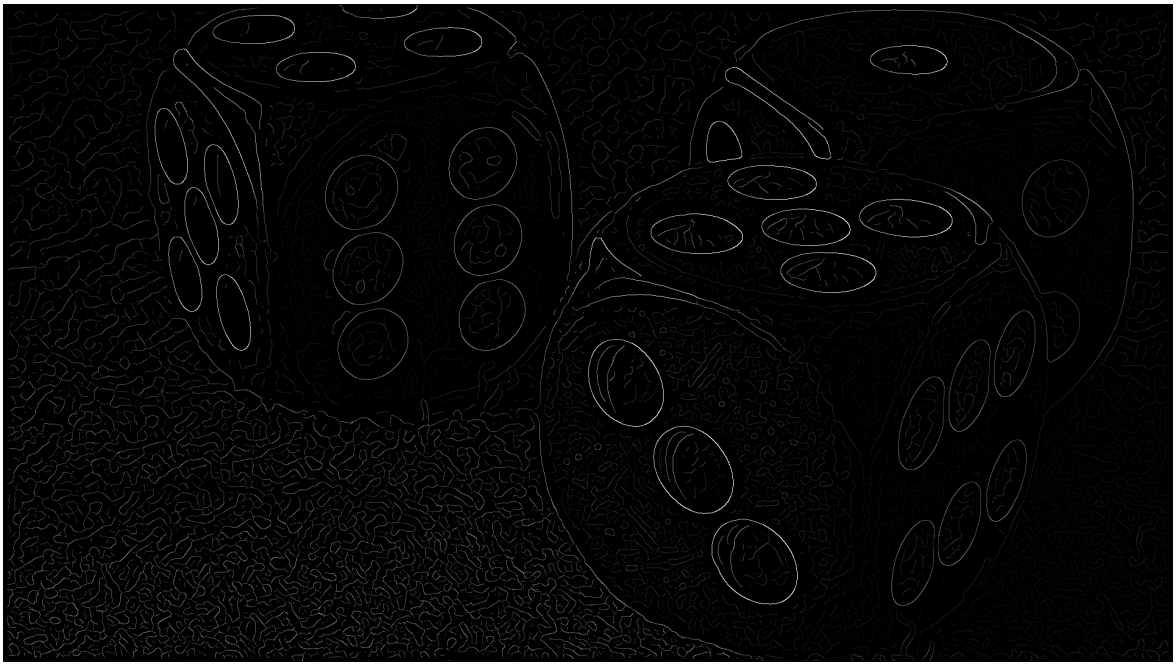
Threshold image:

Hough space:

Edge detection by hough transform:

Original image:

Edge detection :



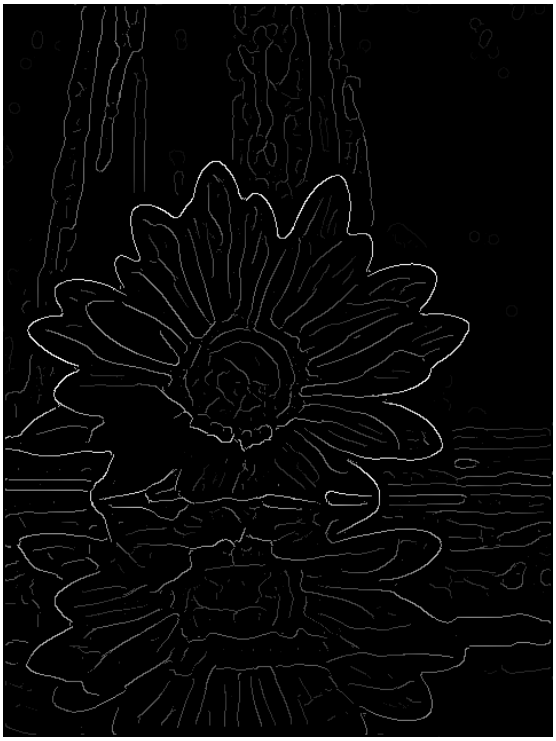
Threshold :

Hough space:

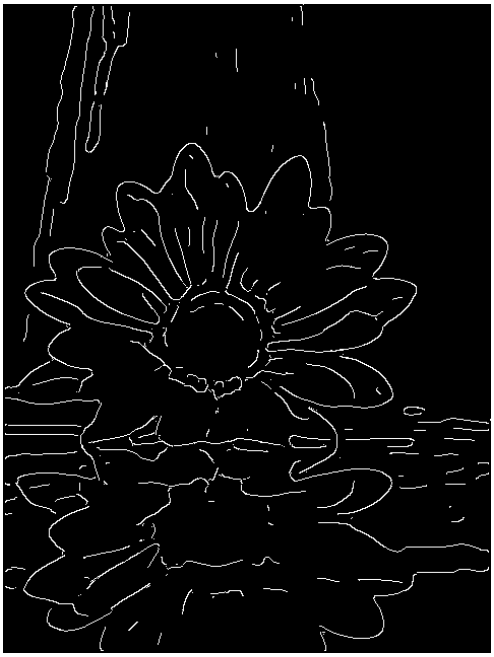
Edge detection by hough transform:

Original image:

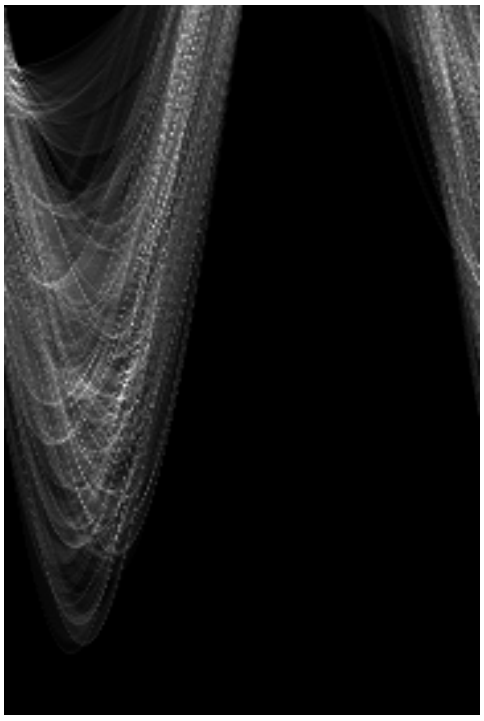
Edge detection:



Threshold:



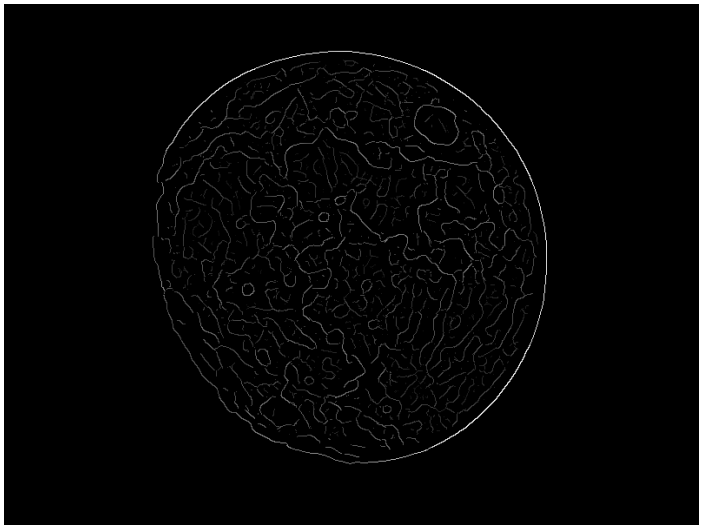
Hough space:



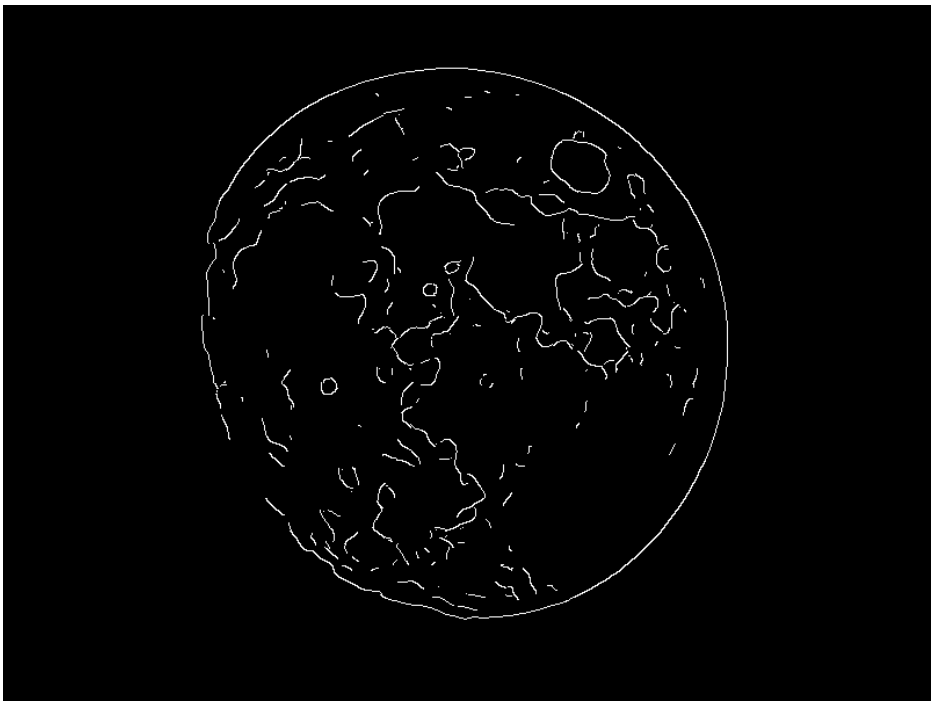
Edge detection by hough transform:

Original image :

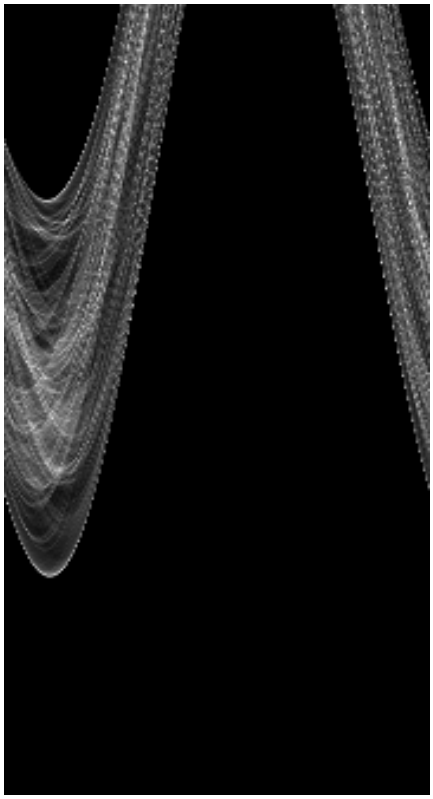
Edge detection :



Threshold:



Hough space:



Edge detection by hough transform:

Original image :

Edge detection:

Threshold:

Hough space:

Edge detection by hough transform:

So it is seen that hough transform has worked well only for the first image which has mostly vertical and horizontal image but it did not work well with the other images which mostly had objects which are circular or curved.