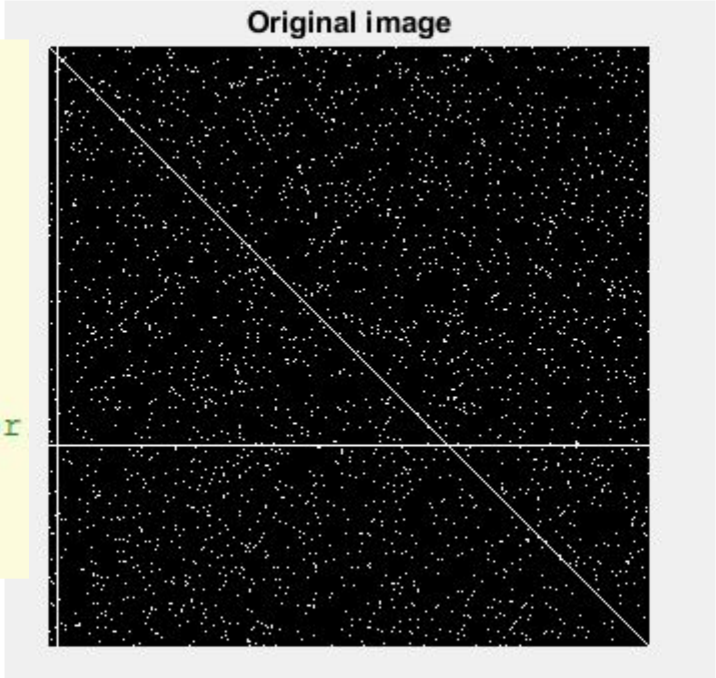
Week 3

I will go through the weekly exercises at 14:15

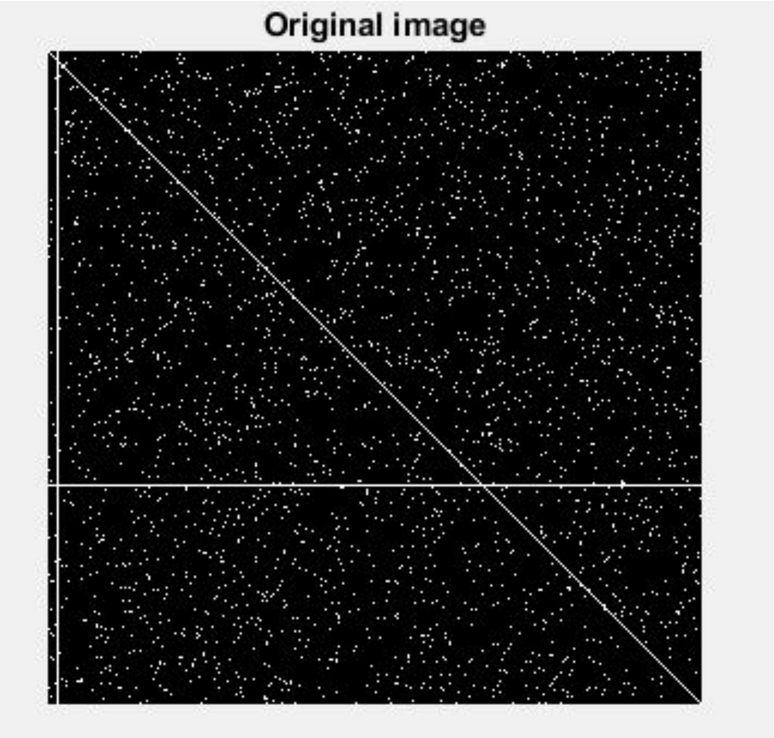
Make a simple image, to see how Hough works

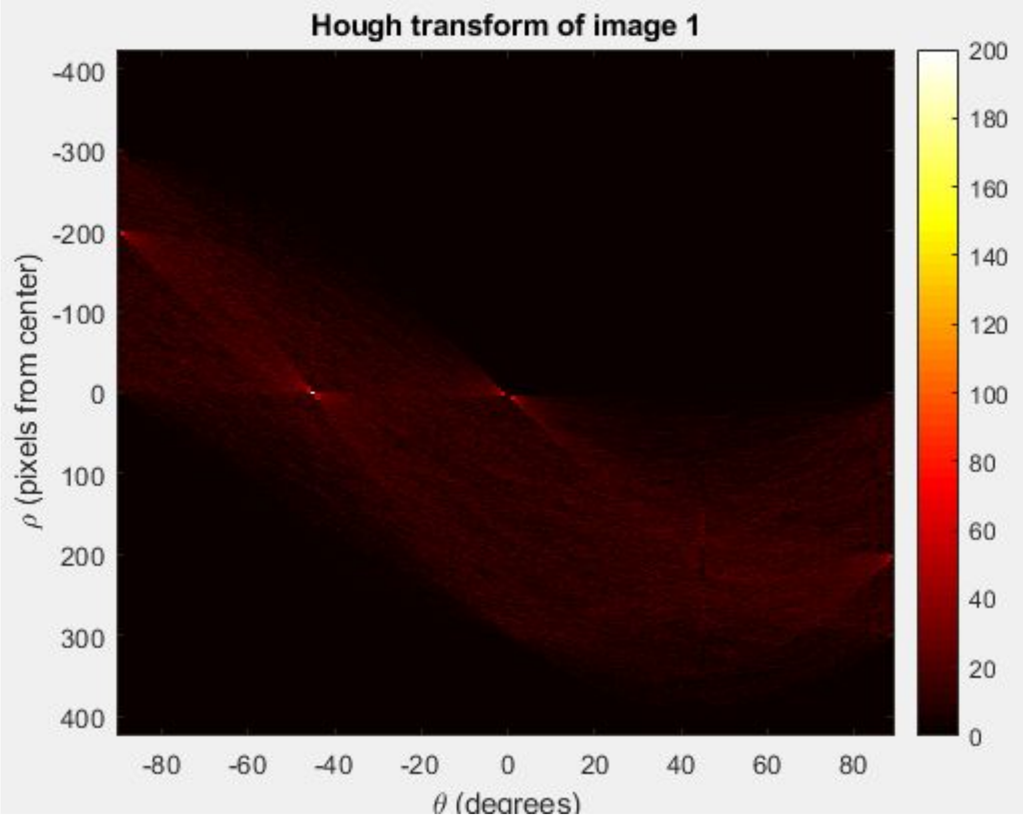
```
% Trying to understand the Hough transform
d=300;
img=eye(d); %make a diagonal matrix
img(1:d,5)= 1; % add a vertical line
img(200,1:d)=1; % add a horizontal line
u = rand(d); %matrix elements ~ uniform(1)
noise = u>0.97;% only use a portion to make noise
img = (img + noise)>0; % add noise and img together
figure(),imshow(img,[])
title('Original image');
```



How does the image look in Hough-space

```
% Compute the Hough transform for the edge image
[H,theta,rho] = hough(img);
```

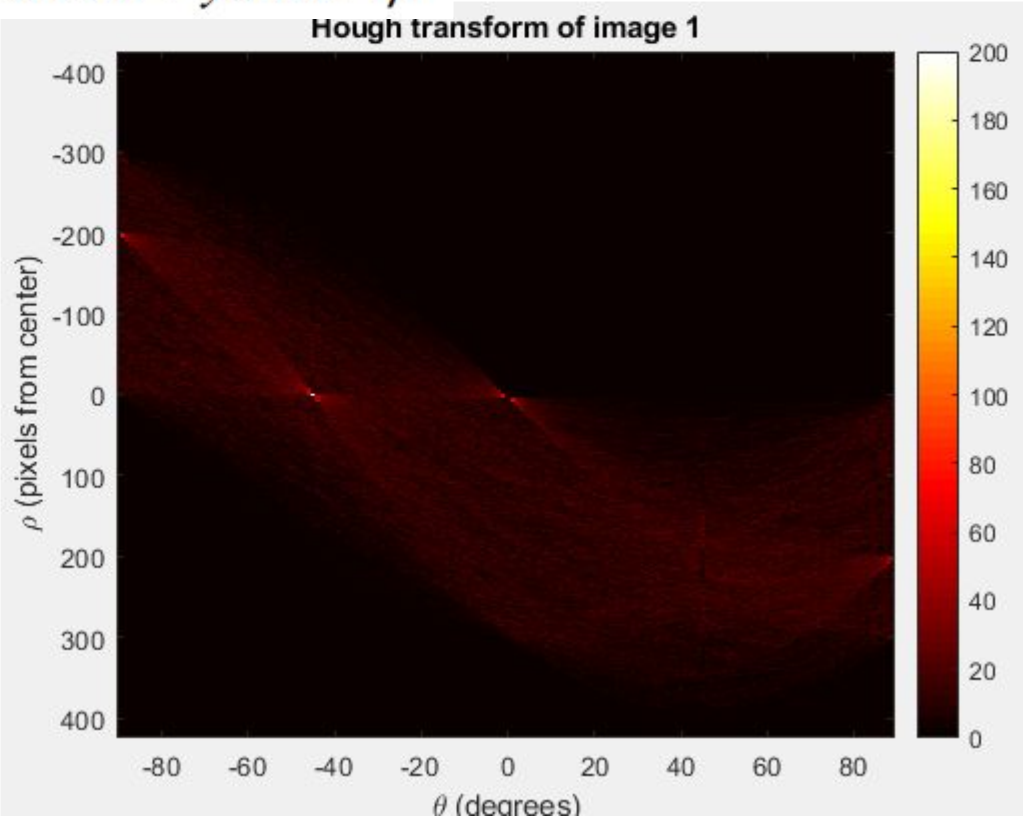




First look at the two peaks in the middle

First lets look at (0,4). What line does this correspond to?

We have the normal representation of a line $x\cos\theta + y\sin\theta = \rho$



This would be a line perpendicular to the vector x*cos(0) + y*sin(0) = 4

x = 4

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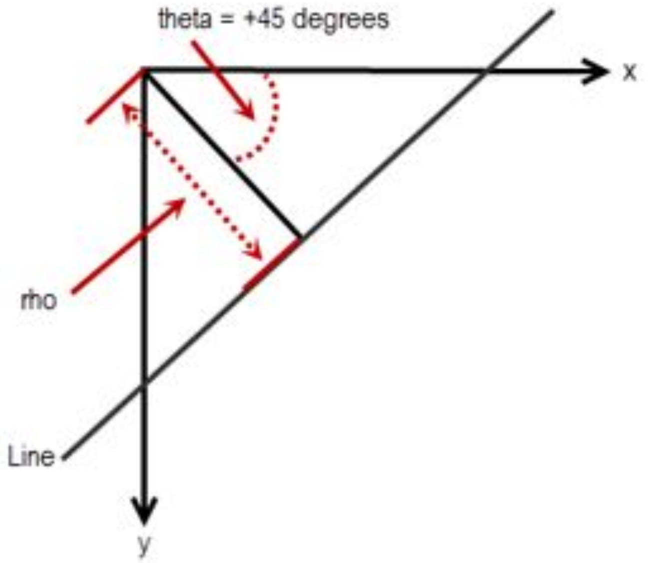
Remember that Matlab uses lefthandsystem and origo is in (1,1)



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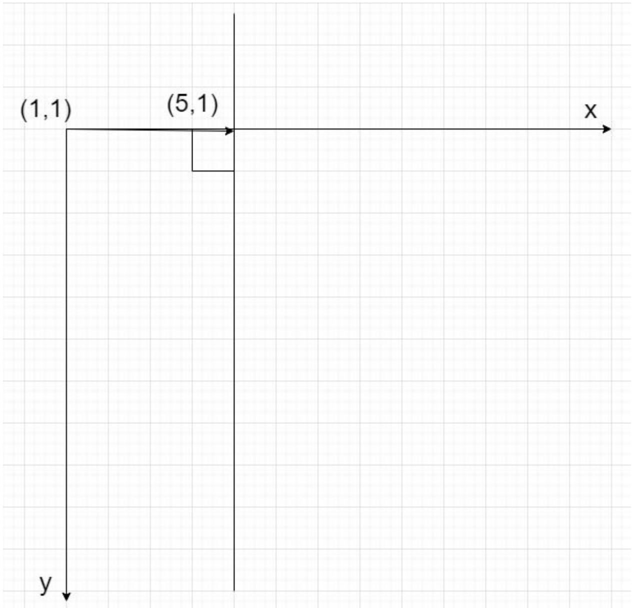

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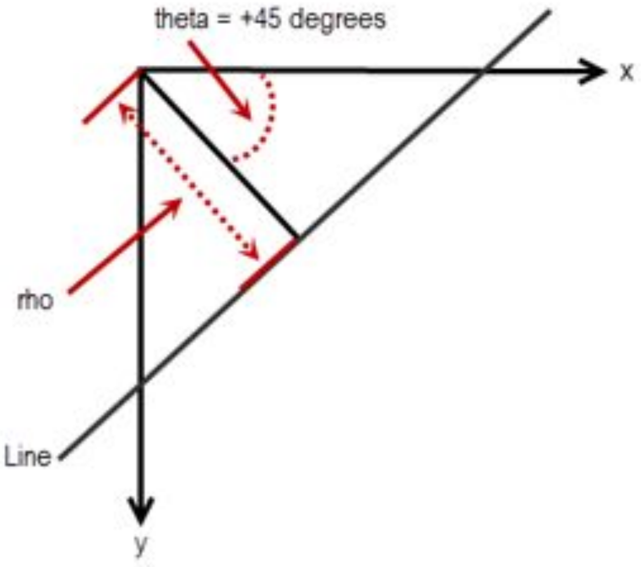


First look at the two peaks in the middle

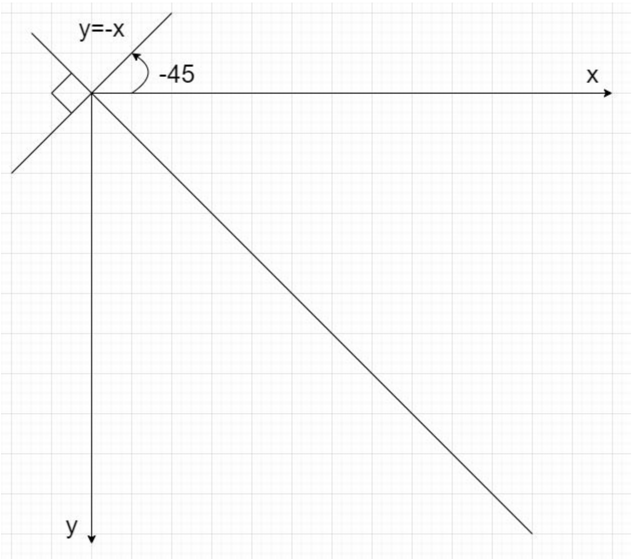
What line does this correspond to?

We have the normal representation of a line $x\cos\theta + y\sin\theta = \rho$

Next lets look at (-45,0)

This would be a line perpendicular to the line x*cos(-45) + y*sin(-45) = 0

y = -x



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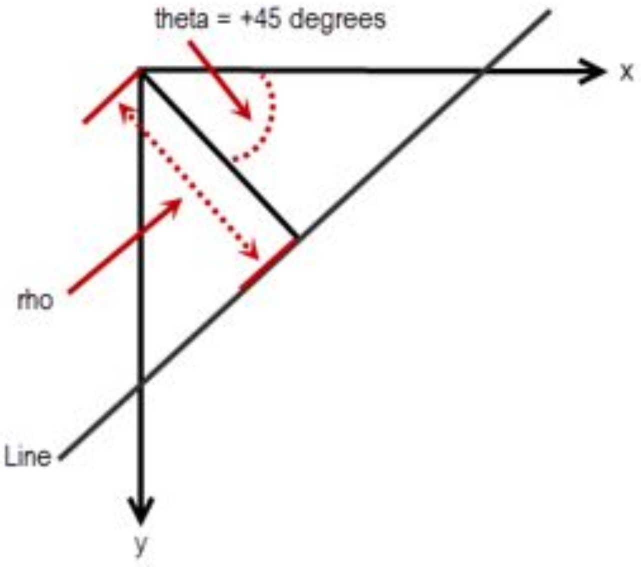
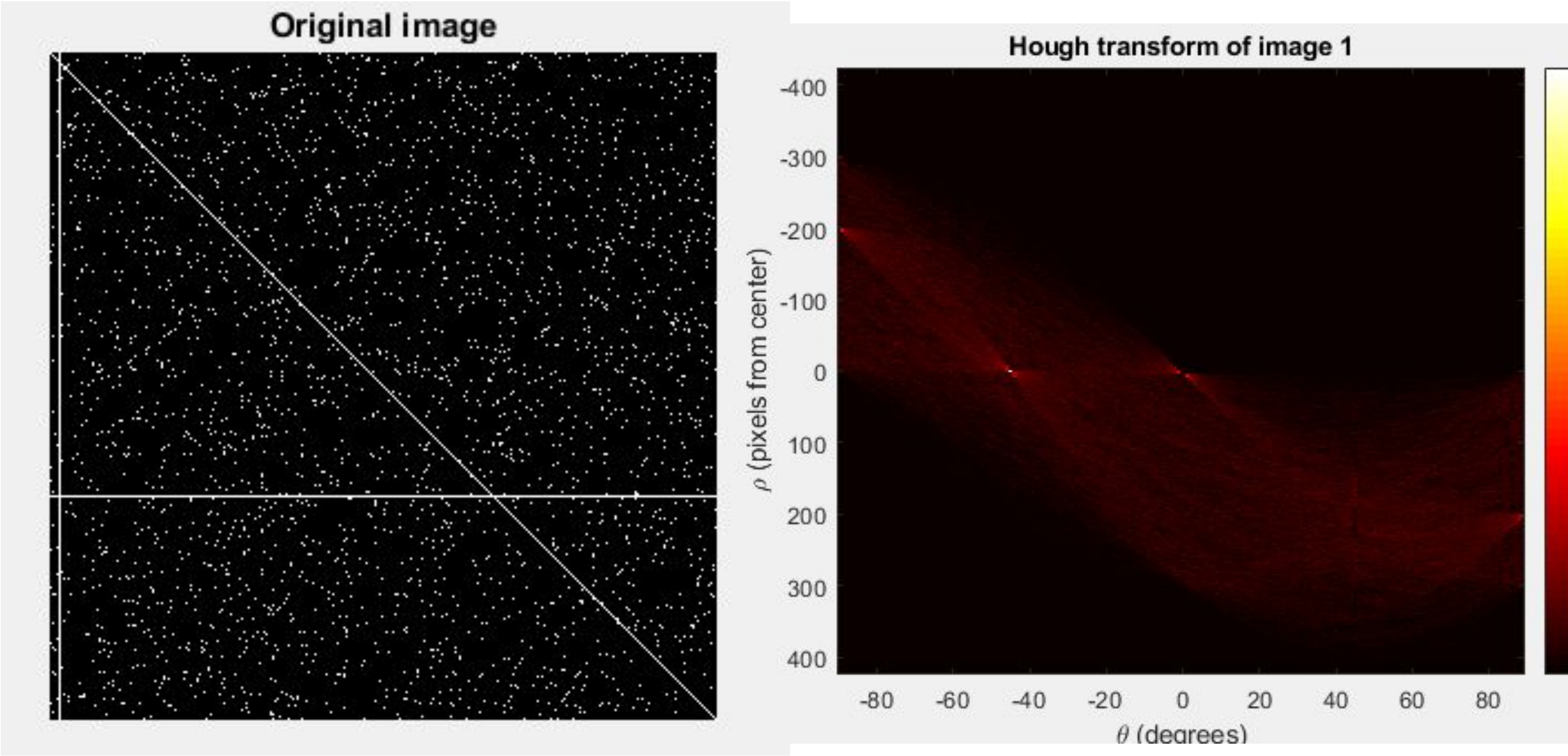
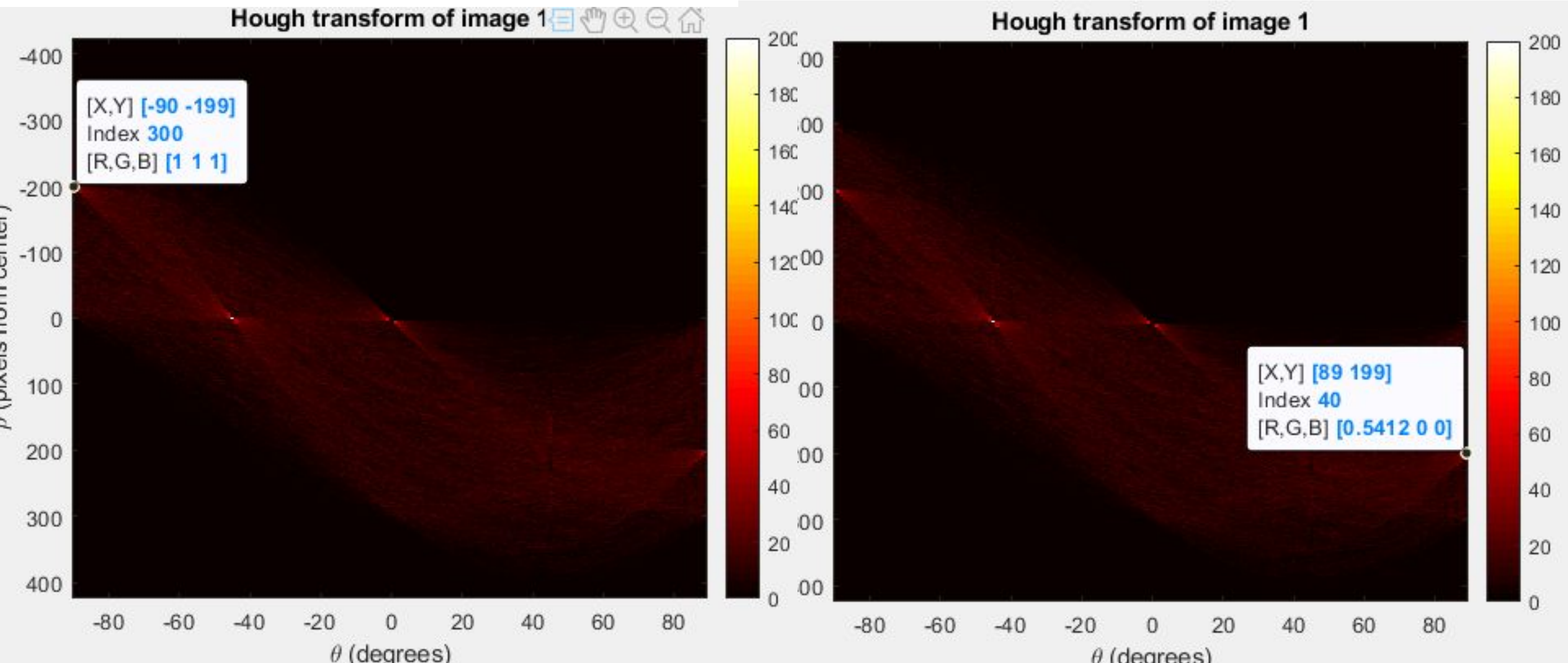


The last line is the horizontal line



The last line

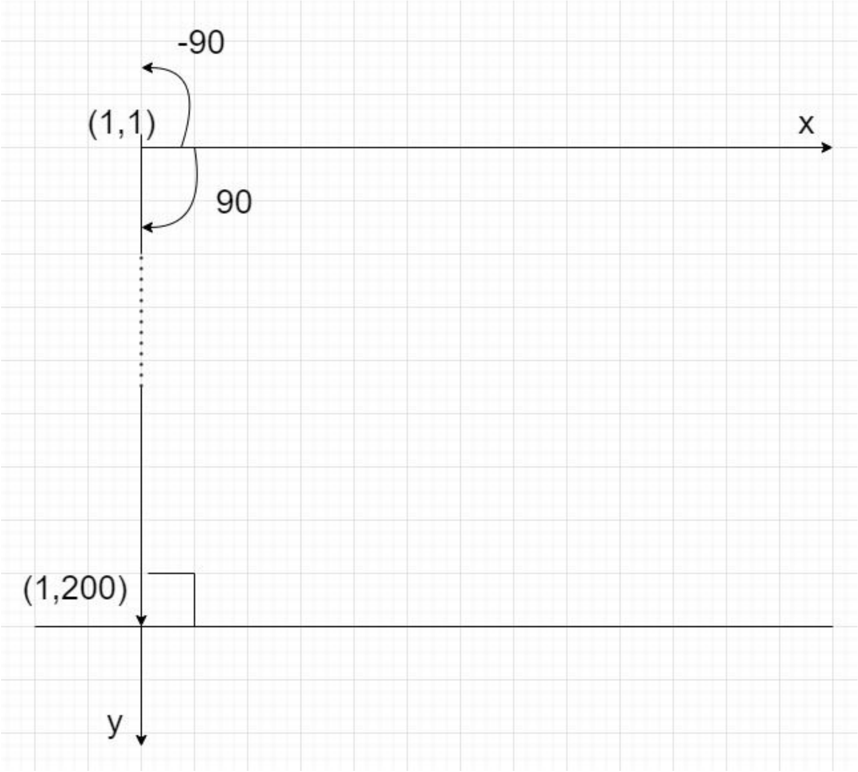
Has two peaks (-90,-199) and (90,199)



The last line

Has two peaks (-90,-199) and (90,199)

xcos(-90) + ysin(-90) = -199
x*0 + y*(-1) = -199
y= 199

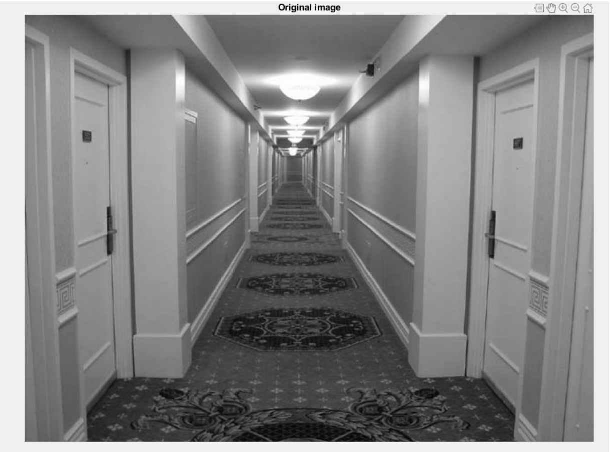


xcos(90) + ysin(90) = 199
x*0 + y = 199
y = 199

Load image and find gradient

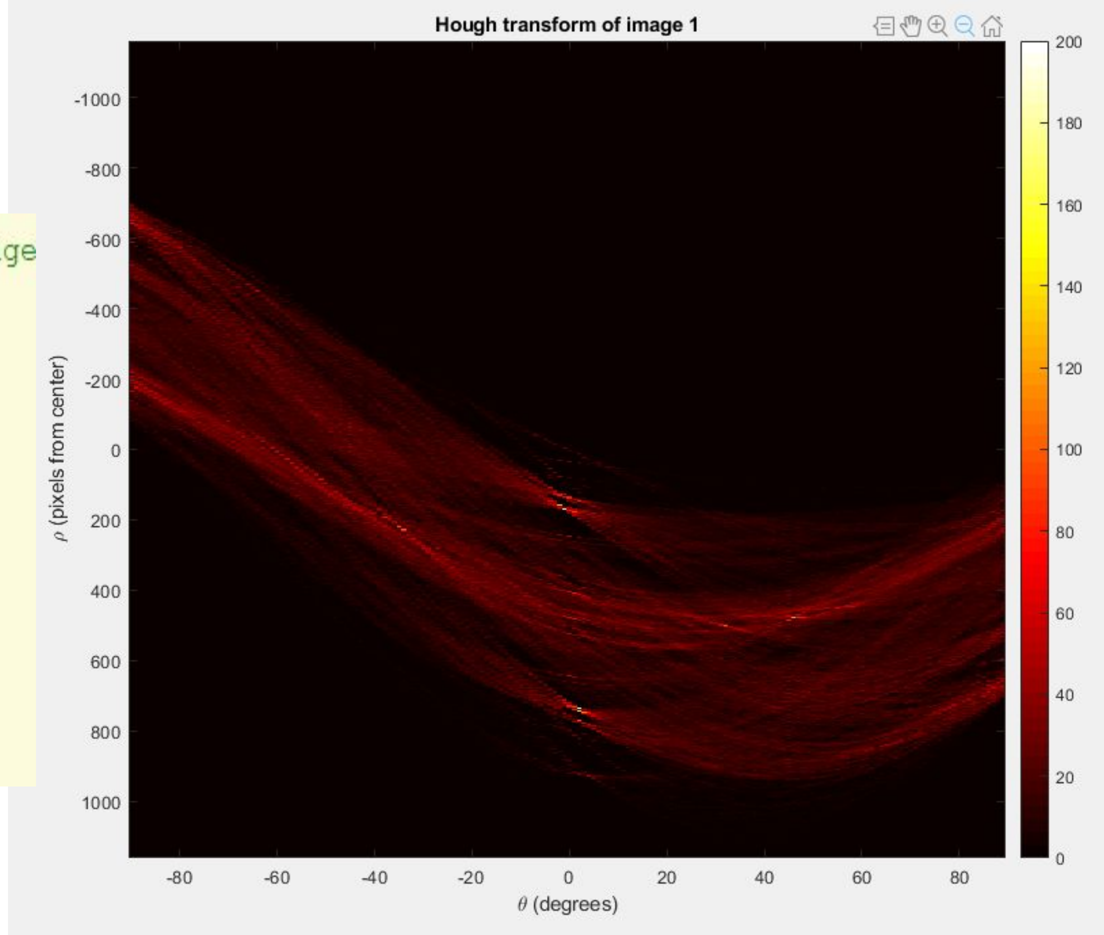
```
% Load and show the corridor image
img=imread('corridor.png');
img=double(rgb2gray(img));
figure(),imshow(img,[])
title('Original image');

% Lets filter the original image with a
% Adjusting the threshold will affect th
% detect.
thresh = 20;
img_edge = edge(img, 'Sobel', thresh);
figure(),imshow(img_edge,[])
title('Sobel magnitude');
```



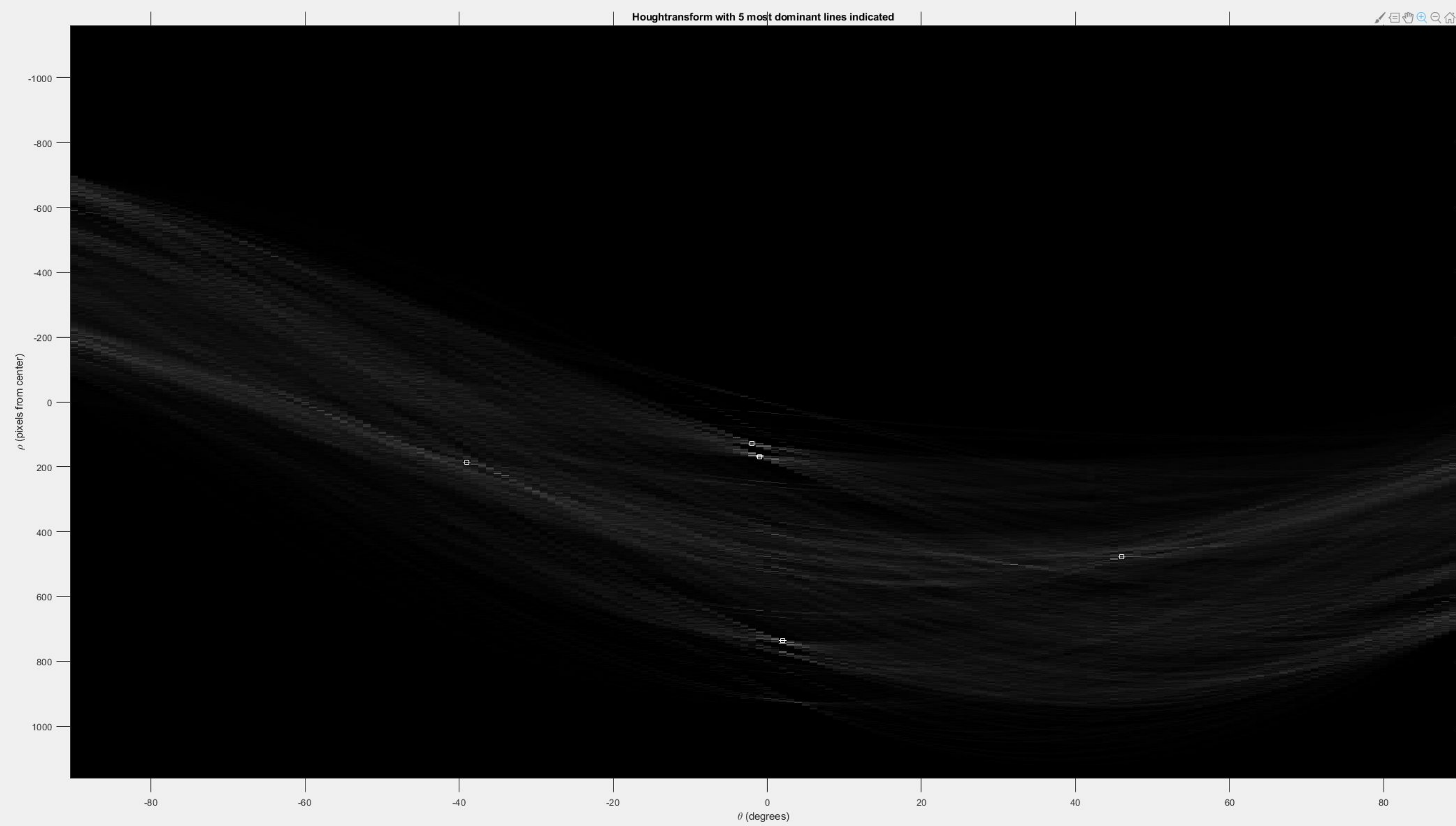
Compute Hough

```
% Compute the Hough transform for the edge image
[H,theta,rho] = hough(img_edge);
% Display the accumulator matrix
figure(15);clf
imagesc(theta,rho,H);
colormap hot
colorbar
caxis([0 200 ])
xlabel('\theta (degrees)')
ylabel('\rho (pixels from center)')
title('Hough transform of image 1')
```

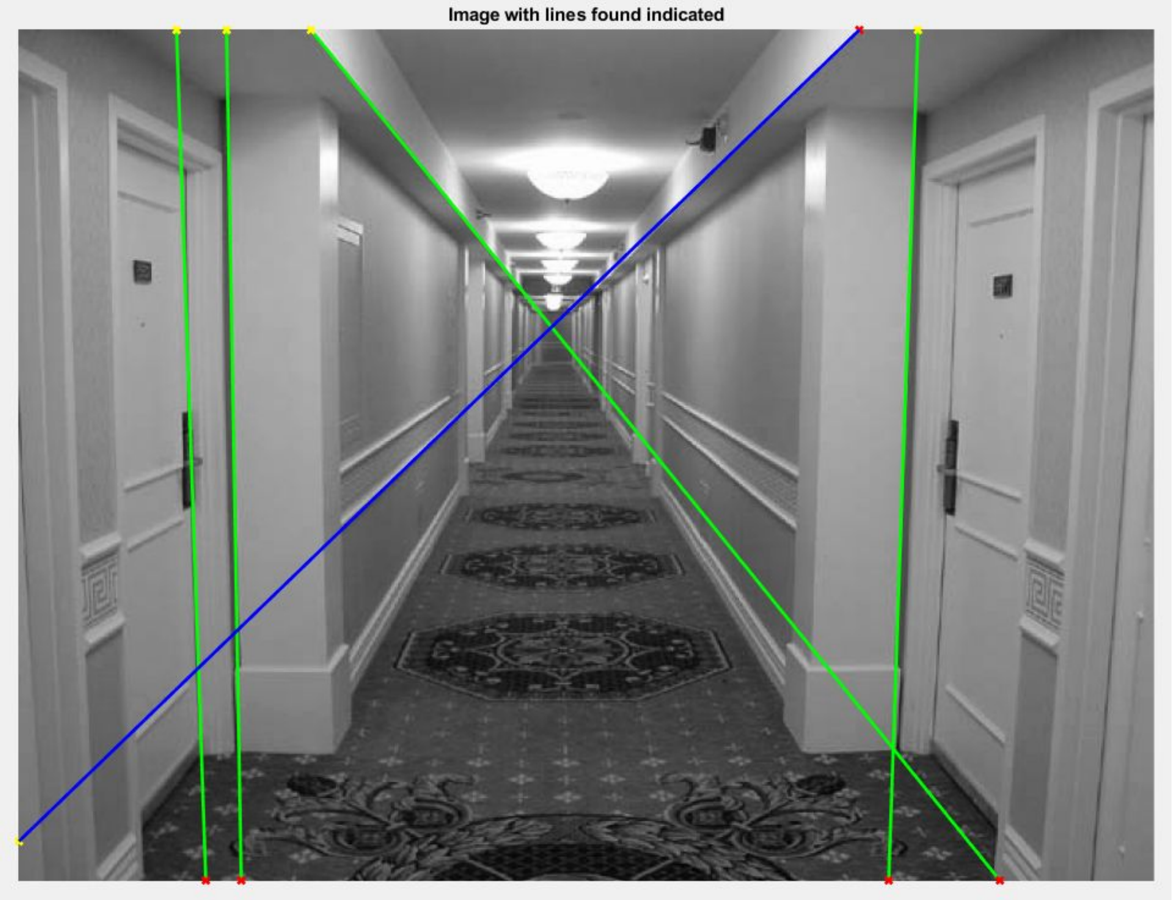


We want to show the top 5 best candidates for lines

use matlabs inbuilt function houghpeaks(H,numpeaks)



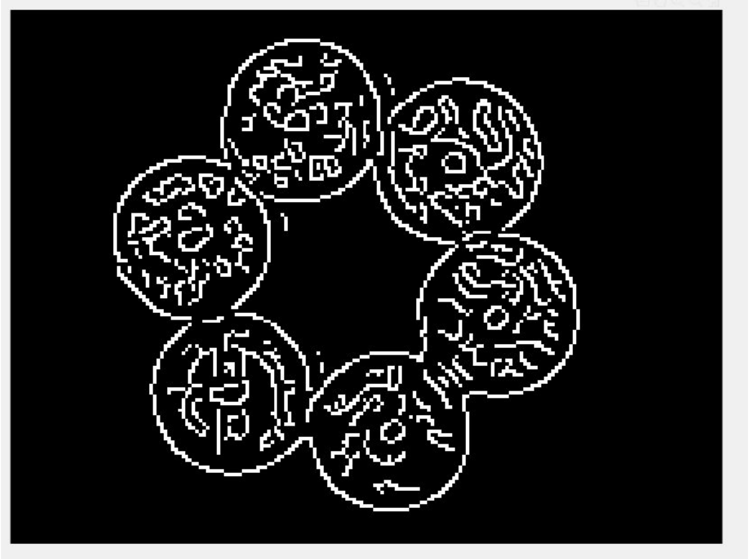
Plot the lines we found



Exercise - Hough with circles

We have an image consisting of 6 coins, they all have the same radius

Canny edge detector

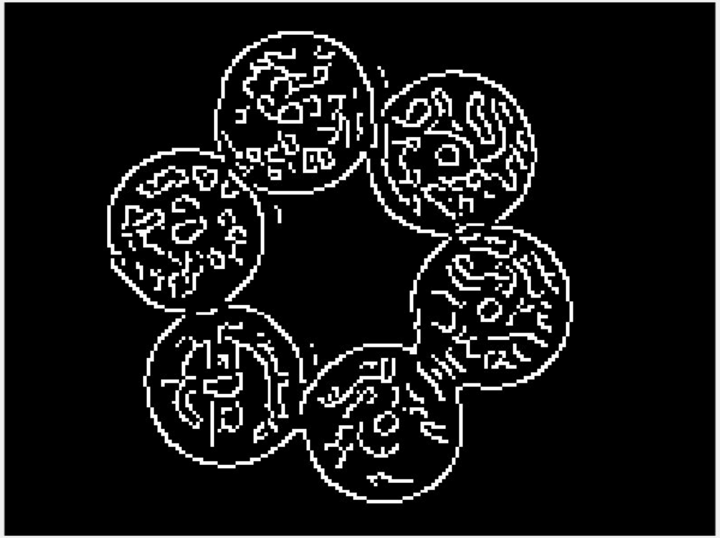


A circle in the xy-plane is given by

$$(x - x_c)^2 + (y - y_c)^2 = r^2$$

So we have a 3D parameter space. What size, what

A simple 3D accumulation procedure:



set all $A[x_c,y_c,r]=0$;
for every (x,y) where g(x,y)>T
    for all x_c
        for all y_c
            $r = sqrt((x-x_c)^2+(y-y_c)^2)$;
            $A[x_c,y_c,r] = A[x_c,y_c,r]+1$;

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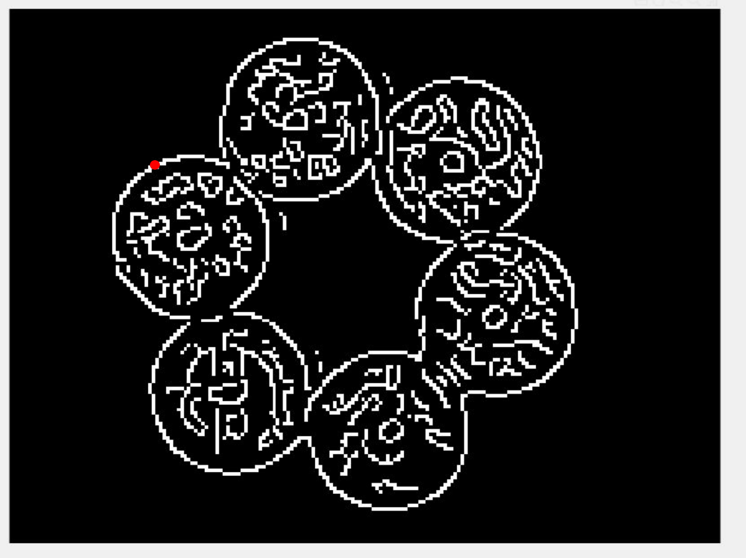

set all $A[x_c, y_c, r] = 0$;

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 for all x_c

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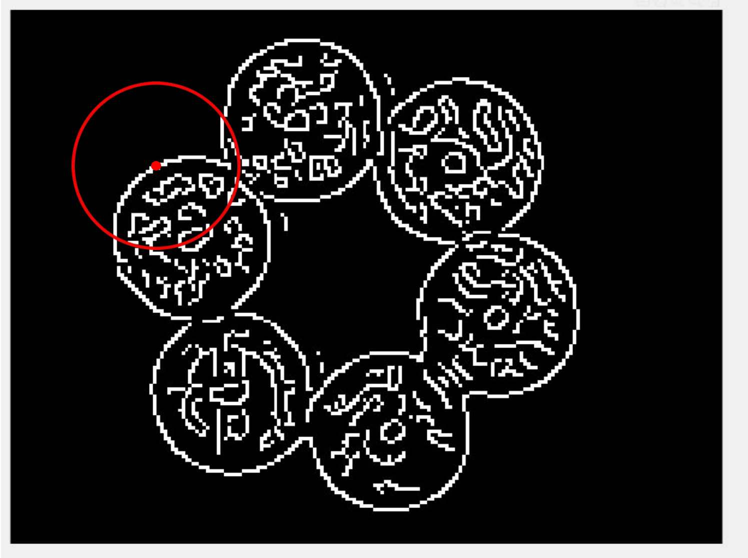

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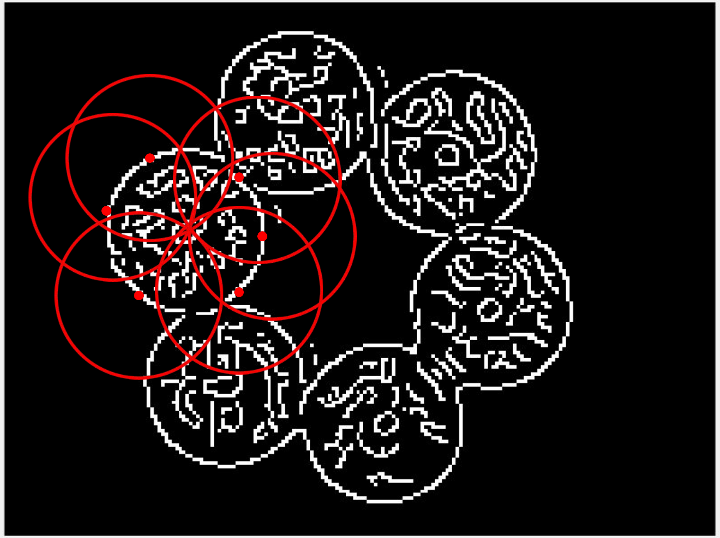


set all $A[x_c, y_c, r] = 0$;

for every (x,y) where g(x,y)>T

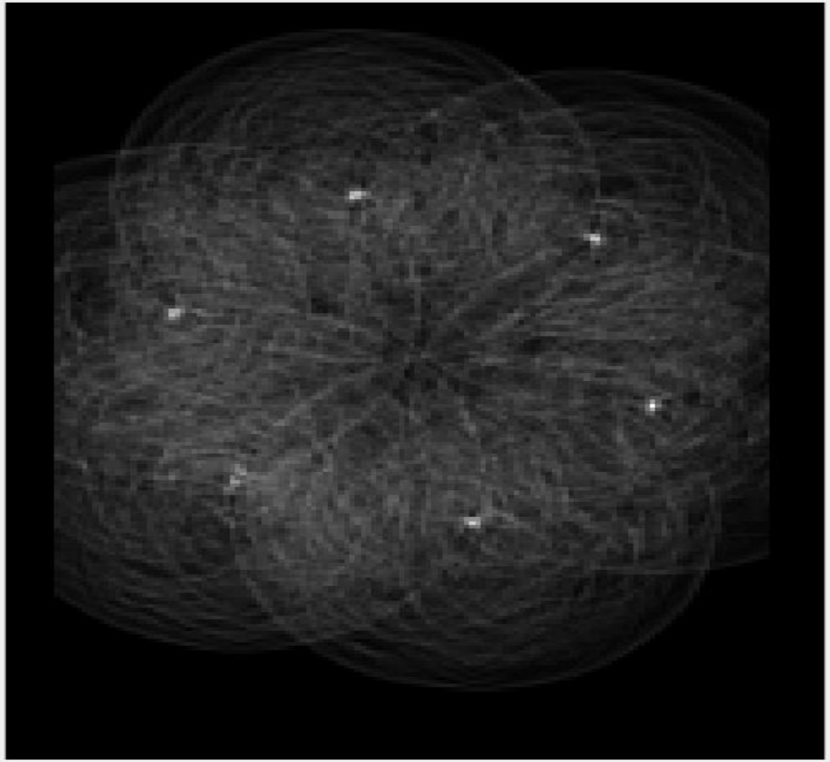
for all x_c

for all y_c

$r = \text{sqrt}((x-x_c)^2+(y-y_c)^2)$;

$A[x_c, y_c, r] = A[x_c, y_c, r]+1$;

We end up with a Hough image



Here we can clearly see the 6 different centers for the coins. This is the accumulator matrix for radius 22 (which got the highest peak)

```
[maxval,radius] = max(max(max(A)));
%gives 22 radius
number_of_circles = 6;
peaks = houghpeaks(A(:,:,radius),number_of_circles)
```

Finally we just plot the circles of r=22 with the centres we found

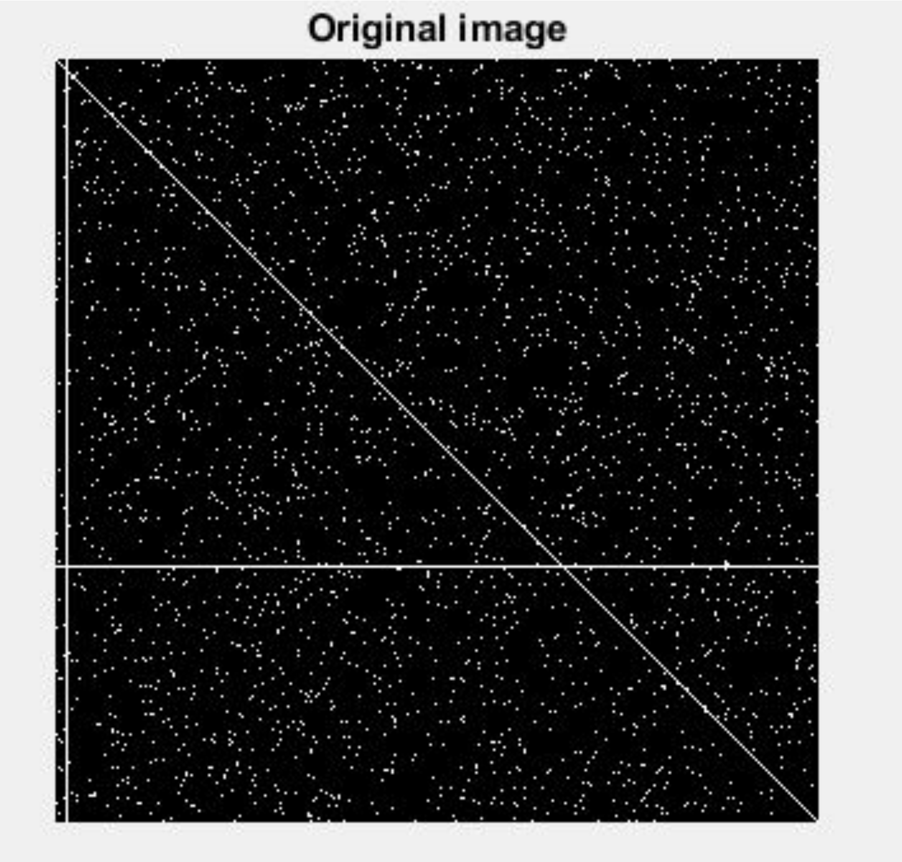
```
figure, imshow(ig,[])
viscircles(peaks,repmat(radius,number_of_circles,1));
```

Fast Hough

while no line is found

Sample two points in where T(x,y)>0
Find the line between the two points
Add to the accumulator matrix A

line is found when a point in A>threshold



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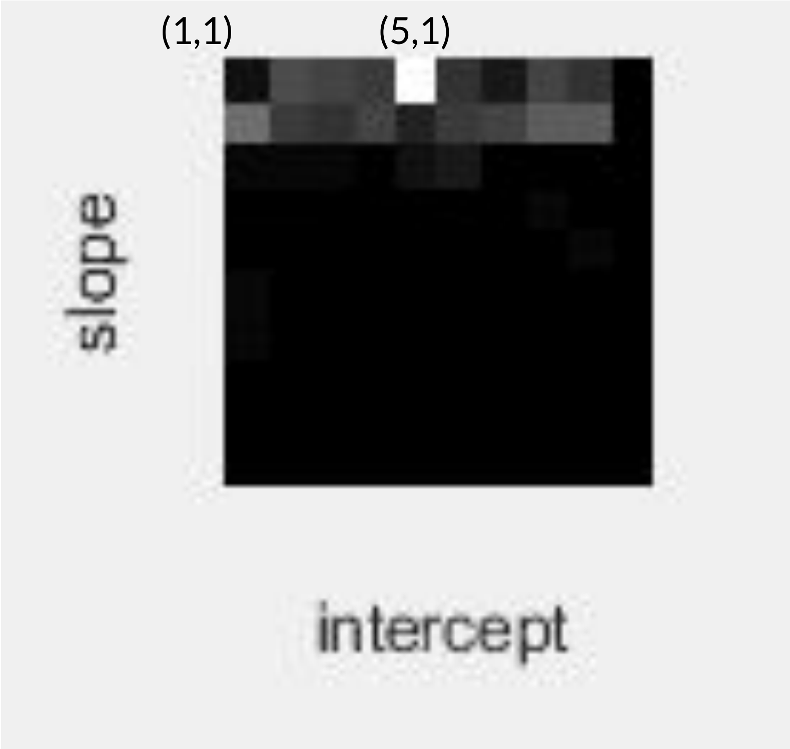

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