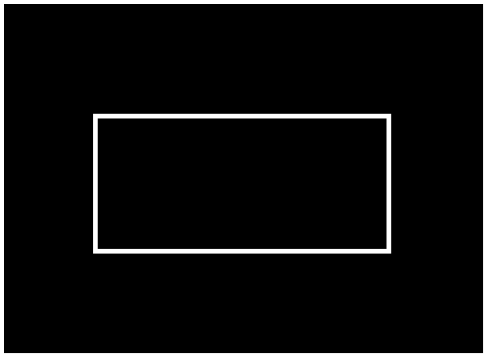
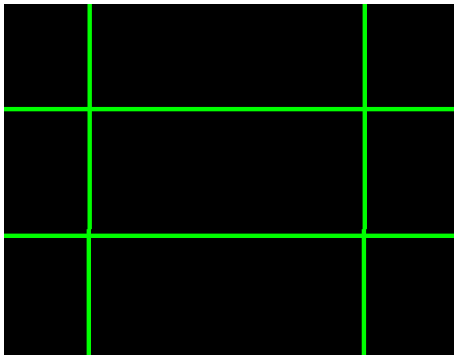
Hough Transformation

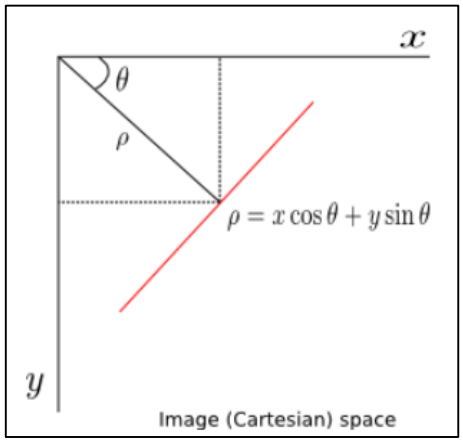


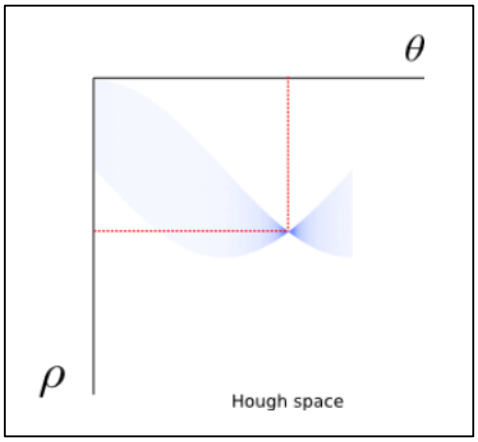


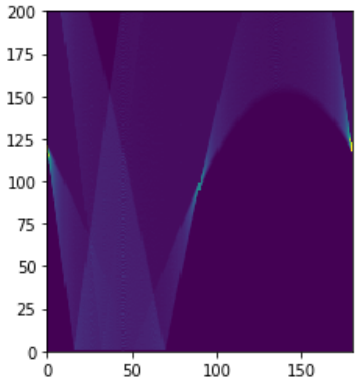
Hough Transformation is a widely used line detection algorithm, and it can be broken down in two main steps:

1. Creation of Hough space
2. Line extraction from Hough space

Step 1 All the pixels in image are treated as points in Cartesian plane [x, y] and then they are converted into polar form [ρ, Θ] (Hough Space) using the parametric form. Each pixel in Cartesian plane is represented by a curve in the Hough space.







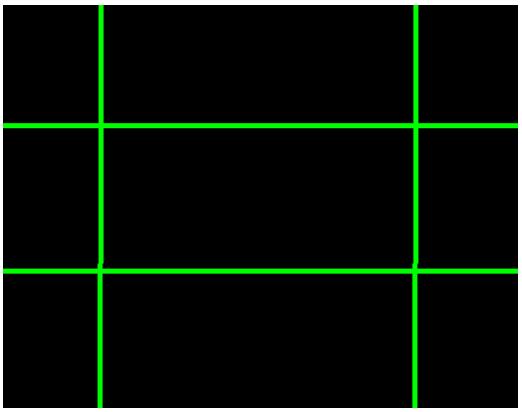
Hough Space

```
theta = np.linspace(-90.0, 90.0, 181)
q = np.ceil(np.sqrt((size_i[0]-1)**2+(size_i[1]-1)**2))
nrho = 2*q + 1
rho = np.linspace(-q, +q, nrho)
I1 = np.zeros((len(rho), len(theta)))
I1 = np.array(I1)
for i in range(size_i[0]):
    for j in range(size_i[1]):
        if(I[i,j]):
            for x in range(len(theta)):
                rad = np.pi / 180.0
                rhoVal=int(np.abs(i*np.sin(theta[x]*rad)+j*np.cos(theta[x]*rad)))
                I1[rhoVal, x] += 1
```

Step 2 From the Hough space, we find the points with highest intensity(maxima) i.e. where the curves meet to detect the lines in Cartesian plane. This is done by transforming values back to [x,y] using the formula:

1. $x = \rho.\cos(\Theta)$
2. $y = \rho.\sin(\Theta)$

Instead of finding maxima we can use threshold function to get accurate results.



This is to check whether the line is straight

```
img = np.zeros(([size_i[0], size_i[1], 3]))
for x in range(len(rho)):
    for y in range(len(theta)):
        if(I1[x, y] > 100):
            b = np.cos(y*np.pi/180.0)
            a = np.sin(y*np.pi/180.0)
            x0 = int(a * x)
            y0 = int(b * x)
            x1 = int(x0 + 1000*(-b))
            y1 = int(y0 + 1000*(a))
            x2 = int(x0 - 1000*(-b))
            y2 = int(y0 - 1000*(a))

            if(np.abs(x1-x2) < 2 or np.abs(y1-y2) < 2):
                cv2.line(img, (x1, y1), (x2, y2), (0, 255, 0), 1)
```

Sources:

- nabinsharma.wordpress.com
- alyssaq.github.io
- moonbooks.org