Edge Detection and Hough Transforms

Recognition Strategy: Determine a measure of change in the pixel's neighbourhood. The first derivative in 2D space is the image gradient.

$$\psi = \text{Direct of the maximum growth of a function}$$

$$|\nabla f(x,y)| = \text{Magnitude of growth}$$

$$\phi = \text{Perpendicular to edge detection}$$

$$|\nabla f(x,y)| = \sqrt{(\frac{\delta f}{\delta x})^2 + (\frac{\delta f}{\delta x})^2}$$

$$\psi = \arctan(\frac{\delta f/\delta x}{\delta f/\delta y}) \qquad \phi = \psi - \pi/2$$

$$h_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \qquad h_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

If the image is very noisy we can use a larger neighborhood in our kernels. These masks are very sensitive to noise so instead we could use the Prewitt operator or the Sobel operator.

Prewitt:

$$h_{hor} = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}, h_{dia} = \begin{bmatrix} 0 & 1 & 1 \\ -1 & 0 & 1 \\ -1 & -1 & 0 \end{bmatrix}, ...$$

Figure 1: Untitled

Sobel (Gaussian):

Hough Transform:

The image space is transformed into a parameter space a voting procedure is carried out in the parameter space and object candidates are obtained as local maxima.

$$h_{hor} = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, h_{ver} = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

Figure 2: Untitled

$$\text{straight line: } f(x, y, \rho, \theta) = x\cos\theta + y\sin\theta - \rho = 0$$

$$\rho = \text{Distance between origin and the line}$$

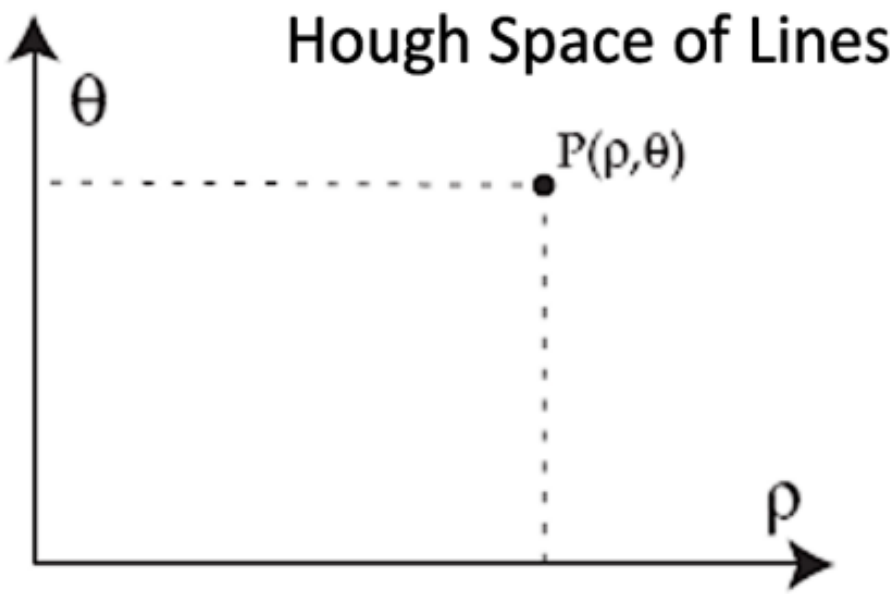

Figure 3: Untitled

Each point in the Hough space is a line defined by its coordinates.

A point(x,y) in the image space is transformed into a sinusoidal curve in the parameter space. Each orientation of lines passing through p(x,y) represents a sinusoidal curve in the Hough transform.

Line Detection:

$H(\rho, \theta) =$ 2D Array for parameter space.1. Find the gradient image: $G(x, y) = |G(x, y)|\angle G(x, y)$2. For any pi

We can define a delta theta range which will allow room for error in the angle of the gradient space.

Circle Detection:

1. For any pixel satisfying $|G(x, y)| > T_s$ increment all elements to satisfythe following simultaneous equations