

# Computational Photography Assignment 5 - Hough Transform

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## 1. Theory Question

1. Given:

- Width ( $w$ ) = 200 pixels
- Height ( $h$ ) = 100 pixels

Compute the diagonal ( $d$ ) of the image:

$$d = \sqrt{w^2 + h^2} = \sqrt{200^2 + 100^2} = \sqrt{40000 + 10000} = \sqrt{50000} \approx 223.61 \text{ pixels}$$

For the Hough Transform:

- The range of  $\theta$  is  $0 \leq \theta < 360^\circ$ , providing 360 bins for  $\theta$ .
- The range of  $r$  is  $0 < r \leq d$ , where  $d$  is the diagonal length of the image, resulting in  $d$  bins for  $r$ .

$$\text{Total number of bins} = d \times 360 \approx 223.61 \times 360 \approx 224 \times 360 \approx \boxed{80499}$$

2. Given:

- Probability ( $p$ ) that an edge pixel is on the object = 0.2
- Desired model accuracy ( $P$ ) = 0.99
- Number of points ( $D$ ) needed to define a line = 2

Calculate the number of required RANSAC iterations ( $N$ ):

$$N = \frac{\log(1 - P)}{\log(1 - p^D)} = \frac{\log(1 - 0.99)}{\log(1 - 0.2^2)} = \frac{\log(0.01)}{\log(0.96)} \approx 112.811$$

Round up to the nearest whole number:

$$N \approx \boxed{113}$$

## 2. Generate Fake Data

**Generated Binary Image with Line and Circle**

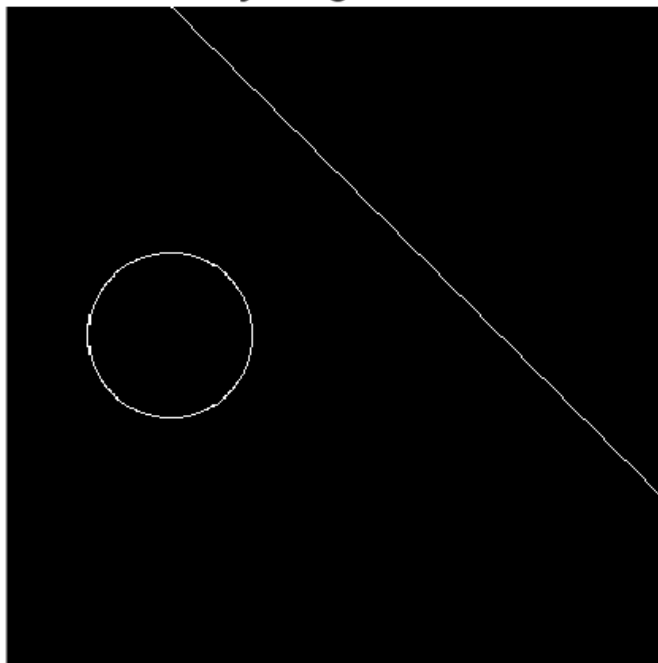


Figure 1: Generated binary image

### 3. Hough Transform for a Line

The value of  $(\theta, \rho)$  that corresponds to the maximum value in the Hough Transform:

$$(\theta, r) = (315^\circ, 71)$$

The corresponding values for  $(m, b)$  where  $m$  is the slope and  $b$  is the y-intercept:

$$(m, b) = (1.00, -100.41)$$

The formulas used to compute  $(m, b)$  from  $(\theta, r)$ :

$$m = -\cot \theta = -\cot 315^\circ = 1.00$$

$$b = \frac{\rho}{\sin \theta} = \frac{71}{\sin 315^\circ} \approx -100.41$$

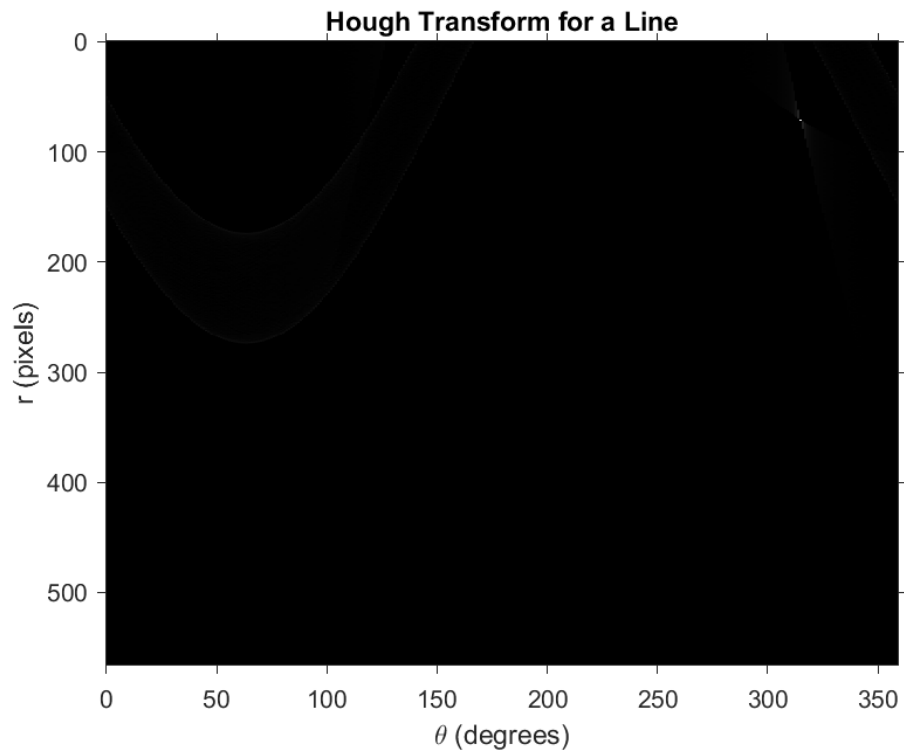


Figure 2: Hough Transform for a Line

## 4. Hough Transform for Circle

The value of  $(x_0, y_0, r)$  that corresponds to the maximum value in the Hough Transform:

$$(x_0, y_0, r) = (100, 200, 50)$$

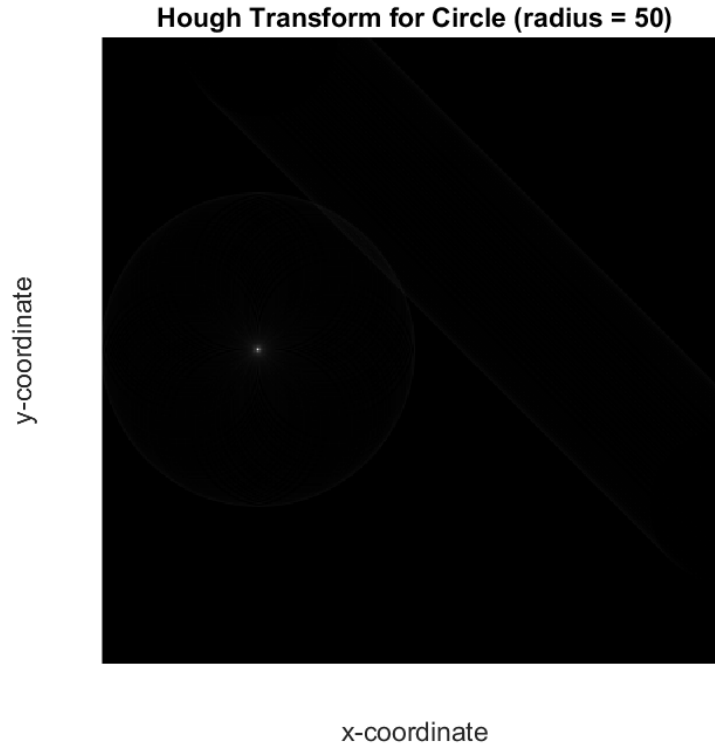


Figure 3: Hough Transform for a Circle

## 5. Apply to a Real Image

Parameters Used: Radius Min: 76 Radius Max: 120

The value of  $(x_0, y_0, r)$  that corresponds to the maximum value in the Hough Transform:

$$(x_0, y_0, r) = (185, 143, 82)$$

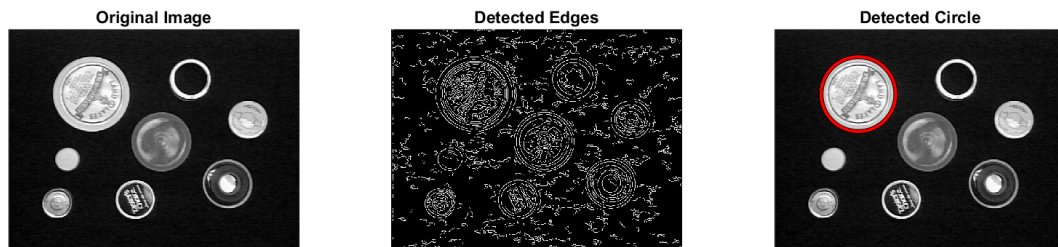


Figure 4: Circle Found!