اصول پردازش تصویر

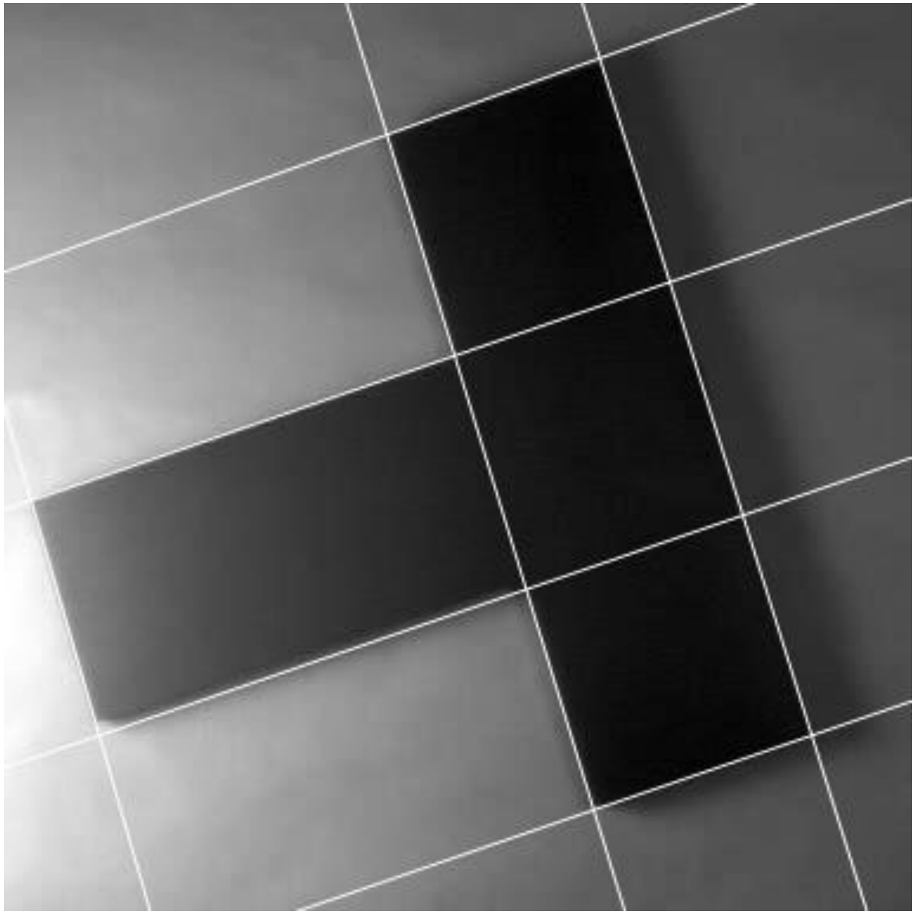
Principles of Image Processing

مصطفی کمالی تبریزی

۲۸ مهر ۱۳۹۹

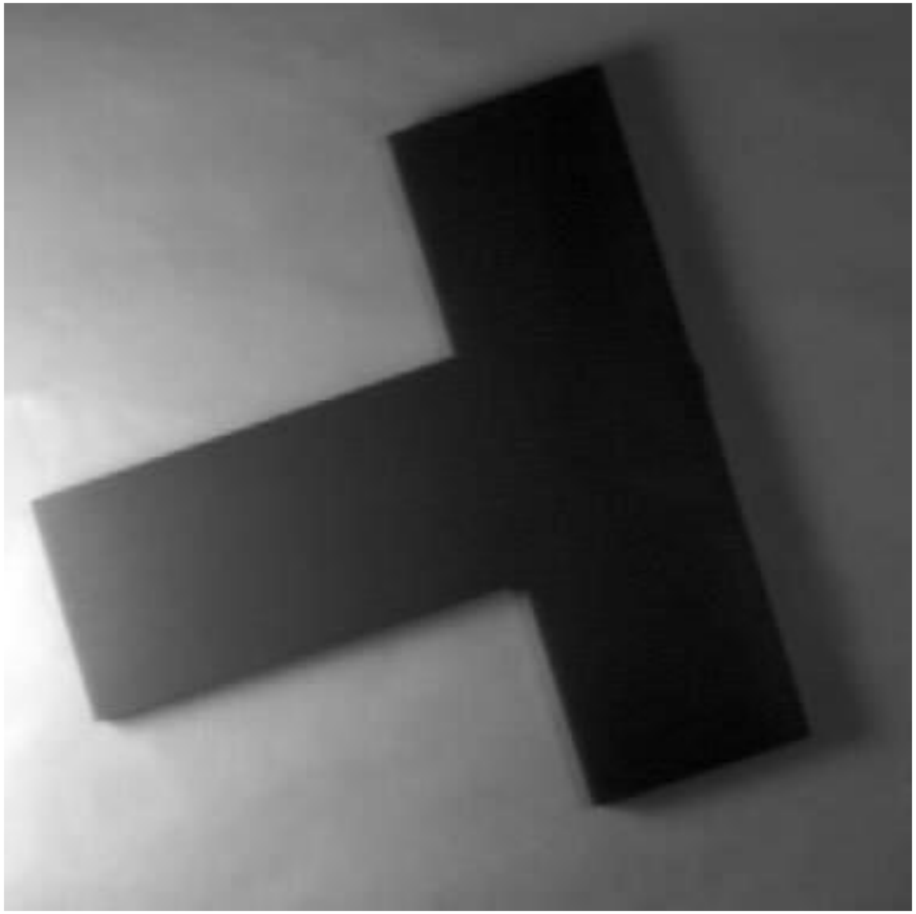
جلسه نهم

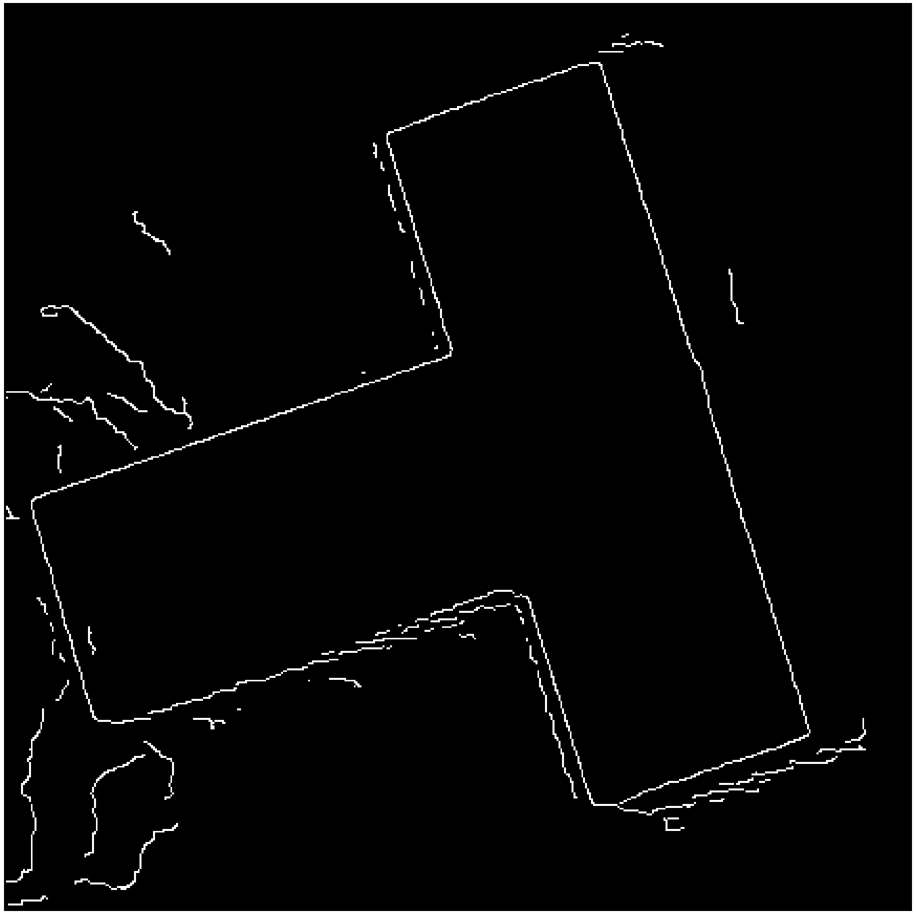
Line Detection
Hough Transform



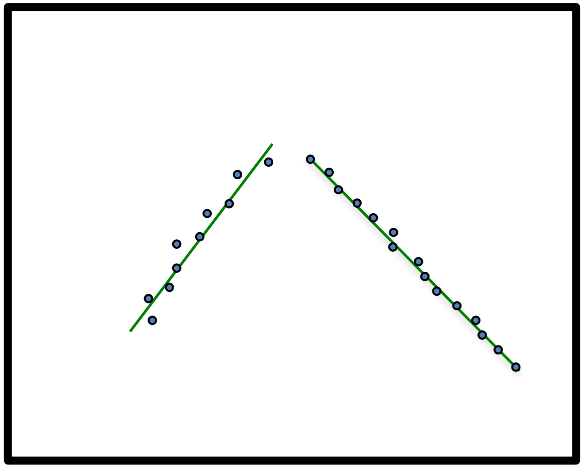
Any idea?

Candidate Pixels

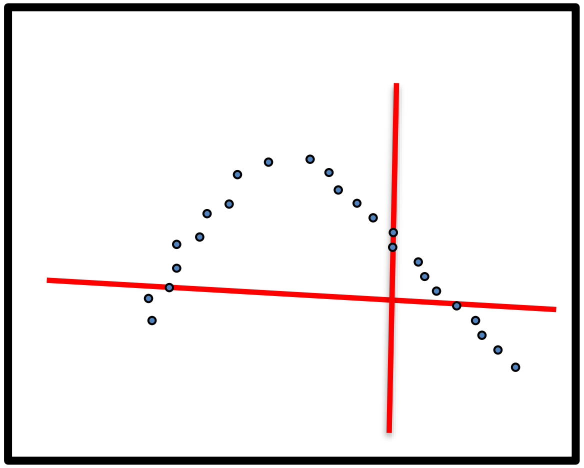




Edge Detector: Canny,   Threshold: 0.1

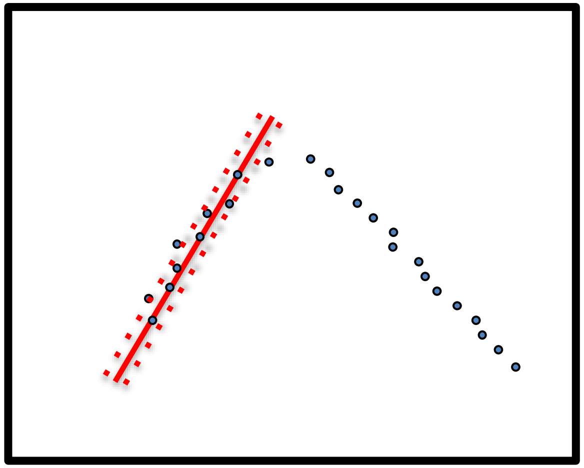


Considering all lines passing through two edge pixels

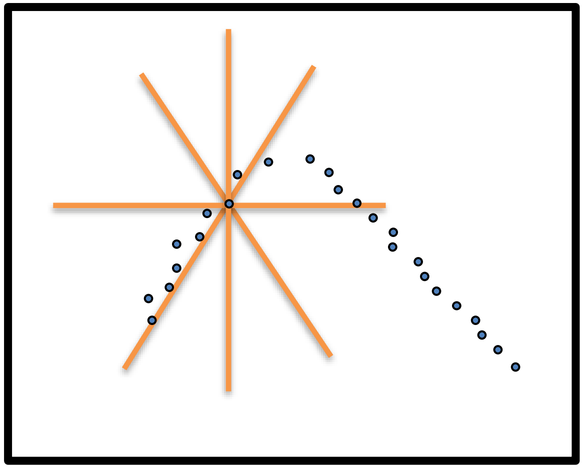


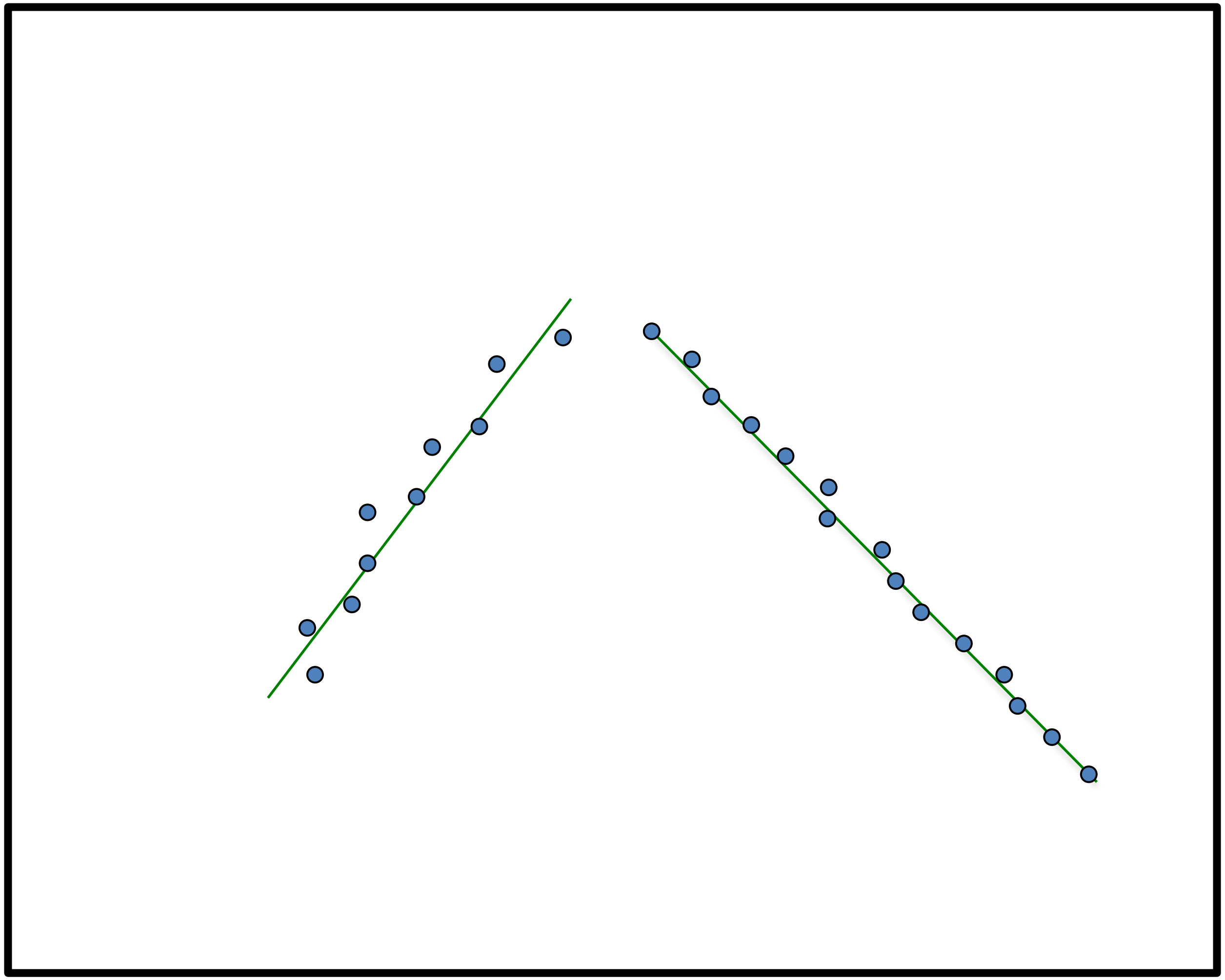
Too Many!

RANSAC based methods

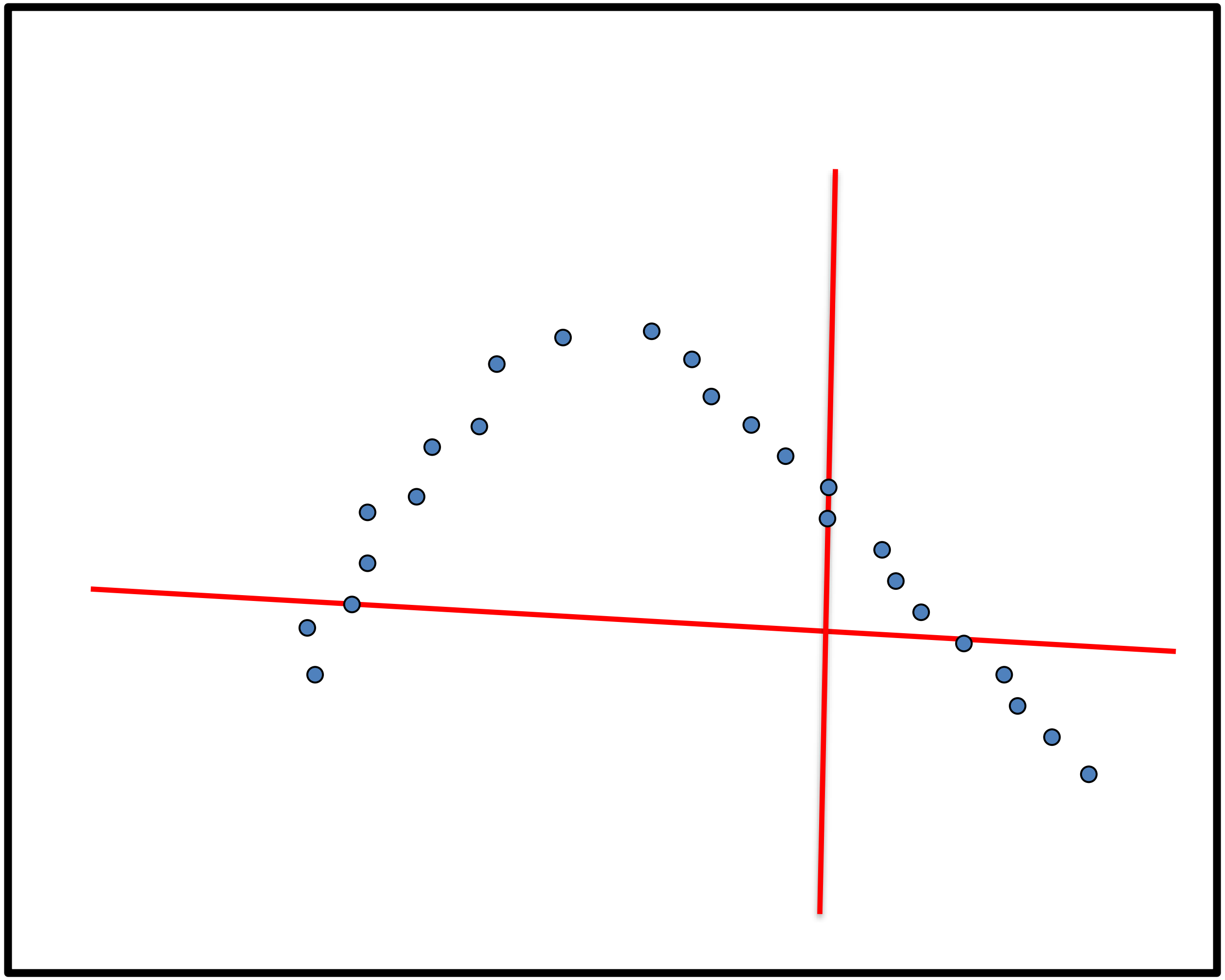


Hough Transform Voting!



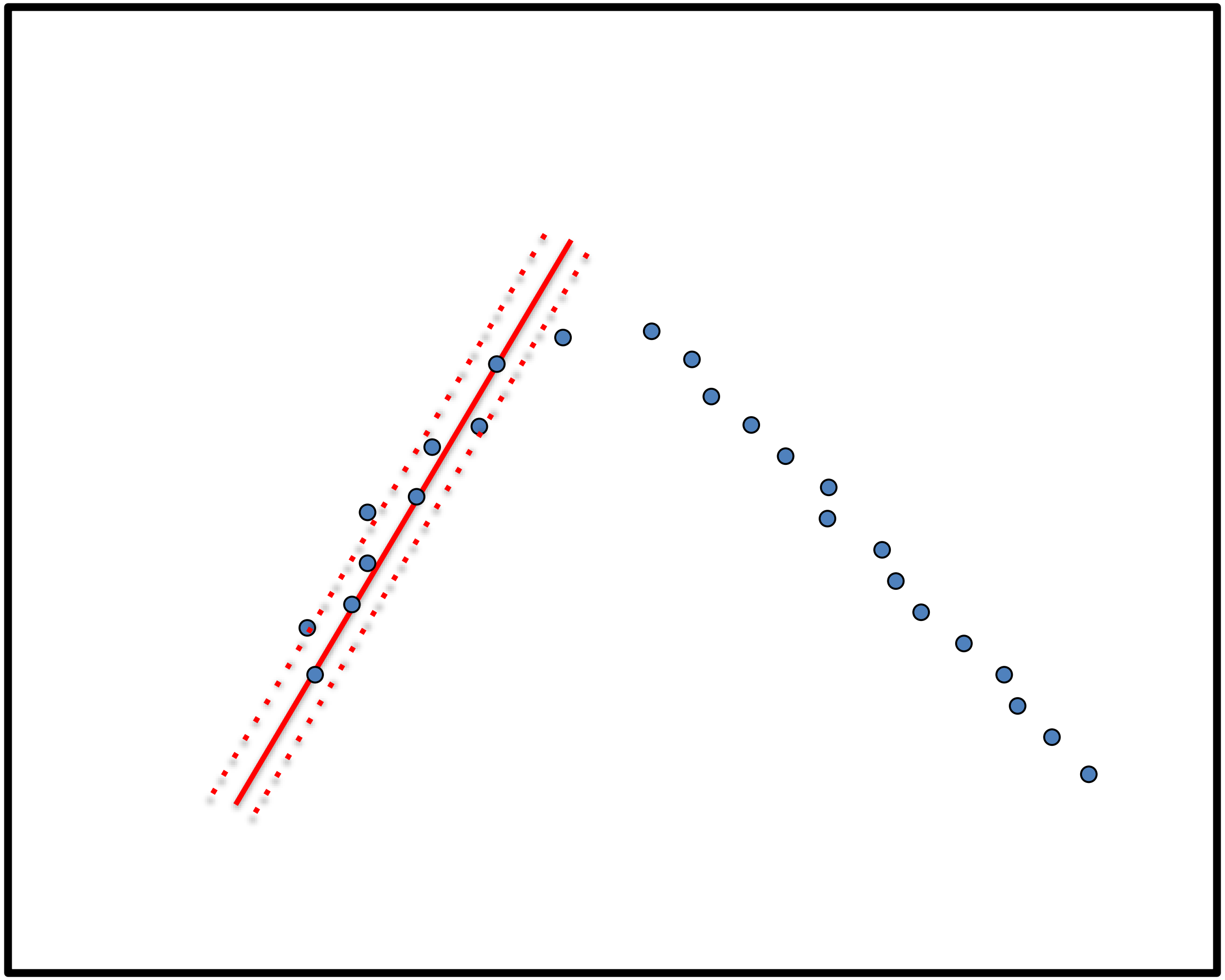


All Pairs



Too many!

RANSAC Based



Voting! Hough Transform

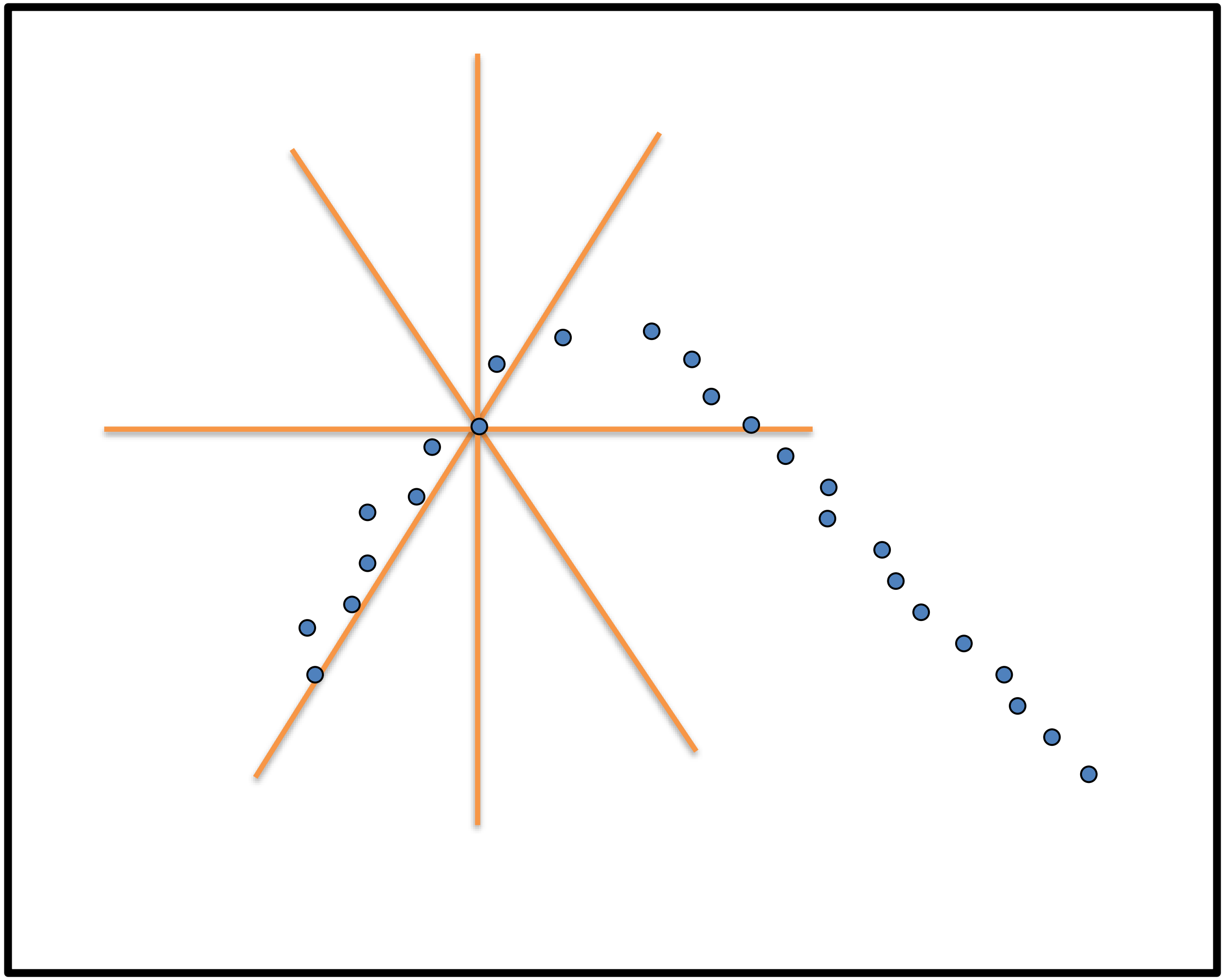
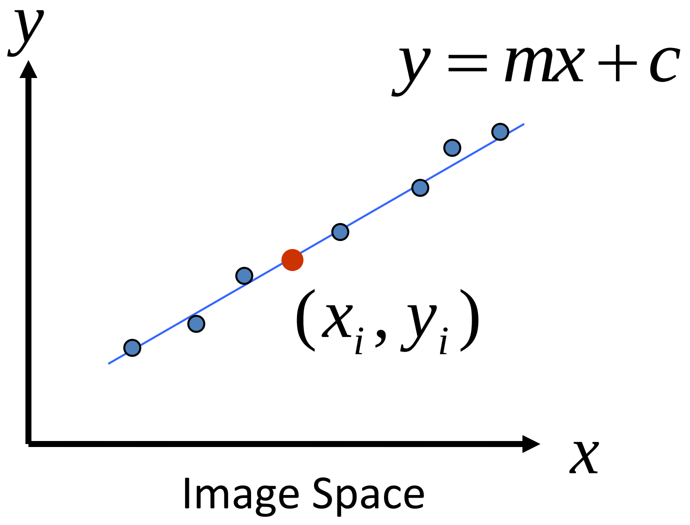


Image and Parameter Spaces

Equation of Line: $y = mx + c$

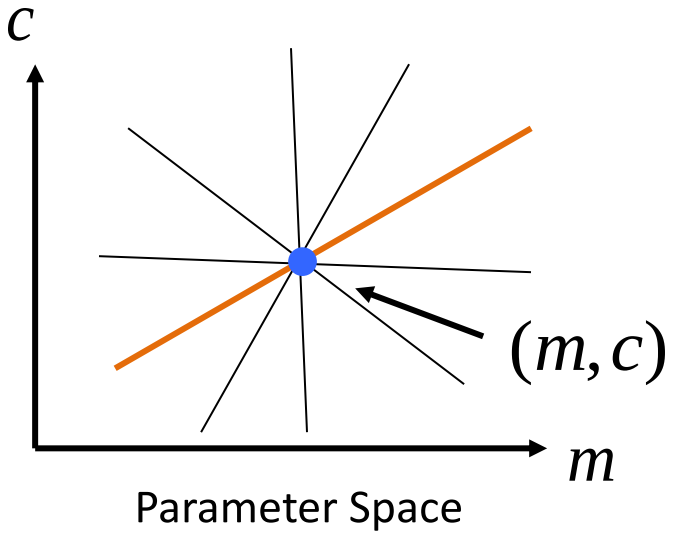
Find: (m, c)

Consider point: (x_i, y_i)

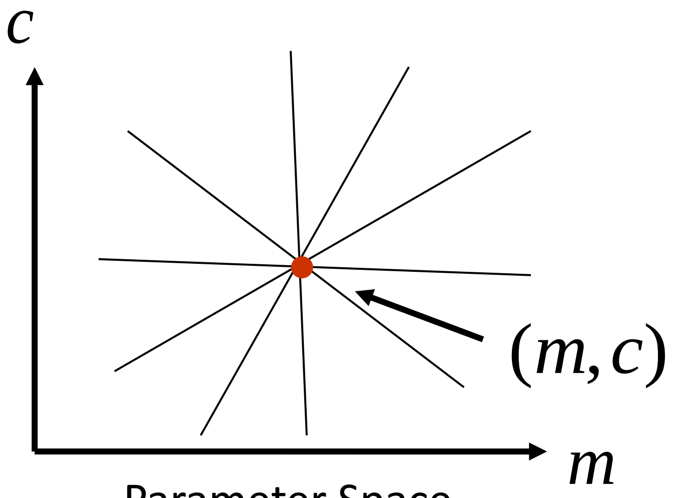


$$y_i = mx_i + c \quad or \quad c = -x_i m + y_i$$

Parameter space also called Hough Space



Line Detection by Hough Transform



Parameter Space

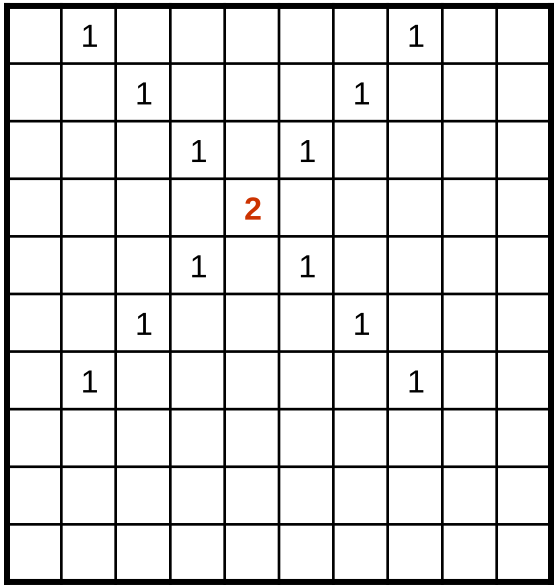
Algorithm:

- Quantize Parameter Space (m, c)
- Create Accumulator Array $A(m, c)$
- Set $A(m, c) = 0 \quad \forall m, c$
- For each image edge (x_i, y_i) increment:

$$A(m, c) = A(m, c) + 1$$

- Find local maxima in $A(m, c)$
- To reduce the computational load, use gradient information
- ***Drawbacks?***

$A(m, c)$



	1					1			
		1			1				
			1		1				
				2					
			1		1				
		1				1			
	1						1		

Better Parameterization

NOTE: $-\infty \leq m\,, c \leq \infty$

Large Accumulator

More memory and computations

Improvement: (Finite Accumulator Array Size)

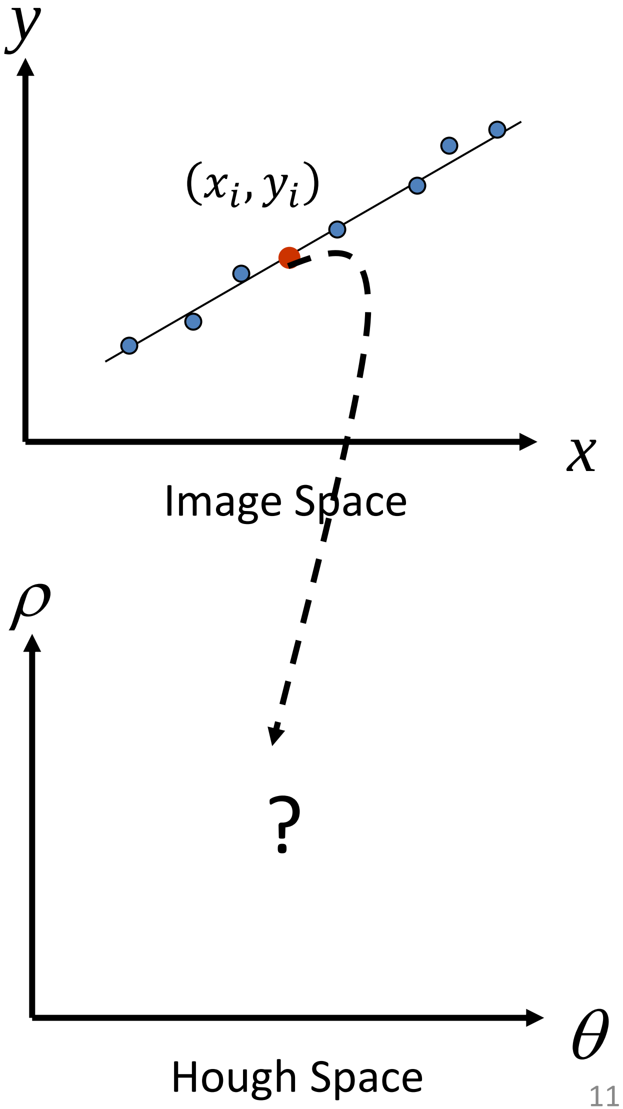
Line equation: $\rho = x\, cos(\theta) + y\, sin(\theta)$

Here:

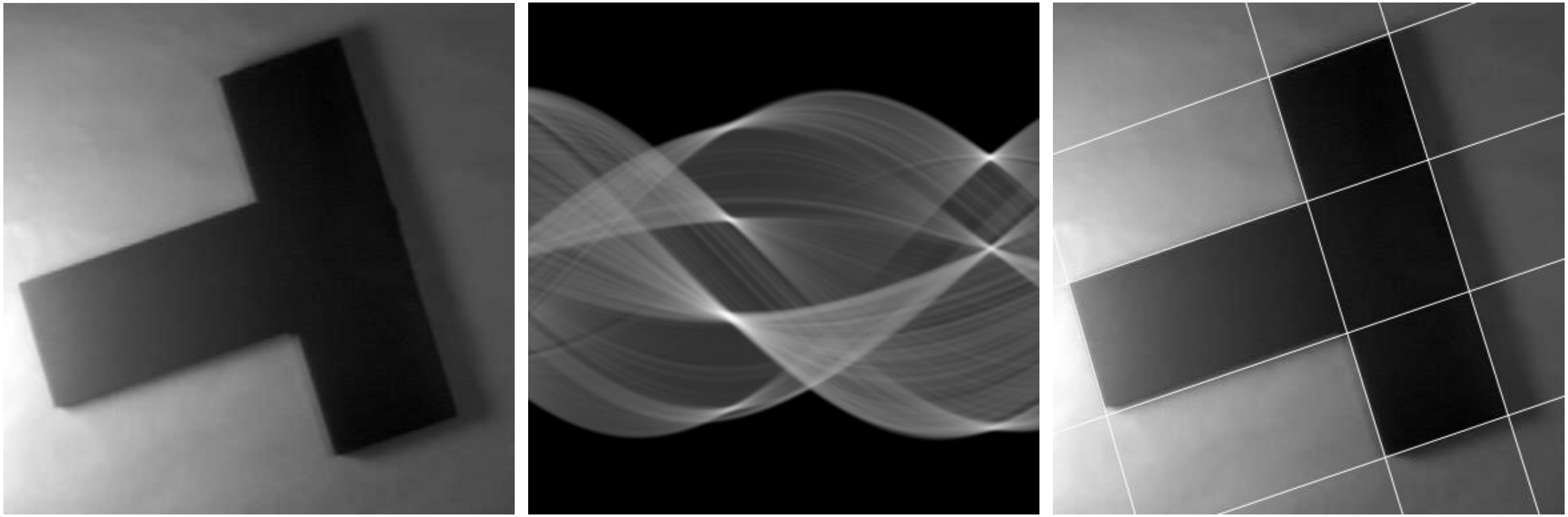
$$-\pi \leq \theta \leq \pi$$
$$-\sqrt{2} \leq \rho \leq \sqrt{2}$$

Image size normalized to 2 by 2

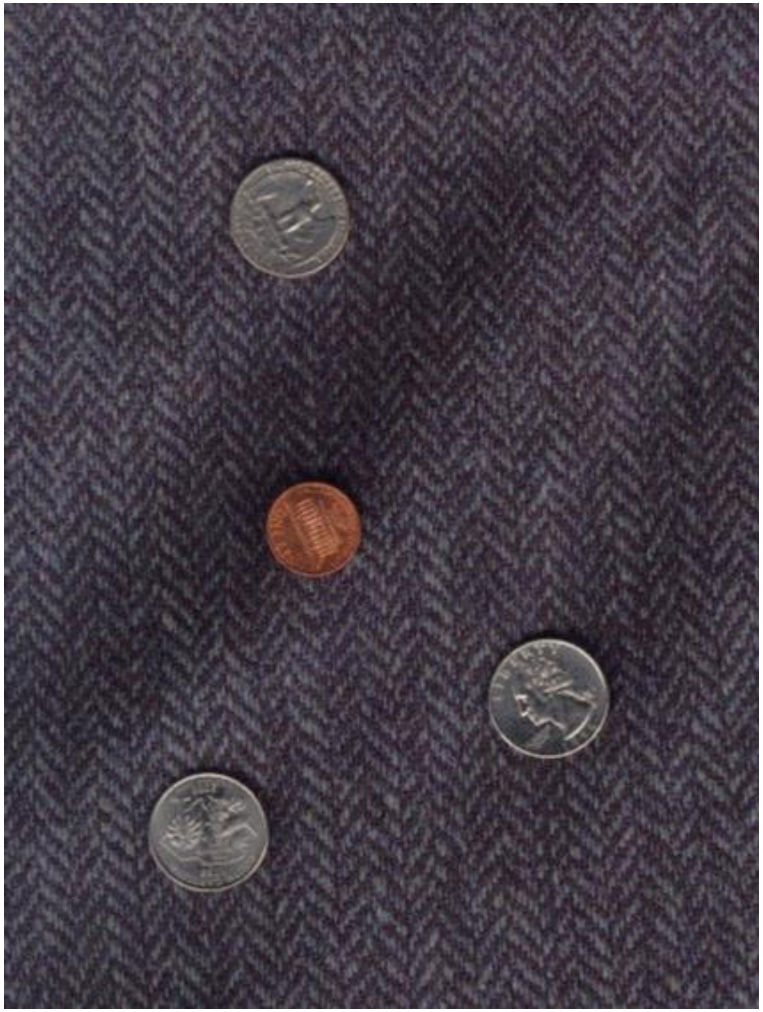
Given points (x_i, y_i) find (ρ, θ)



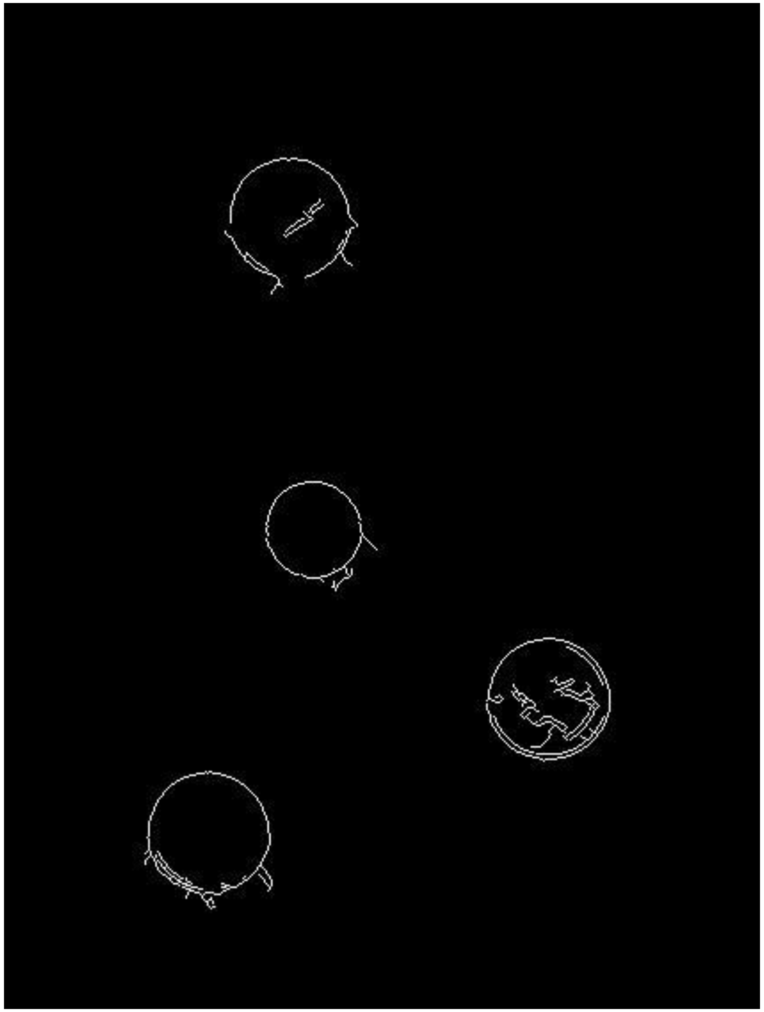
Example



Detection of Circles by Hough Transform

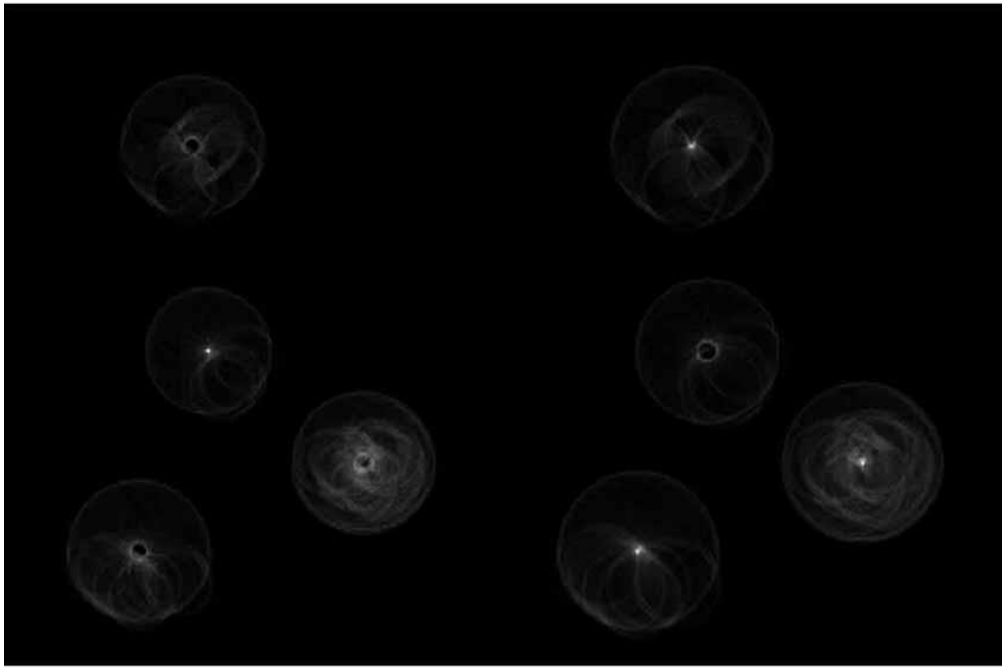


Original Image

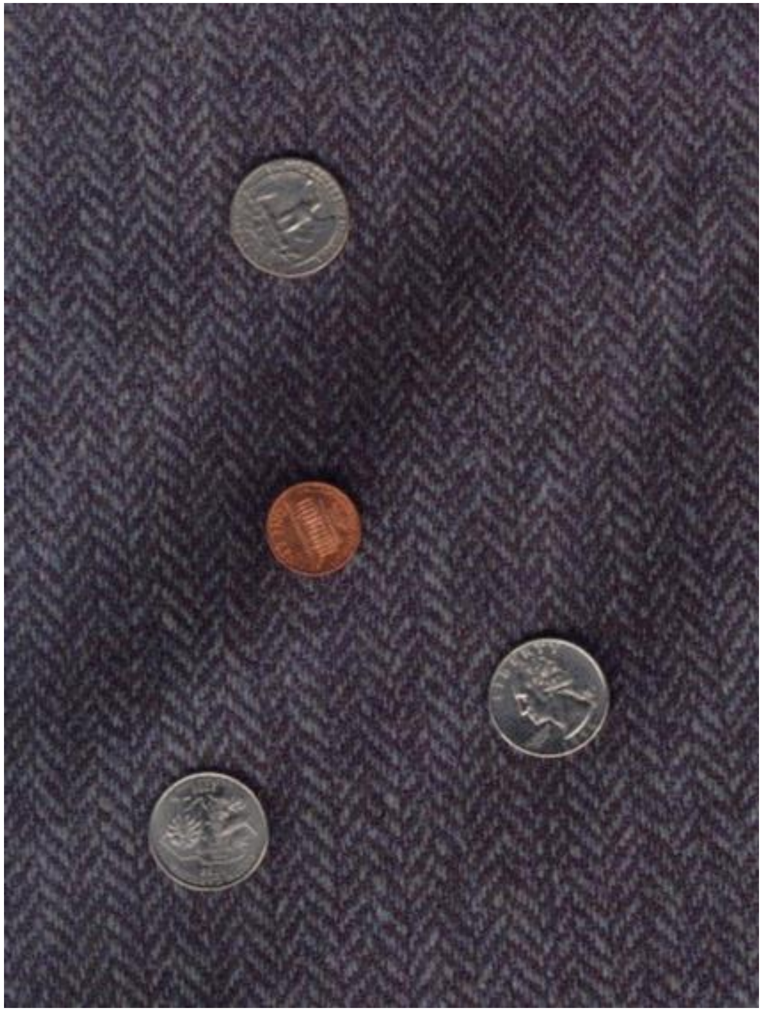


Edge Points

Detection of Circles by Hough Transform



Hough Space



Detected Circles

Reference

- Szeliski
  Section 4.3.2, Hough Transform