Edge-based Image Segmentation

基于边缘检测的图像分割

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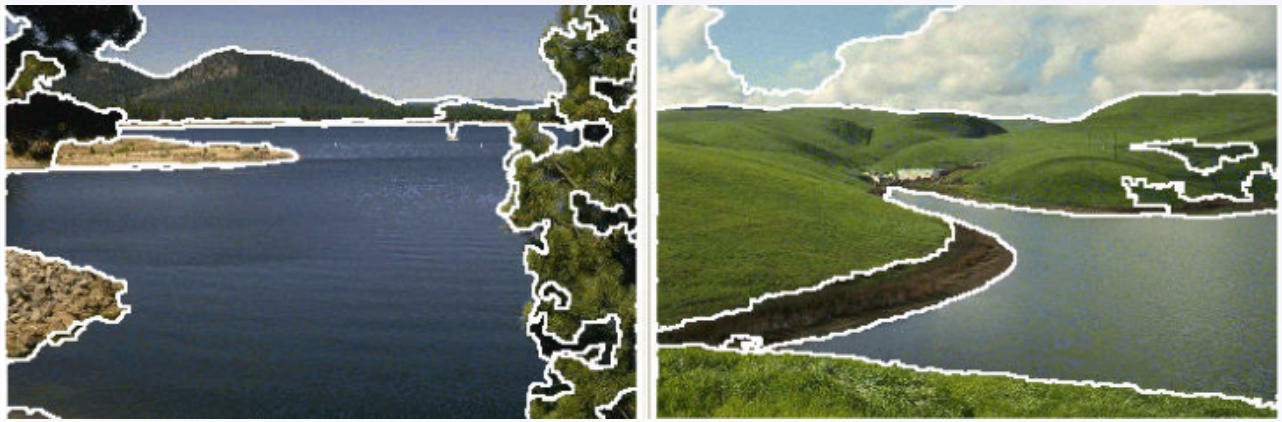
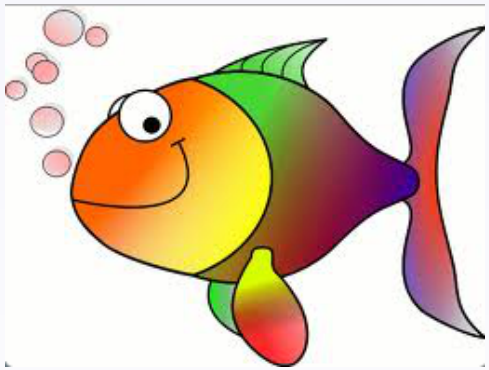
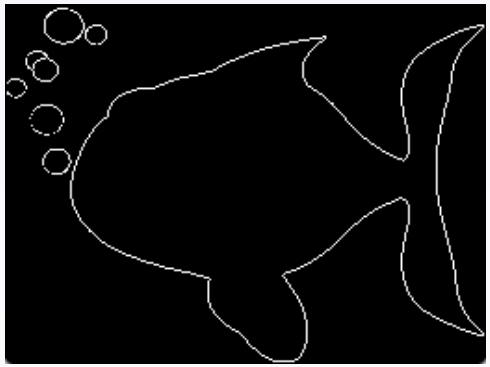
Contents

What?



Edge & Boundary



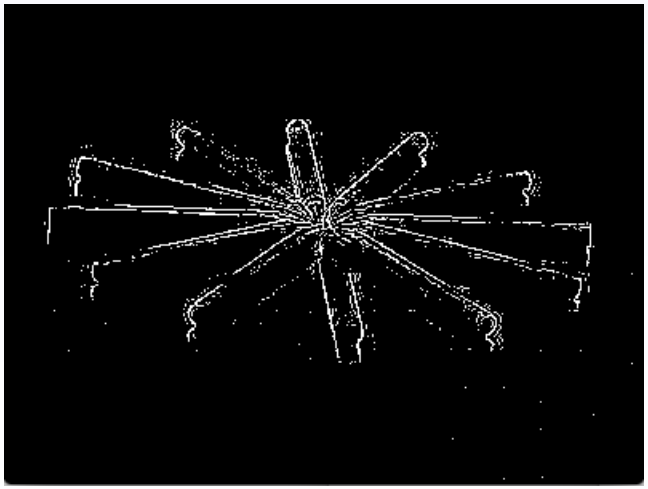


The edge of object may be not a boundary, the boundary may also be not edge.

Problems

Edge detection is a simple and fast technique used in segmentation methods. However, there also are some problems:

- Noise and background affect the accurate of edge detection.
- Edges are the sign of lack of continuity, and ending.



Steps in Edge Detection

1. Filtering: Filtering to reduce noise results in a loss of edge strength.
2. Enhancement: In order to facilitate the detection of edges, it is essential to determine changes in intensity in the neighborhood of a point.
3. Detection: Find the zero crossing and peak value to detect edge.

Problems

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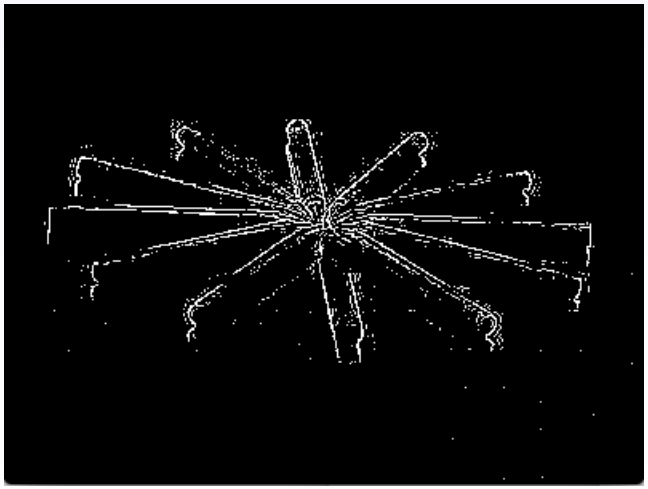
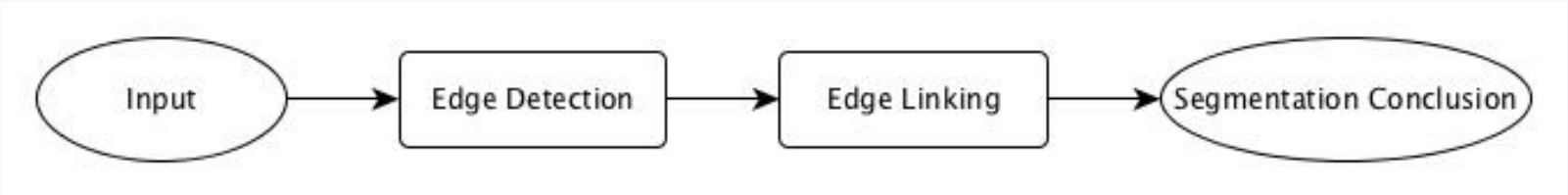


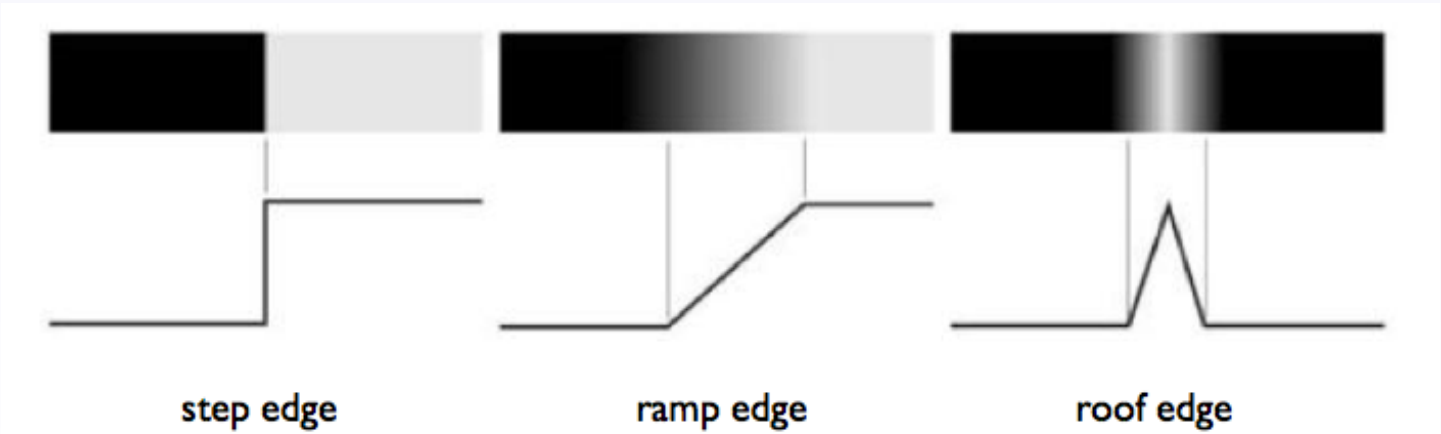
Step in Image Segmentation



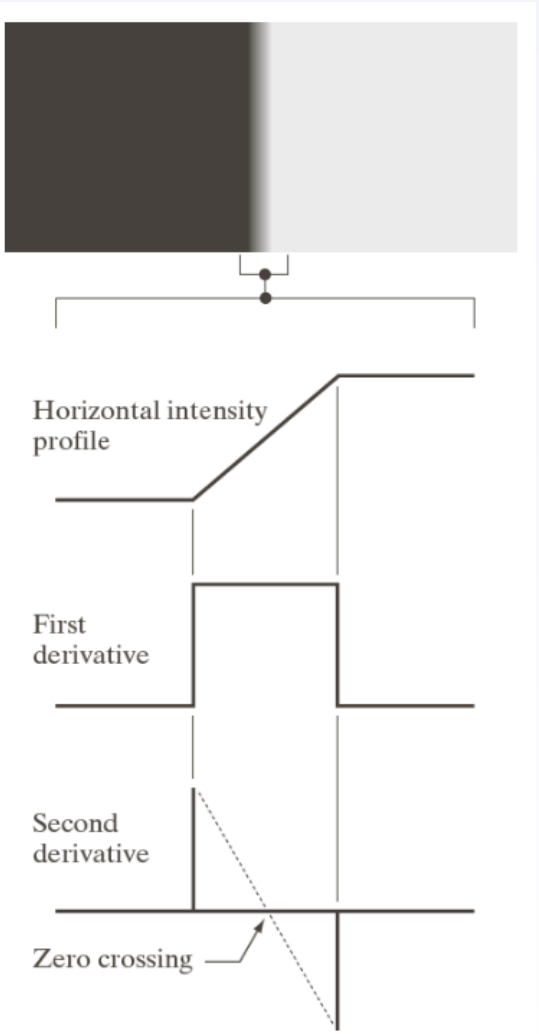
Edge Detection

Three edge types and definitions:

- Step edge
- Ramp edge
- Roof edge



Edge Detection



Edge Detection Techniques[1]

- Roberts Edge Detection
- Sobel Edge Detection
- Prewitt Edge Detection
- Kirsch Edge Detection
- Marr-Hildreth Edge Detection (LoG)
- Canny Edge Detection

[1] Muthukrishnan.R *et al.*, "Edge Detection Techniques For Image Segmentation", IJCSIT, 2011.

Edge Detection Techniques

- Roberts Edge Detection

-1	0
0	+1

0	-1
+1	0

- Sobel Edge Detection

-1	-2	-1
0	0	0
+1	+2	+1

-1	0	-1
-2	0	+2
-1	0	+1

- Prewitt Edge Detection

-1	-1	-1
0	0	0
+1	+1	+1

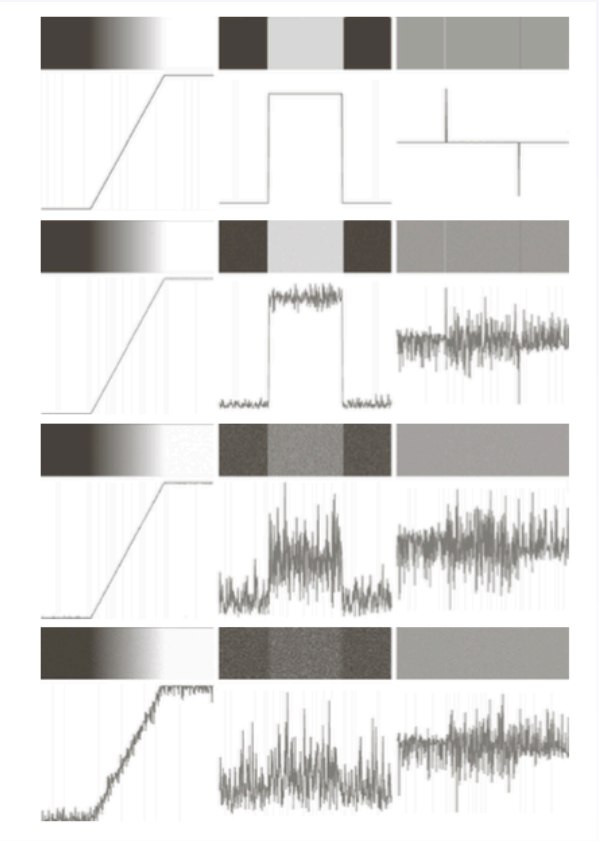
-1	0	+1
-1	0	+1
-1	0	+1

Marr-Hildreth Edge Detection (LoG)

This method combines Gaussian filtering with the Laplacian for edge detection.

How does it work?

- The edge points of an image can be detection by second derivation.
- However, the second derivation is very sensitive to noise. A Gaussian filer is used to swipe away noise from the image.



Canny Edge Detection

Canny is the best edge detection detector.

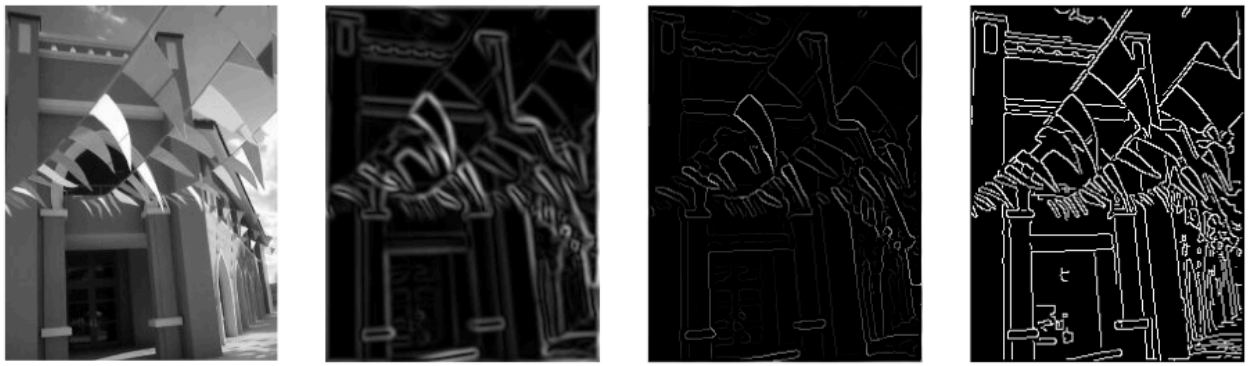
Three basic objectives:

- Low error rate
- Edge points should be well localized

Canny Edge Detection

Canny algorithm:

- Smooth image
- Compute gradient
- Non-maxima suppression
- Double thresholding



Canny Edge Detection

Non-maxima suppression (NMS)

- Problem: Edges generated using gradient typically contain wide ridges around local maxima.
- Use non-maxima suppression to thin those ridges to find thin edges corresponding to local maxima.

Canny Edge Detection

Double thresholding

- Problem: The received image may still contain false edge points.

Edge Linking

- Edge Tracking
- Curve Fitting
- Hough Transform
- Dynamic Programming

...

Edge Tracking

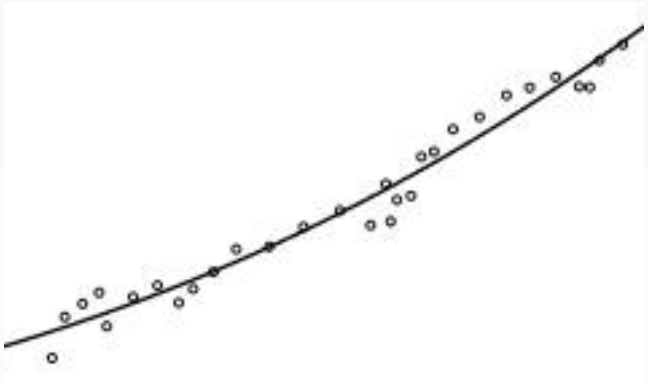
Each point is linked to the adjacent if magnitude and direction of the gradient are similar.

$e(x, y)$ is magnitude of the gradient, $\phi(x, y)$ is the direction of the gradient, if two each points meet the following conditions:

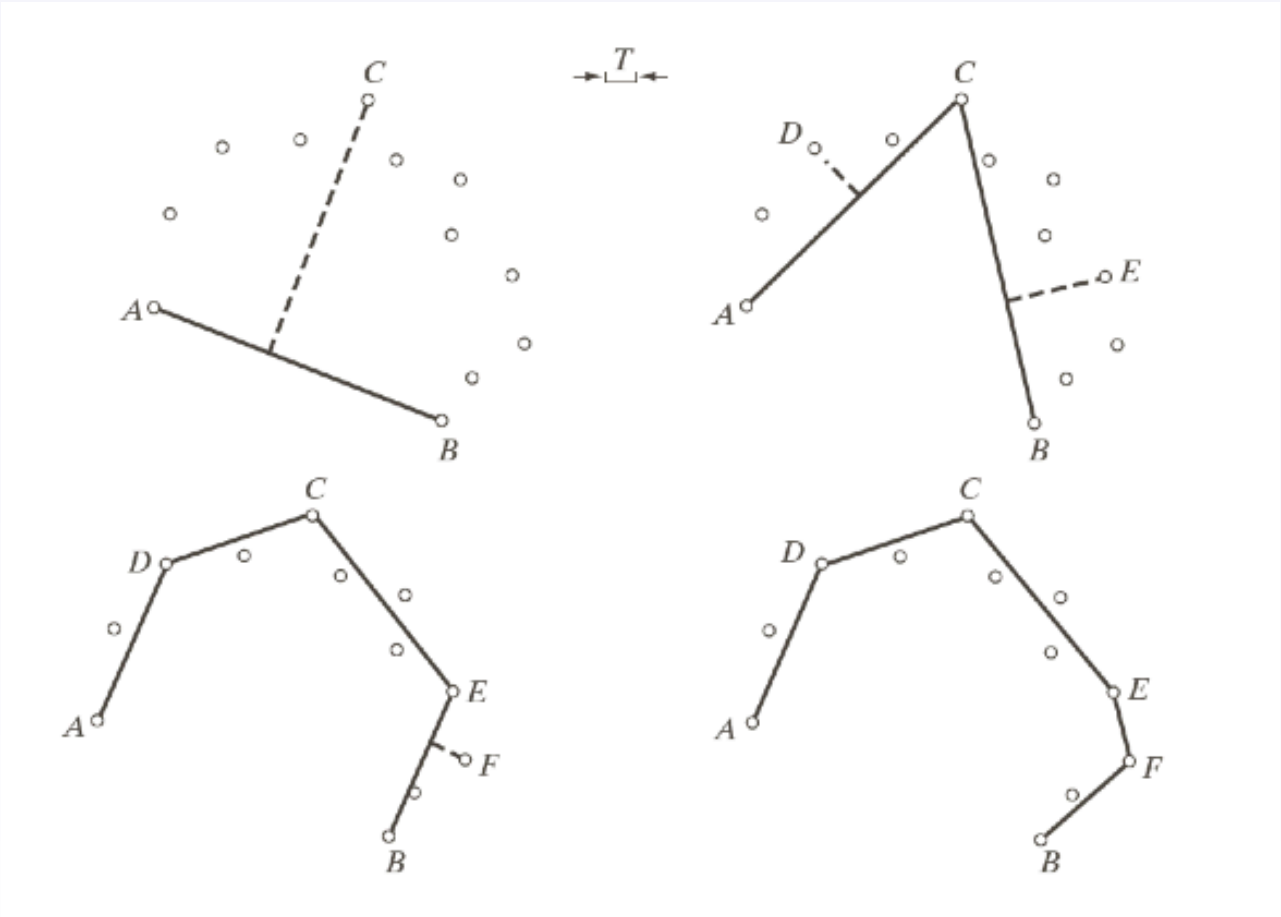
$$\begin{cases} \mid e(x_i, y_i) - e(x_j, y_j) \mid \leqslant E \\ \mid \phi(x_i, y_i) - \phi(x_j, y_j) \mid \leqslant A \\ \mid e(x_i, y_i) \mid, \mid e(x_j, y_j) \mid > E \end{cases}$$

Curve Fitting

Starting from a set of edge points, segments of a polygonal line are iteratively added until all the points are close enough to a segment.

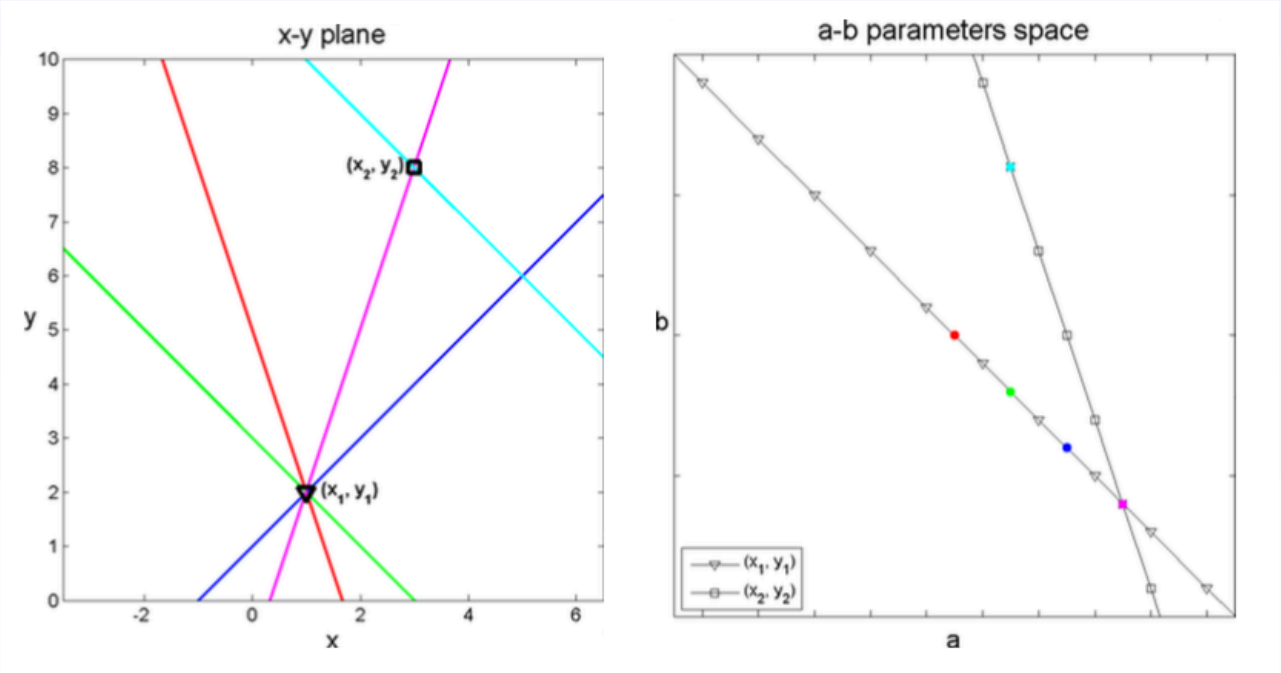


Polygon Fitting

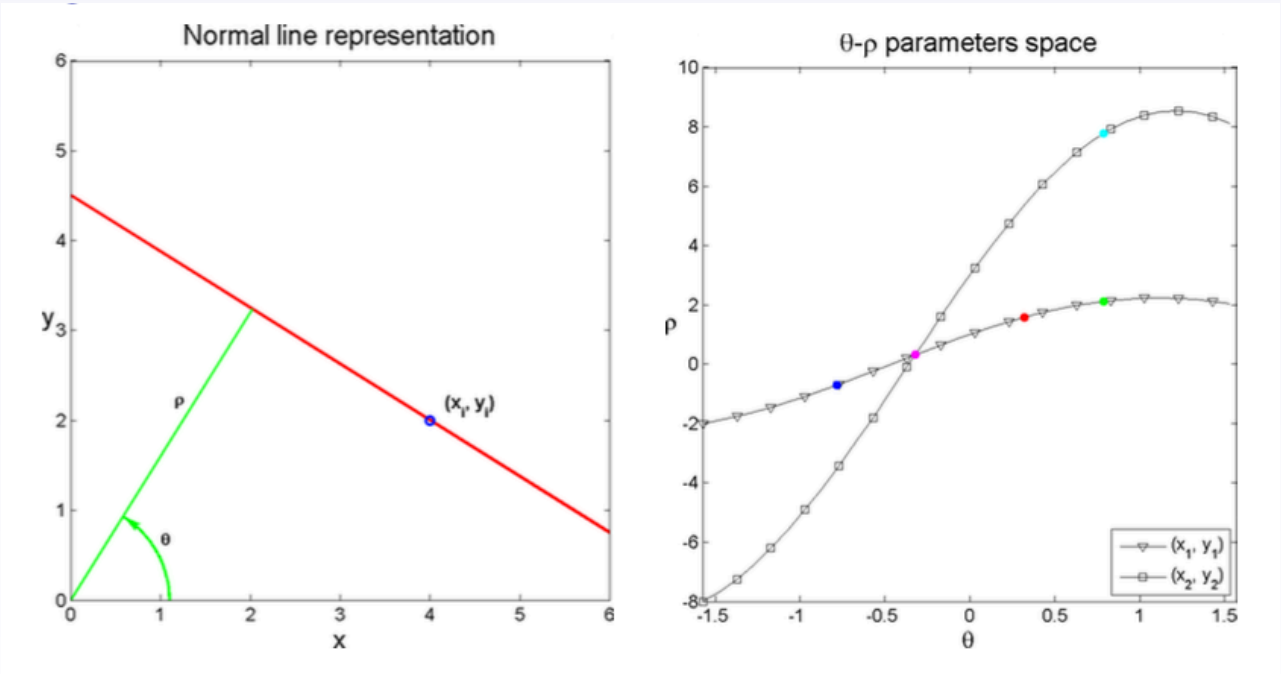


Hough Transform

Find the most probable lines.



Hough Transform



Thanks