Computer Vision Module – Session 10

Computer Vision

Dr. Sunita Dhavale, DIAT

Online Training & Certification Course on Artificial Intelligence & Machine Learning
Defence Institute of Advanced Technology (DU), Pune.

Computer Vision

Dr Sunita Dhavale

Hough Transform

Online Training & Certification Course on AI & ML
Defence Institute of Advanced Technology (DU), Pune.

Outline of Presentation

- Introduction
- Algorithm Details
- Recap – previous all sessions

Introduction

- Missing edge continuity, many spurious edges
- identification of lines in the image, positions of arbitrary shapes like circles or ellipses.
- invented by Richard Duda and Peter Hart in 1972
- straight line $y = mx + b$
- Edges VOTE for the possible model

Image and Parameter Spaces

Equation of Line: $y = mx + c$

Find: (m, c)

Consider point: (x_i, y_i)

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

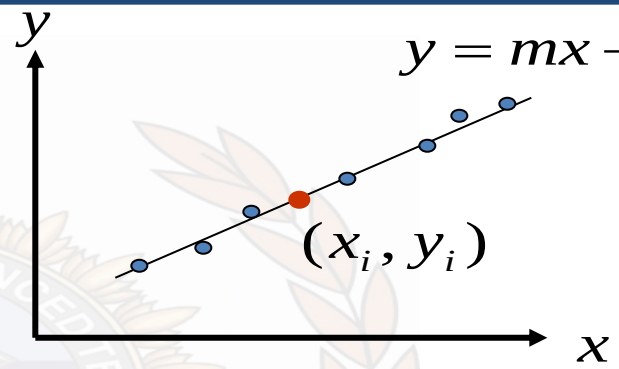
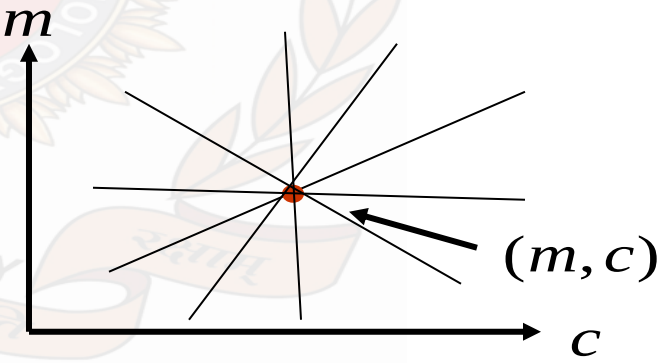


Image Space

Parameter space also called Hough Space



Parameter Space

Line Detection by Hough Transform

Algorithm:

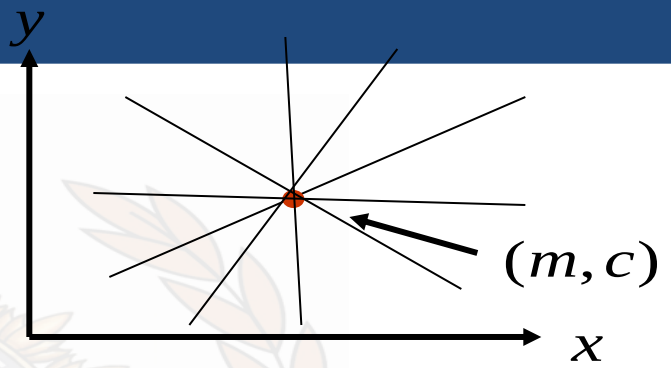
- Quantize Parameter Space (m, c)
- Create Accumulator Array $A(m, c)$
- Set $A(m, c) = 0 \quad \forall m, c$
- For each image edge (x_i, y_i) increment:

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

- If (m, c) lies on the line:

$$c = -x_i m + y_i$$

- Find local maxima in $A(m, c)$

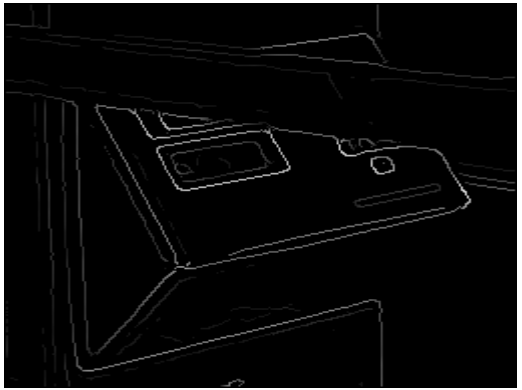


Parameter Space $A(m, c)$

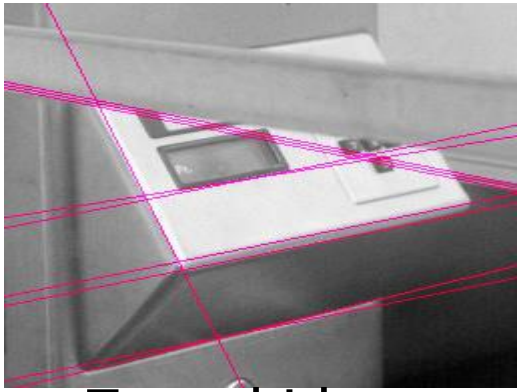
	1						1		
		1				1			
			1		1				
				2					
			1		1				
		1				1			
	1						1		

Example

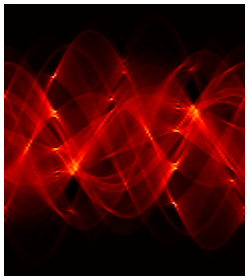
Original



Edge Detection



Found Lines



Parameter Space

Hough transform algorithm

- Typically use a different parameterization

$$d = x\cos\theta + y\sin\theta$$

  - d is the perpendicular distance from the line to the origin
  - θ is the angle this perpendicular makes with the x axis
  - Why?

Hough transform algorithm

- Typically use a different parameterization $d = xcos\theta + ysin\theta$
  - d is the perpendicular distance from the line to the origin
  - θ is the angle this perpendicular makes with the x axis
- Basic Hough transform algorithm
  1. Initialize H[d, θ]=0
  2. for each edge point I[x,y] in the image
     for θ = 0 to 180
     $d = xcos\theta + ysin\theta$
     H[d, θ] += 1
  3. Find the value(s) of (d, θ) where H[d, θ] is maximum
  4. The detected line in the image is given by $d = xcos\theta + ysin\theta$
- What's the running time (measured in # votes)?

Step 2 Extension: Use the image gradient and give more votes for stronger edges

for each edge point I[x,y] in the image

compute unique (d, θ) based on image gradient at (x,y)

H[d, θ] += 1

Finding Circles by Hough Transform

Equation of Circle: $(x_i - a)^2 + (y_i - b)^2 = r^2$

If radius is known: (2D Hough Space)

Accumulator Array $A(a, b)$

If radius is not known: 3D Hough Space!

Use Accumulator array

Recap

Part I (10 Hrs)	Part II (10 Hrs)
Introduction to Image processing techniques Images, Noise, Convolution, Filtering Thresholding techniques, Image segmentation Edge Detection techniques Interest Point Detection, Harris Corner Detector SIFT, Histograms of Oriented Gradients Binary shape analysis, connectedness, object labeling and counting Boundary tracking procedures, active contours Boundary descriptors, chain codes, Fourier descriptors, region descriptors, moments Hough Transform	Optical Flow, Motion Models, Global Motion KLT Tracking, Mean-Shift Tracking Deep Sort Camera Model and Calibration Fundamental Matrix, Stereo Images 3 D Image processing Deep learning for Chest X-ray Image analysis Face Recognition based on video Human activity detection based on video Audio/speech, based personality detection/prediction

Reference Material

- 1. E. R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
- 2. R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
- 3. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012.
- 4. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
- 5. Sunita Dhavale, “Advanced Image-Based Spam Detection and Filtering Techniques”, Book Published by CyberTech: An Imprint of MKP Technologies, Hershey, PA, USA IGI Global, March 2017, ISBN13: 9781683180135|ISBN10: 1683180135|EISBN13: 9781683180142|DOI: 10.4018/978-1-68318-013-5.

<<Epilogue>>

- We will meet in next scheduled lecture.
- Try to implement the code using python.
- Feel free to ask your questions.
- Email: sunitadhavale@diat.ac.in

Thank You!