Hough Transform

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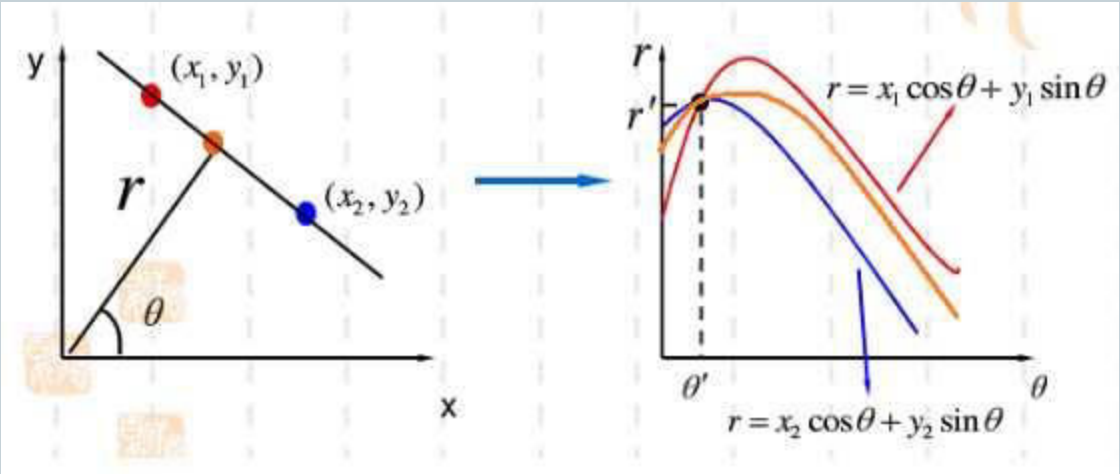
HOUGH TRANSFORM

- In image space,a line is plotted as x vs y and modeled as y=mx + c or xcosθ + ysinθ = ρ
- In parameter space or feature space a line is represented by a point “m” vs “b”
- Each line is represented as a single point with (m,b) co-ordinates or (ρ,θ) parameters



Parameter Space Representation

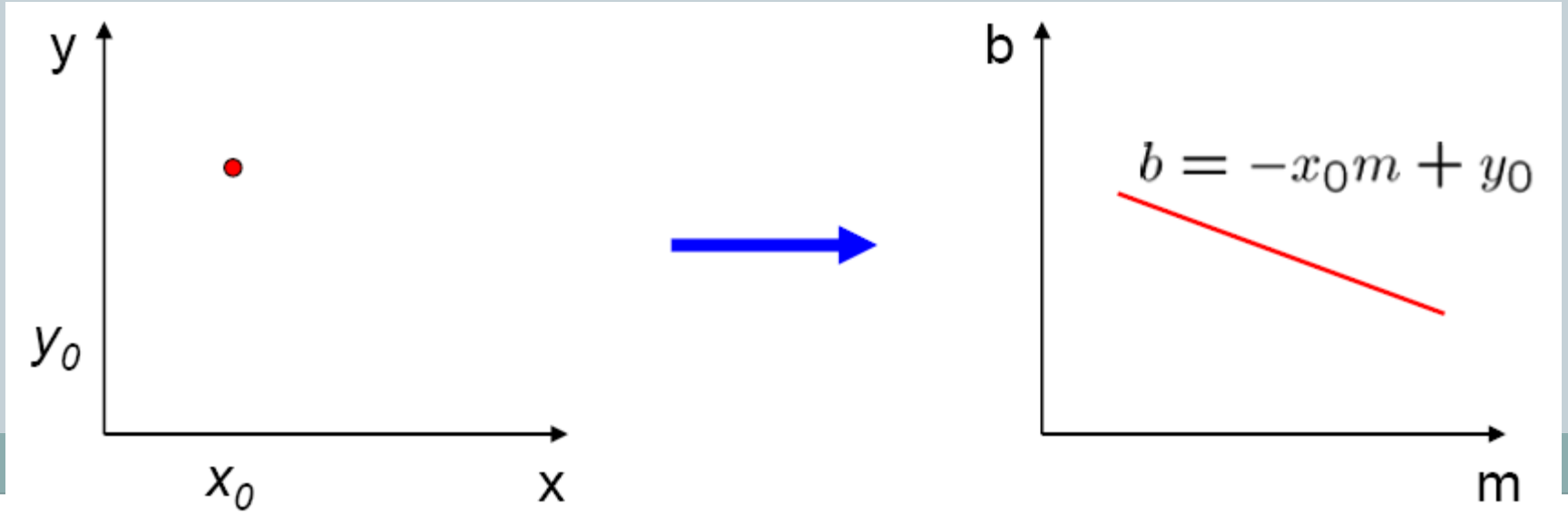
•What does a point (x_0, y_0) in the image space map to in the Hough space?

Answer: the solutions of $b = -x_0m + y_0$

This is a line in Hough space

Image space

Hough space



Parameter Space Representation

•Where is the line that contains both (x_0, y_0) and (x_1, y_1)?

It is the intersection of the lines $b = -x_0m + y_0$ and $b = -x_1m + y_1$

Image space

Hough space

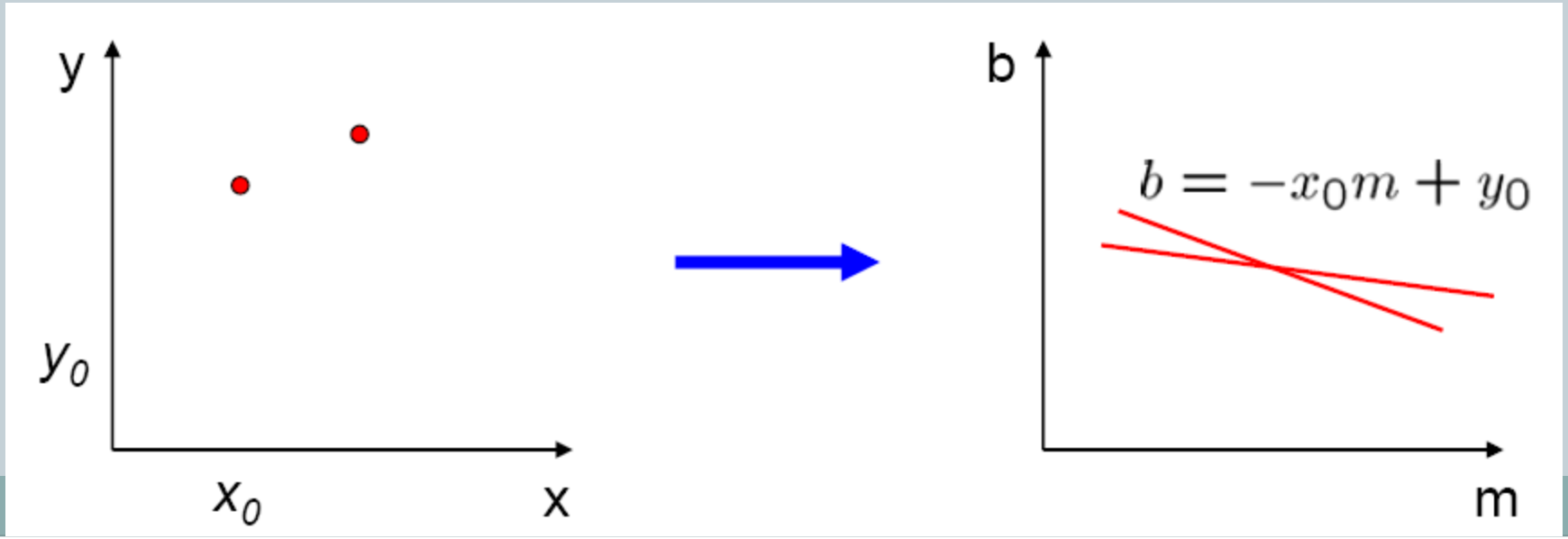


Image and Parameter Spaces

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

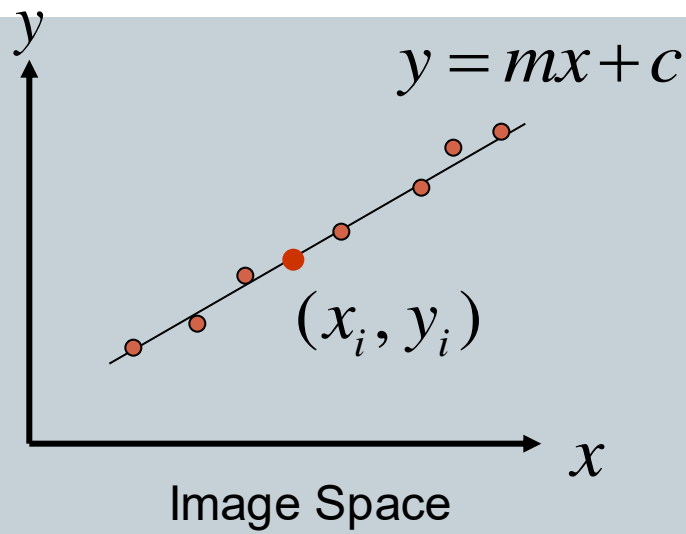
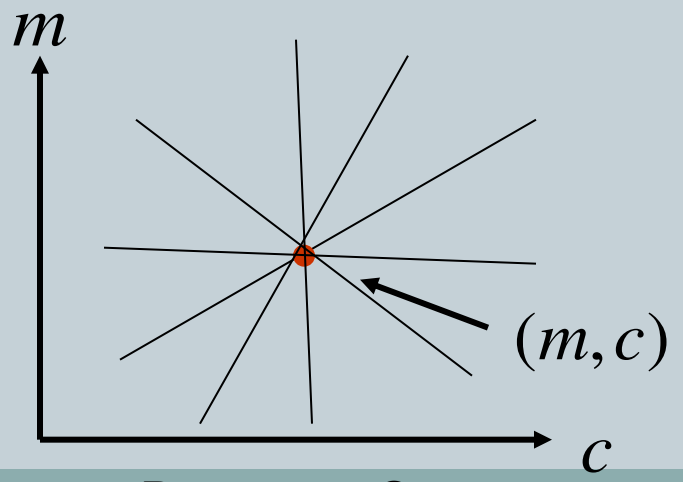


Image Space



Parameter Space

Little Knowledge ..

- It is invented by Paul Hough
- The hough transform was patented in 1962 with the name of “method and means for detecting complex pattern”,where the patent uses slope –intercept model for st. lines
- It is redefined by R.O Duda and P.E hart in 1972,which is known as Generalised Hough Transform which is used where a simple analytic description of feature is not possible
- Classical hough can locate reguler curves like s. lines,circles ,eclipse etc
- Image ->Edge Detection -> LHT -> (ρ,Θ) accumulater
- Hough space same as cartesian or polar system but instead of x axis ,it has angles in accumulator and as y axis it has the distance of line from origin.
- Each element of a matrix has a value equal to number of points that are positioned on line represented by quantized parameter

Line Detection by Hough Transform

Algorithm:

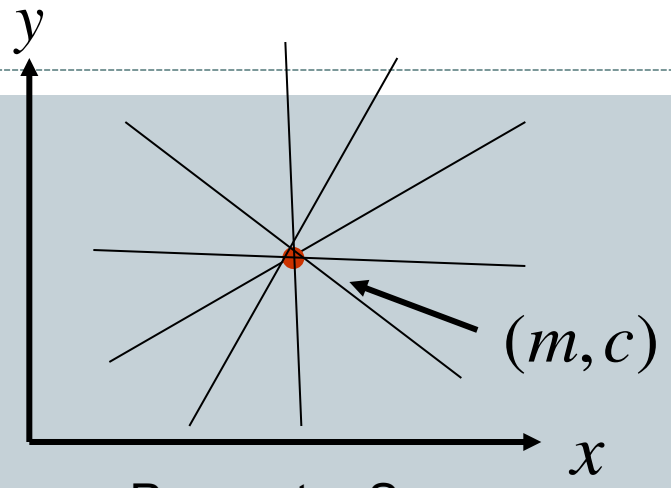
- Quantize Parameter Space (m, c)
- Create Accumulator Array $A(m, c)$
- Set $A(m, c) = 0 \quad \forall m, c$
- For each image edge (x_i, y_i) increment:

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

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

$$c = -x_i m + y_i$$

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



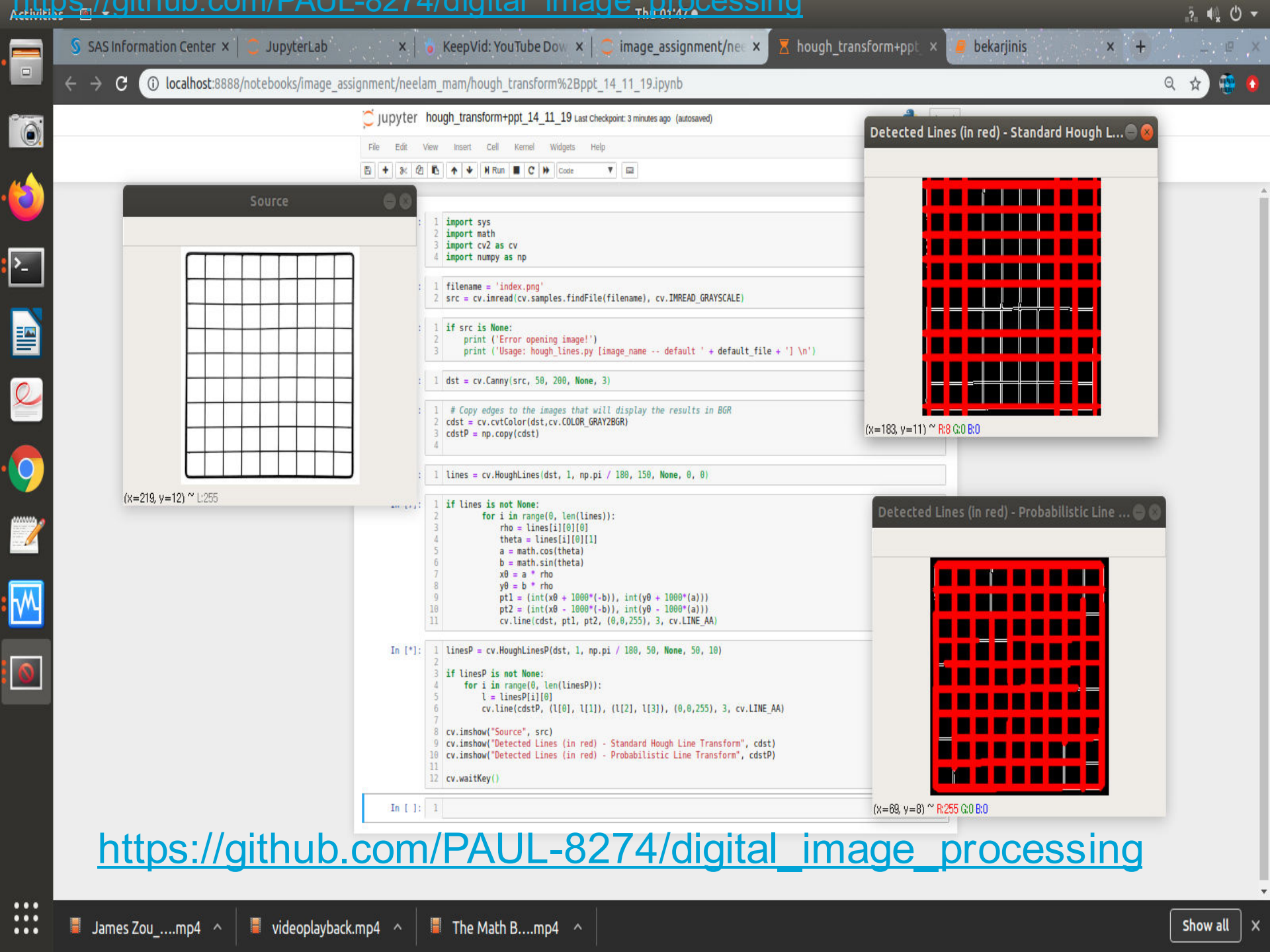
Parameter Space

$A(m, c)$

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

Algorithm for polar system

- Initialize accumulator H to all zeros
- For each edge point (x,y) in the image
  For $\theta = 0$ to 180
  $\rho = x \cos\theta + y \sin\theta$
  $H(\theta, \rho) = H(\theta, \rho) + 1$
  end
  end
- Find the value(s) of (θ, ρ) where $H(\theta, \rho)$ is a local maximum
  - The detected line in the image is given by
    $\rho = x \cos\theta + y \sin\theta$


https://github.com/PAUL-8274/digital_image_processing
SAS Information Center
JupyterLab
KeepVid: YouTube Dow
image_assignment/nee
hough_transform+ppt
bekarjinis
localhost:8888/notebooks/image_assignment/neelam_mam/hough_transform%2Bppt_14_11_19.ipynb
jupyter hough_transform+ppt_14_11_19 Last Checkpoint: 3 minutes ago (autosaved)
File Edit View Insert Cell Kernel Widgets Help
Source
(x=219, y=12) ~ L:255
Detected Lines (in red) - Standard Hough L...
(x=183, y=11) ~ R:8 G:0 B:0
Detected Lines (in red) - Probabilistic Line ...
(x=69, y=8) ~ R:255 G:0 B:0
https://github.com/PAUL-8274/digital_image_processing
James Zou_....mp4
videoplayback.mp4
The Math B....mp4
Show all

Advantages

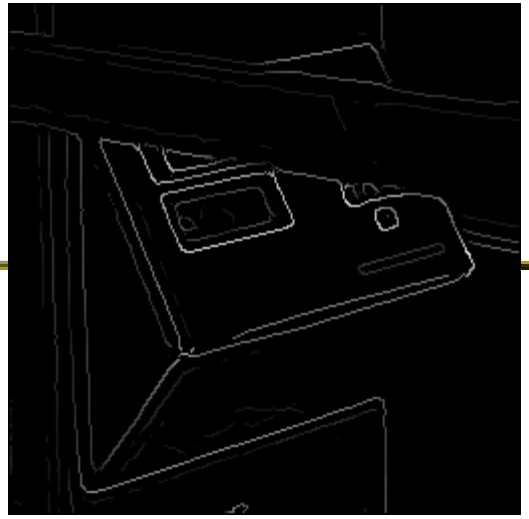
- Conceptually simple technique for object recognition
- Handled missing occluded data gracefully
- Can be adapted for many other forms
- Tolerent to noise and gap
- Robust to partial deformation of shape

Disadvantages

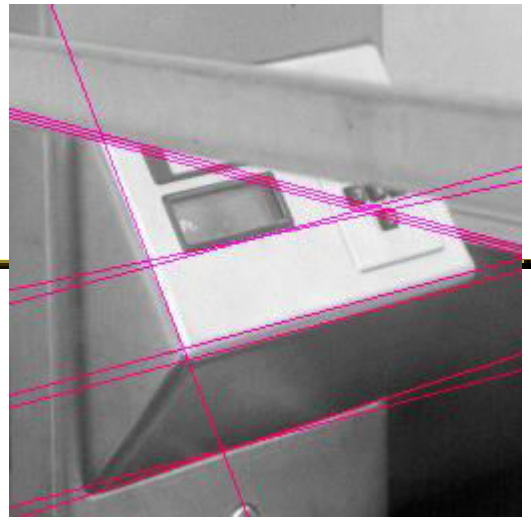
- Checks for only one type of objects
- Large storage space
- Lot of computation is required

Real World Example

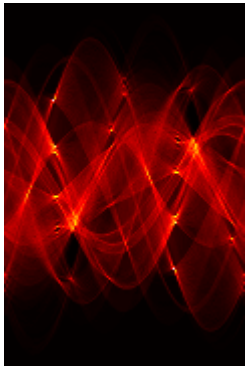
Original



Edge Detection



Found Lines



Parameter Space

References

- Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods