
Programmazione di Processori *MultiCore*: *Hough Transform*

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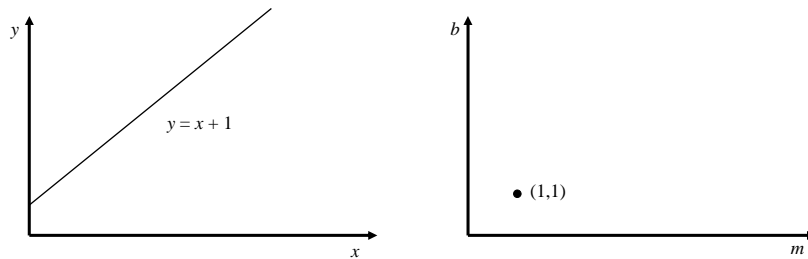


Hough Transform

- A technique to identify features in signals and images
- Basic ideas
 - You know the shape you are looking for
 - Shape can be represented via parameters
 - You build an histogram of all possible candidates in parameter space
 - And select the histogram peaks (i.e. voting)
- The concept is much simpler than it appears



Back to Linear Algebra

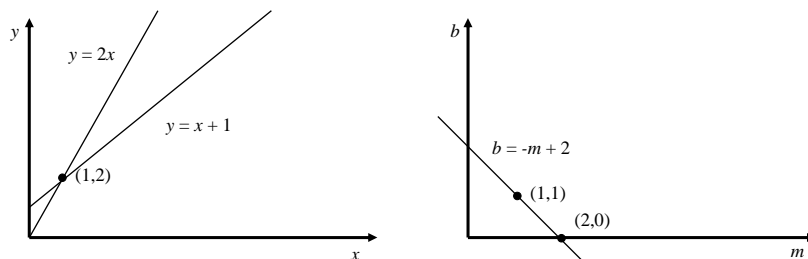


- A straight line in a 2D space:
 $y = mx + b$
- I.e. the point (m, b) in parameter space



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System of Two Linear Equations

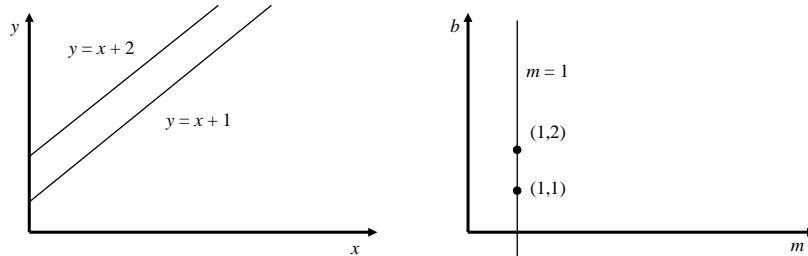


- Two straight lines map to two points
- And their intersection (x_0, y_0) maps to the line $b = -x_0m + y_0$
- Thus a line in parameter space represents all straight lines through a point



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A Linear System with no Solutions



- Two straight lines map to two points
- And if they are parallel, they have they are vertically aligned in parameter space



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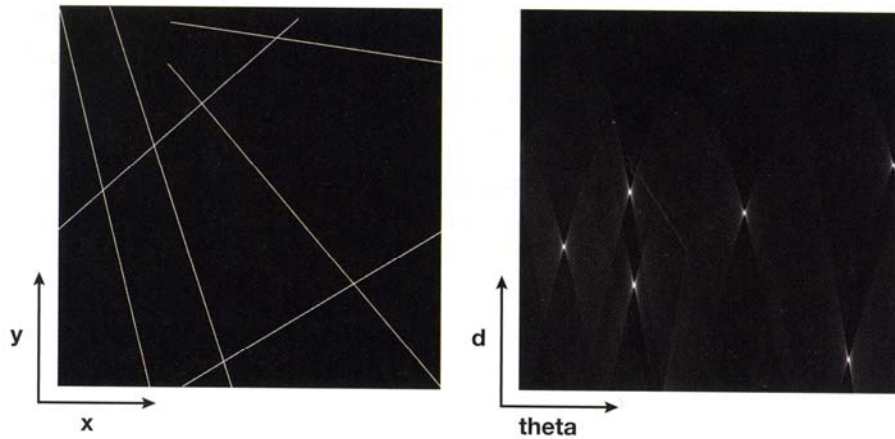
Line Detection using Hough Transform

- You have a B&W raster image and want to identify straight lines in it
 1. Take a zero-initialized array $h[B][M]$
 2. For each pixel (i, j) in original image
 1. If it's black, ignore it
 2. Otherwise, assume it is part of a line you don't know the parameters of
 3. And add 1 to all h elements "lying" on the line $b = -i*m + j$
 3. Look for the "brightest spots" in h ! Their coordinates are the parameters of the straight lines you are looking for
- Hints:
 - Use Bresenham line algorithm for step 2.3
 - Dimensions B and M depend on image resolution



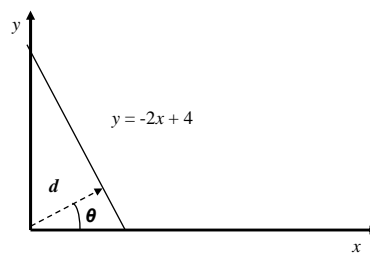
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Line Detection Example



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The Truth about d and θ



- Vertical lines have $m = \infty$
- And are annoying to cope with
- Thus it's more convenient to use the length d of shorter vector from the origin to the line, and its angle θ with the x axis
- And draw in parameter space the sinusoidal curve $d = x_0 \cos \theta + y_0 \sin \theta$ instead of a straight line...



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Generalizing the Hough Transform

- The Hough Transform is by no means limited to detecting straight lines, or straight lines intersections
- Could be used for any curve in original space, as long as you can parameterize it
- And could be used for region of space, instead of curves
- And this is its most common usage in signal analysis
- And it has a lot of parallelism to exploit

