Lecture 6: Edge Detection

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Line Detection

Intro to Hough transform

- Hough Transform: find the location of lines in images.
- Hough transform can detect lines, circles and other structures only if their parametric equation is known
- It can give robust detection under noise and partial occlusion

Prior to Hough Transform

- Assume that we have performed edge detection, for example, by thresholding the gradient magnitude image

Naive Line Detection

- For every pair of edge pixels: – Compute equation of line – Check if other pixels satisfy equation - Complexity: $O(N^2)$

Detecting lines using Hough transform

- First step: transform edge points into new space
- Consider an edge point of known coordinates (x_i, y_i), there are many potential lines passing through it.
- This family of lines have the form: $y_i = a * x_i + b$
- (x_i, y_i) are constants, while (a,b) can change. This gives rise to a new space where (a,b) are the variables
- a point (x_i, y_i) transforms into a line in the (a,b) space: $b = -a * x_i + y_i$
- Another edge point(x_2, y_2) will give rise to another line in the (a, b) space
- Colinear points in the (x,y) space transform into lines in the (a,b) space that intersec at a single point (a',b').
- We can detect lines by finding such intersection point (a',b') in the (a,b) space
- Our resulting line equation in the original space is $y = a' * x + b'$

- To find the intersection points in the (a,b) space: quantizing it into cells
- Instead of transforming a point to an explicit line, we vote on the discrete cells that are 'activated' by the transformed line in (a,b) (accumulator cells)
- Cells that receive more than a certain number of votes are assumed to corresponding to lines in (x,y) space
- For each (x,y) edge point:
– Vote on cells that satisfy the corresponding (a,b) line equation
- Find cells with more votes than threshold
- However, this cannot represent vertical lines as the slope parameter will be unbounded. Alternatively, we parameterize a line using $\theta \in [-\pi, \pi]$ and p $\in R$ as follows:

$$p = x \cdot \cos\theta + y \cdot \sin\theta$$