

Homework 2

Canny Edge Detector

Deadline: 6/5 11:59 pm

10 points

In second homework, you will work on canny edge detector algorithm. The algorithm consists of three parts. The gradient estimation, non-maximum suppression, and hysteresis thresholding.

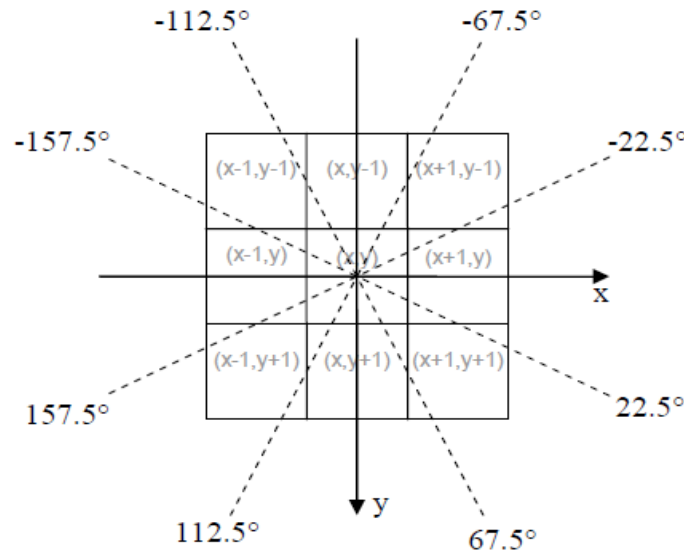
The first step is to calculate the gradient and smooth the image. The best way to do this is as below:

$$g_x = \frac{\partial}{\partial x} (I * G_{xy}) = I * \frac{\partial}{\partial x} (G_{xy}) = I * \frac{\partial}{\partial x} (G_x * G_y) = I * \frac{\partial}{\partial x} (G_x) * G_y$$

We use the fact that Gaussian is separable. The same thing should be done to calculate the gradient in the y direction.

Based on the gradients calculated now compute the magnitude and orientation of the gradients:

$$g(x, y) = \sqrt{g_x(x, y)^2 + g_y(x, y)^2} \quad \theta(x, y) = \tan^{-1} \left[\frac{g_y(x, y)}{g_x(x, y)} \right]$$



In the process of non-maximum suppression, we need the pixels that are neighbors in the direction of the gradient. In that case, if any orientation is negative add 180 to it and use the table below:

<i>Theta Values</i>	<i>Direction</i>	<i>Pixels</i>
$\theta \leq 22.5^\circ$ or $\theta > 157.5^\circ$	$\theta = 0^\circ$	$(x-1, y)$ $(x+1, y)$
$22.5^\circ < \theta \leq 67.5^\circ$	$\theta = 45^\circ$	$(x-1, y-1)$ $(x+1, y+1)$
$67.5^\circ < \theta \leq 112.5^\circ$	$\theta = 90^\circ$	$(x-1, y+1)$ $(x+1, y-1)$
$112.5^\circ < \theta \leq 157.5^\circ$	$\theta = 135^\circ$	$(x, y+1)$ $(x, y-1)$

Now check every pixel. If the current pixel is smaller in magnitude, compare to any two pixels in the direction of the gradient then set the current pixel to zero otherwise keep the gradient magnitude.

The last step is hysteresis thresholding to remove weak edges. Choose a high and low threshold. Any gradient magnitude that is above the high threshold will be an edge and any lower that that will be ignored. Any gradient magnitude that is between the high and low threshold will be chosen if they are connected to a pixel with magnitude greater than the high threshold. A simple way is to check, starting from different corner of the image each time. (Better algorithm for this is connected component algorithm)

Reference: <https://cecas.clemson.edu/>

- 1) Choose at least three images for showing your result.
- 2) Apply different sigma and different thresholding (high-low) and discuss the results.
- 3) Include your code with comments in the report.
- 4) If you are using libraries that have canny edge detector compare your implementation of canny with the method and discuss the change.
- 5) Put your code and report in a zip file and upload it to the Brightspace.