Canny Edge Detector

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Introduction

- The main purpose of Canny edge detection is to reduce the amount of data in an image, while preserving the subcultural properties.
- Why Canny edge detection?
  1. Low probability of missing a genuine edge.
  2. Good locality.
  3. Single response for an edge.
  4. Low probability of false alarm.
- There are mainly four operations.
  1. Smoothen the image with Gaussian Filter.
  2. Compute the gradient magnitudes along x and y directions.
  3. Shrink the edges by applying Non-Maxima suppression to the gradient magnitudes.
  4. Detect the edges by double thresholding.

Smooth the image with Gaussian filter

Smoothing: A *Smoothing* operation is used to suppress the high frequency signal and enhance the low frequency signals.

- Smoothing is basically depends on the variance and size of the Gaussian mask.

$$G(X) = \frac{1}{\sqrt{2\pi}\sigma} \exp \frac{-(x^2 + y^2)}{2\sigma^2}$$

  where σ— Variance; (x, y)— image coordinate
- If σ is too small then noise can be treated as edges and if σ is too large there may be chances of losing actual edges.
- Smoothing is also depends on the size of Gaussian mask.

Smoothing result with different Sigma

(i) sigma= 0.13, window size = 3;

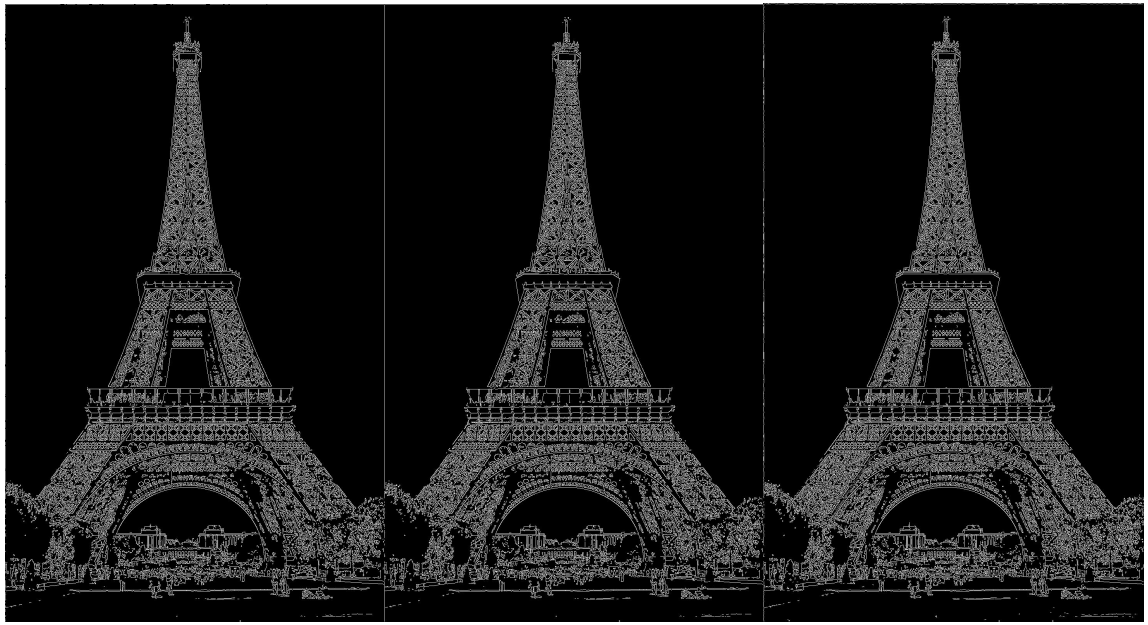
(i) sigma= 0.2, window size = 3

Smoothing result with different Sigma

(i) sigma= 0.45, window size = 3;

(i) sigma= 1.1, window size = 3;

Smoothing result with Different Mask Size



(i) window size = 7 X 7;
(ii) window size = 5 X 5;
(iii) window size = 3 x 3;

Compute the gradient magnitude

- Sobel operator is used to obtain 2-D spatial gradient.z

-1	0	+1
-2	0	+2
-1	0	+1

Table: Gy

+1	+2	+1
0	0	0
-1	-2	-1

Table: Gx

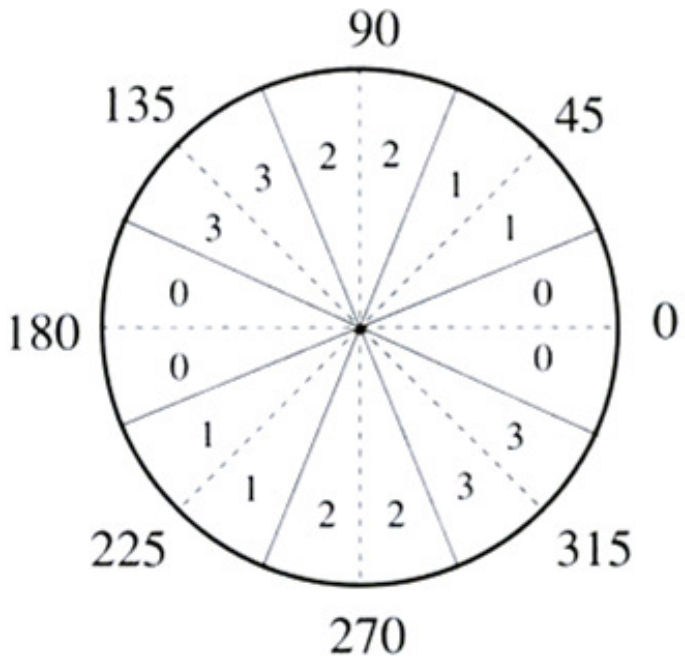
$$\theta = \arctan \frac{\frac{\partial \sigma}{\partial x}}{\frac{\partial \sigma}{\partial y}}$$

$$M = \sqrt{\frac{\partial \sigma}{\partial x}^2 + \frac{\partial \sigma}{\partial y}^2}$$

Thin edges by applying Non maxima supression to the gradient magnitude

Non maxima supression: To obtain one accurate reponse non maxima supression is used.

- Reduce angle of Gradient θ[i,j] to one of the 4 sectors.



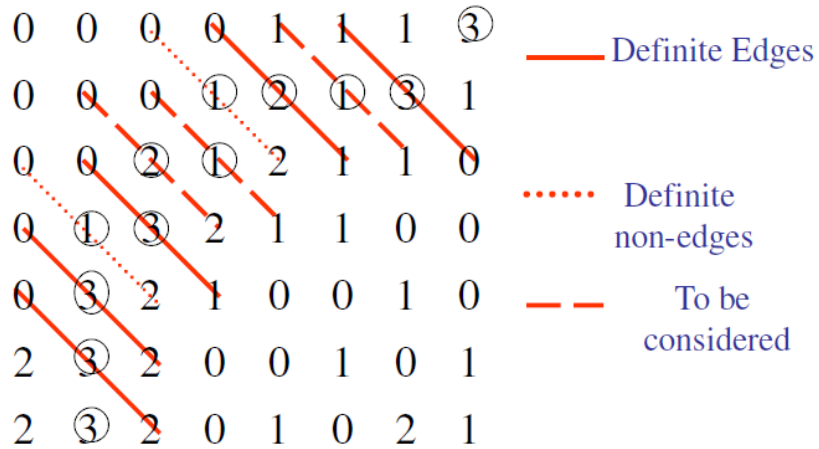
http://moodle.iitb.ac.in/enrol/index.php?id=6887

NMS

Sectors

- 0:337.5 to 22.5 or 157.5 to 202.5
- 1:22.5 to 67.5 or 202.5 to 247.5
- 2:67.5 to 112.5 or 247.5 to 292.5
- 3:112.5 to 157.5 or 292.5 to 337.5

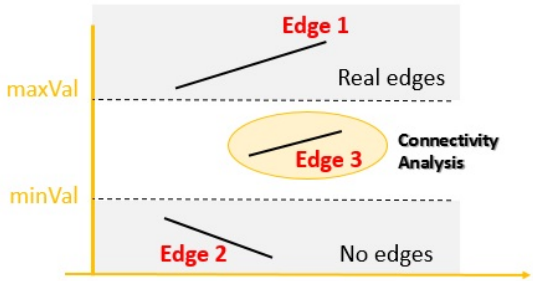
Local maxima in M[i,j] is to be find out by suppressing all values along the line of the Gradient that are not peak values of the ridge



http://moodle.iitb.ac.in/enrol/index.php?id=6887

Hysteresis Thresholding

Falls edges caused by noise and color variation can be reduces by applying two threshold.



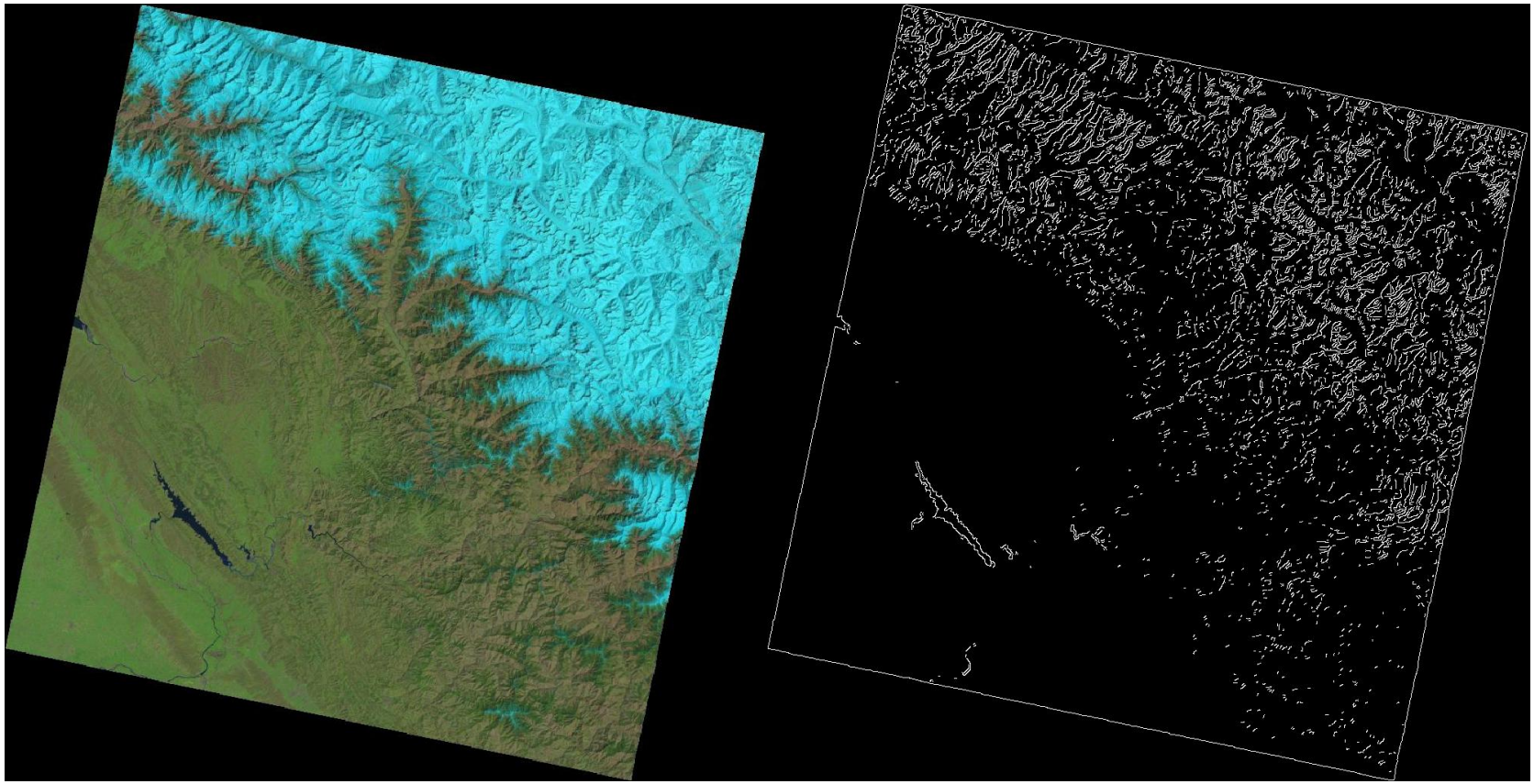
http://www.meccanismocomplesso.org/en/opencv-python-canny-edge-detection//

- If the gradient at a pixel is above 'High', declare it an 'edge pixel'
- If the gradient at a pixel is below 'Low', declare it a 'non edge pixel'
- If the gradient at a pixel is between 'Low' and 'High' then declare it an 'edge pixel' if and only if it is connected to an 'edge pixel' directly or via pixels between 'Low' and 'High'

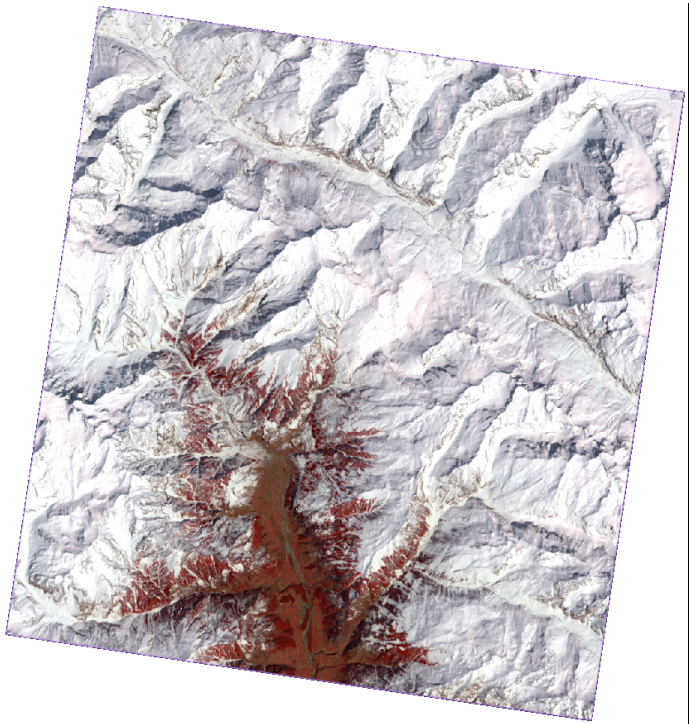
Thresholding results

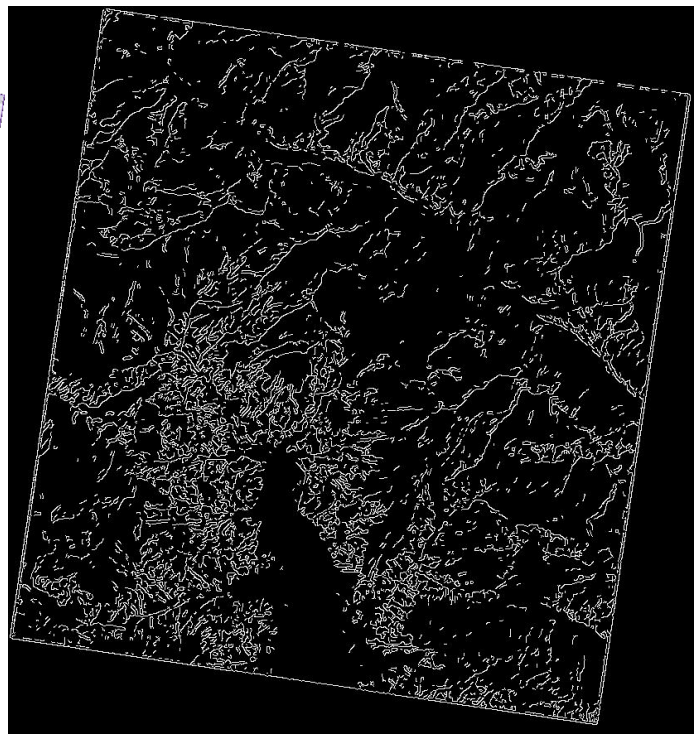
Figure: a)lower-0.026 higher-0.188 b)lower-0.026 higher-0.52

Results on sample Snow Images



Results on sample Snow Images





Improvements on Canny

- Instead of Normal Gaussian function adaptive Gaussian will give more better result as Smoothing is different for noise and real edge.
- 5X5 sobel filter will give more noise supression than 3 x 3 sobel filter (Might also loose important sharp edges though).

Thank You