ELEC 546 Assignment #3 Edge Detection

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1 Part 1

For canny edge detection algorithm, there are three performance criteria:

- Good detection
  There should be a low probability of failing to mark real edge points, and low probability of falsely marking nonedge points.

- Good localization
  The points marked as edge points by the operator should be as close as possible to the center of the true edge.

- Only one response to a single edge
  This is implicitly captured in the first criterion since when there are two responses to the same edge, one of them must be considered false.

What Canny did is to represent the three criteria in mathematical way. The process of the algorithm is listed below.

- Use a Gaussian filter to filter the input image in order to lower error rate.
- Compute the gradient of each pixels. Calculate the gradient magnitude and direction.
- According to the direction of gradient, use non maximum suppression to the magnitude of gradient.
- Use Hysteresis thresholding to threshold the pixels.

2 Part 2 Implementation

2.1 Noise Reduction

Here is the image after filtering

Figure 1: Filtered image

2.2 Gradient Magnitude and Angle

- Here is the image after D_x derivatives.

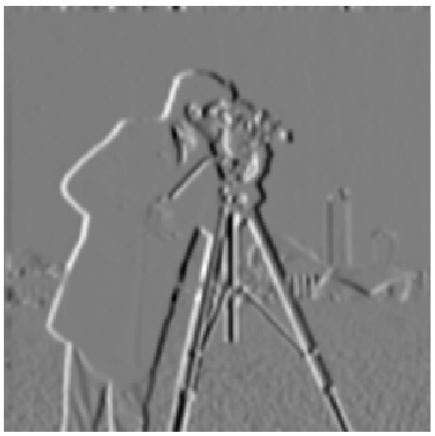


Figure 2: After D_x filter

- Here is the image after D_y derivatives.

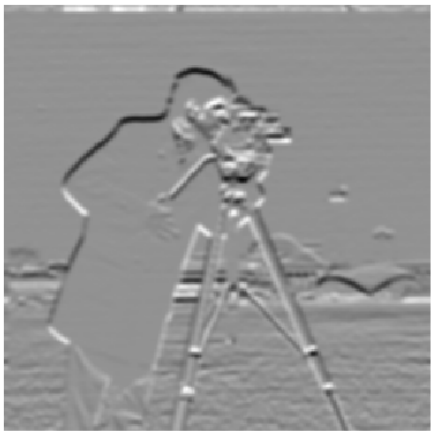


Figure 3: After D_y filter

2.3 Non-Maximum Suppression

Here is the image after non-maximum suppression.

Figure 4: Non maximum suppression

2.4 Hysteresis Thresholding

Here is the image after Hysteresis Thresholding.

Figure 5: Hysteresis Thresholding

Finally, the whole processing looks like below.

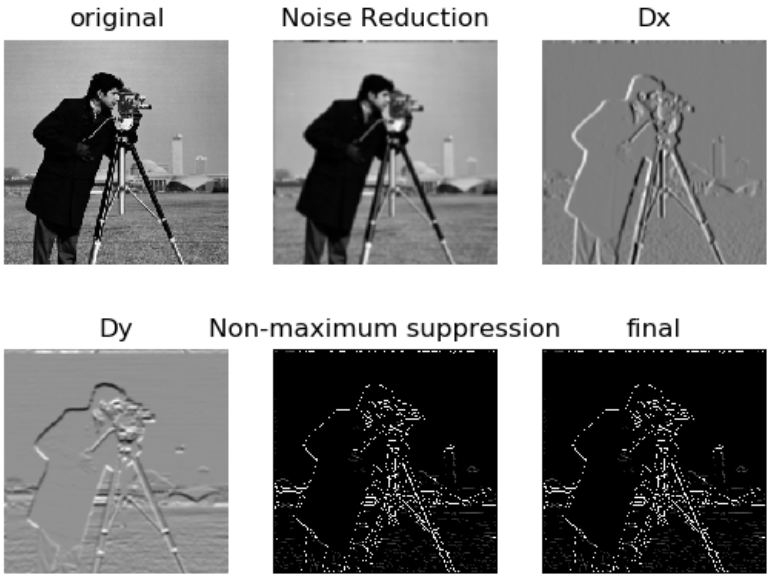


Figure 6: whole process

2.5 Compare with CV2 implementation

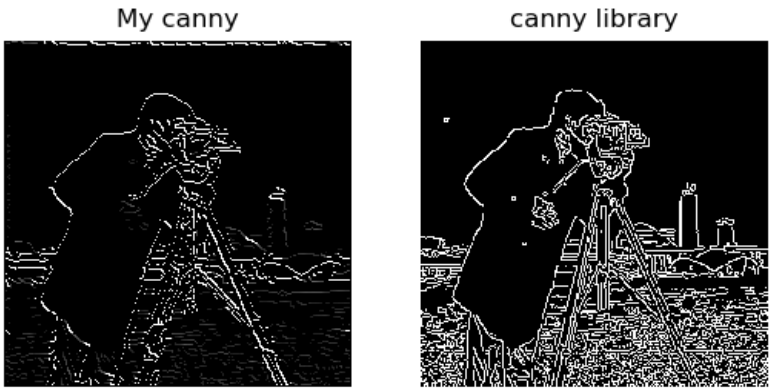


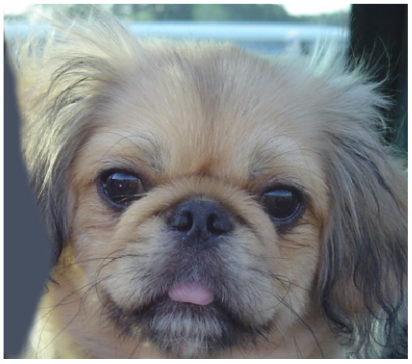
Figure 7: Compare

3 Hybrid Images

A hybrid image is an image that is perceived in one of two different ways, depending on viewing distance, based on the way humans process visual input. A hybrid image is obtained by combining two images, one filtered with a low-pass filter(G_1) and the second one filtered with a high pass filter($1 - G_2$).

$$H = I_1 \cdot G_1 + I_2 \cdot (1 - G_2)$$

I implemented hybrid image from a dog and a cat images shown below.



(a) Dog

(b) Cat

The hybrid image is shown below.

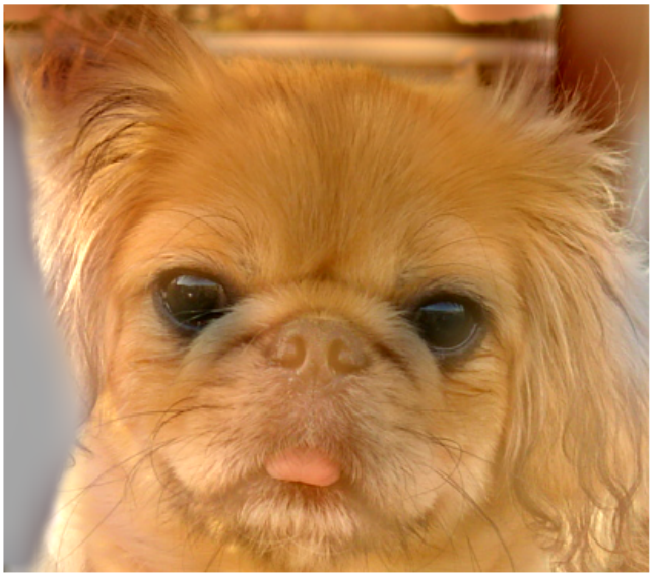


Figure 8: Hybrid image

Figure 9: By different distances for dog and cat

When you see the image in a short distance, it looks like a dog, but when you go farther away, it looks like

a cat. For hybrid image below Einstein and Marilyn, I choose a lower Gaussian sigma and the image is shown below.

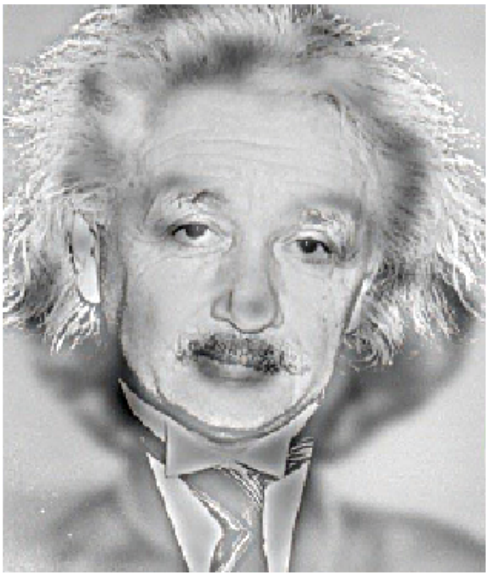


Figure 10: Hybrid image

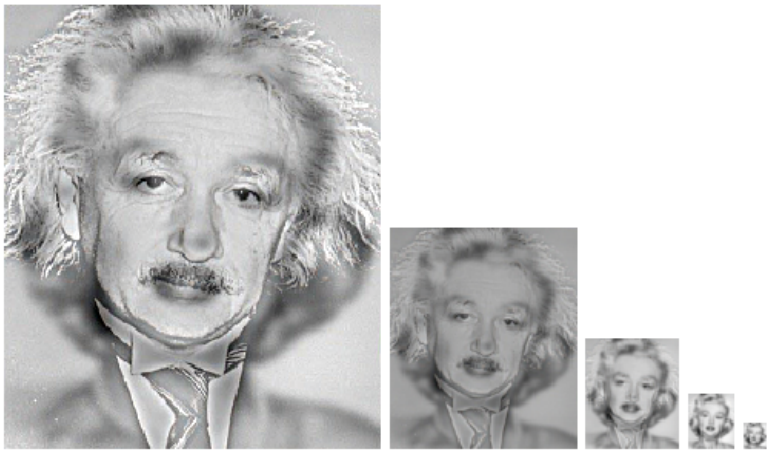


Figure 11: By different distances for Einstein and Marilyn

When you see the image in a short distance, it looks like Einstein, but when you go farther away, it looks like

Marilyn.
I found that this hybrid image algorithm is sensitive to the initial images which need to be similar or in a similar position, or the hybrid image will not have a good result.