

DIP Lab Assignment-18

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1 Introduction

Edge detection is a fundamental task in digital image processing used to identify object boundaries and structural information. In this project, I implemented the Canny Edge Detection (CED) algorithm in Python and analyzed:

- The effect of different Gaussian kernel sizes
- The effect of using Gaussian smoothing versus not using it

The Canny algorithm, proposed by John F. Canny in 1986, is widely regarded as one of the most optimal edge detection methods due to its ability to detect true edges while minimizing noise and false responses.

2 Canny Edge Detection Algorithm

The Canny Edge Detection algorithm consists of the following stages:

- Noise reduction using Gaussian smoothing
- Gradient computation (Sobel operators)
- Non-maximum suppression
- Double thresholding
- Edge tracking by hysteresis

Each stage plays an important role in achieving accurate and thin edges.

3 Effect of Different Gaussian Kernel Sizes

Gaussian smoothing removes noise before gradient calculation. I experimented with various kernel sizes:

- 3×3
- 5×5
- 7×7
- 9×9

3.1 Small Kernel (3×3)

- Minimal smoothing
- Preserves fine details
- More sensitive to noise
- Some false edges detected

Edges are sharper but noisy.

3.2 Medium Kernel (5×5)

- Balanced smoothing
- Noise reduced
- Edges remain clear
- Good compromise between detail and stability

Best visual result for most images.

3.3 Large Kernel (7×7 , 9×9)

- Strong smoothing
- Removes small details
- Thin structures disappear
- Edges become softer

Over-smoothing reduces edge precision.

4 Effect of Using vs Not Using Gaussian Smoothing

4.1 Without Gaussian Smoothing

When Gaussian blur was not applied before Canny:

- Many false edges appeared.
- Noise was detected as edges.
- Edge map was cluttered.

Reason: Gradient operators amplify noise.

4.2 With Gaussian Smoothing

When Gaussian blur was applied:

- Noise significantly reduced.
- Edges became continuous.
- Fewer false positives.
- More stable hysteresis thresholding.

Reason: Gaussian smoothing suppresses high-frequency noise before gradient computation.

5 Result

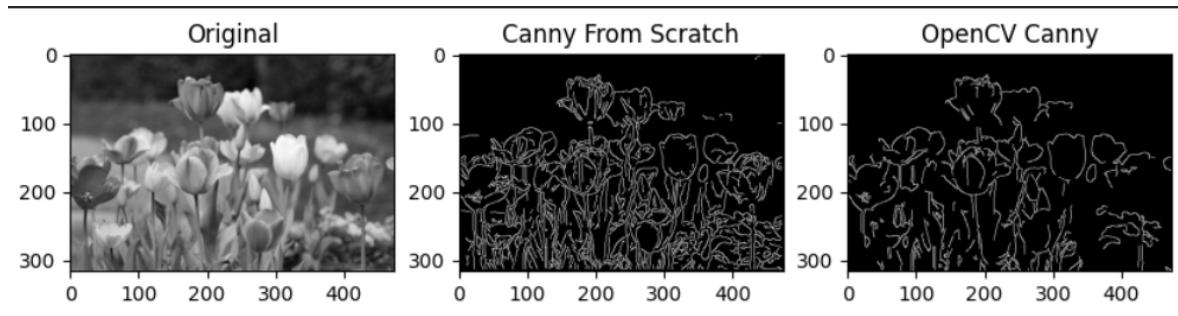


Figure 1: Canny Edge Detection

6 Code

https://github.com/Aziz-Ru/DIP_AI_DL/blob/main/dip/assignments/homework-20.ipynb