

Homework 08

Canny Edge Detection Algorithm

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Introduction

Edge detection is one of the most fundamental tasks in digital image processing and computer vision. It helps to identify the structural boundaries of objects in an image. Among different edge detection techniques, the **Canny Edge Detection Algorithm** is considered one of the most optimal because of its accuracy and robustness against noise. In this experiment, we applied Canny Edge Detection on a grayscale image using Python's OpenCV library and analyzed the results along with image histograms.

Methodology

The complete Python code used for this experiment is available at the following link:

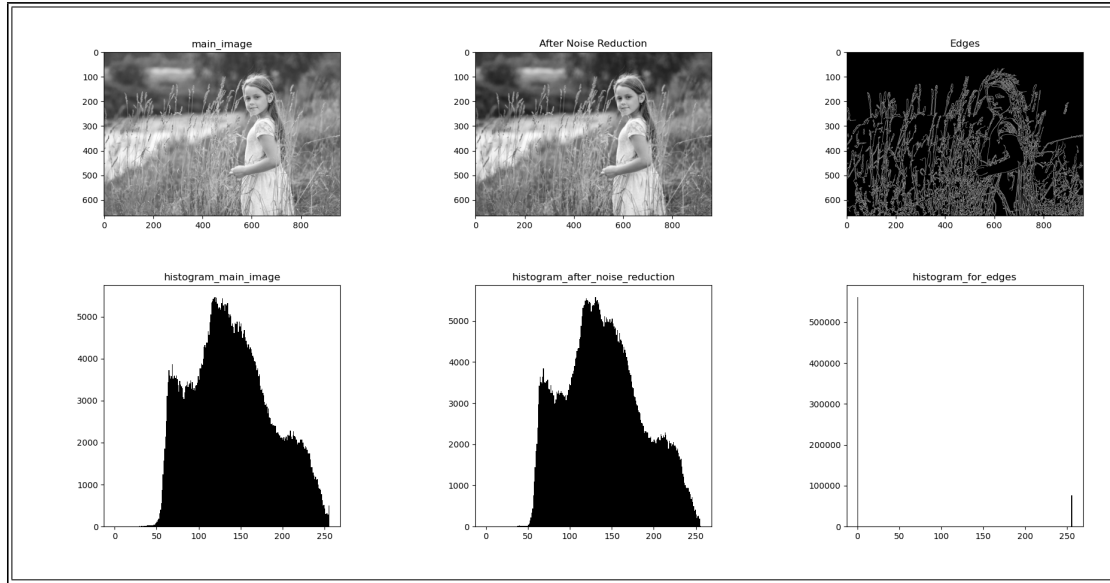
https://github.com/Al-Amin134/Digital-Image-Processing/blob/main/canny_edge_detection.py

The implementation follows these major steps:

- **Image Loading:** The input image is read in grayscale mode.
- **Noise Reduction:** Gaussian Blur with a 3×3 kernel is applied to reduce noise.
- **Canny Edge Detection:** Edges are detected using low threshold = 20 and high threshold = 150.
- **Histogram Analysis:** Histograms of the original, blurred, and edge images are plotted.
- **Visualization:** The results are displayed together in a single figure.

Results & Discussion

The following figure shows the original grayscale image, the noise-reduced image, the edge-detected image, and their respective histograms.



- The original grayscale image contains intensity values ranging from 0–255.
- After Gaussian Blur, the histogram becomes smoother due to noise reduction.
- The Canny Edge Detection output clearly highlights object boundaries. The histogram of the edge image shows two peaks at 0 (background) and 255 (edges).
- This confirms that edges are successfully extracted as binary data.

Conclusion

In this experiment, the Canny Edge Detection algorithm was successfully implemented using OpenCV. Noise reduction with Gaussian Blur ensured better edge detection. The algorithm effectively detected object boundaries, and histogram analysis validated the transformations at each step.

Thus, Canny Edge Detection is a powerful technique for edge-based feature extraction in digital images.