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Digital Image Processing (DIP)
Assignment 2

The goal of this assignment is to **implement and compare two classical edge detection algorithms manually** the **Canny Edge Detector** and the **Marr–Hildreth (Laplacian of Gaussian)** without using any built-in OpenCV or SciPy edge detection functions.
The algorithms were evaluated using **Precision, Recall, and F1-score** metrics against provided ground truth edge maps.

Methodology:

(a) Canny Edge Detection (Manual Implementation)

Steps implemented:

1. Gaussian smoothing
2. Gradient magnitude and direction (Sobel operator)
3. Non-maximum suppression
4. Double thresholding
5. Edge tracking by hysteresis

This implementation focuses on retaining strong edges while suppressing noise through adaptive thresholding.

(b) Marr–Hildreth (LoG) Edge Detection

Steps implemented:

1. Laplacian of Gaussian (LoG) filtering
2. Zero-crossing detection

3. Edge thresholding

This method enhances edges through second-derivative analysis after Gaussian smoothing, making it more sensitive to fine details but also to noise.

Comparison

Both the Canny and Marr–Hildreth (Laplacian of Gaussian) methods are used for edge detection but differ in precision and noise handling. The **Marr–Hildreth detector** applies a Gaussian smoothing followed by the Laplacian operator, detecting edges as zero-crossings. It is simpler but tends to produce thicker edges and may detect false edges in noisy images. In contrast, the **Canny detector** uses gradient-based detection with non-maximum suppression and double thresholding, resulting in **thinner, more accurate, and continuous edges**. Overall, Canny provides **better noise suppression and edge localization**, while Marr–Hildreth is more sensitive to noise but computationally less complex.

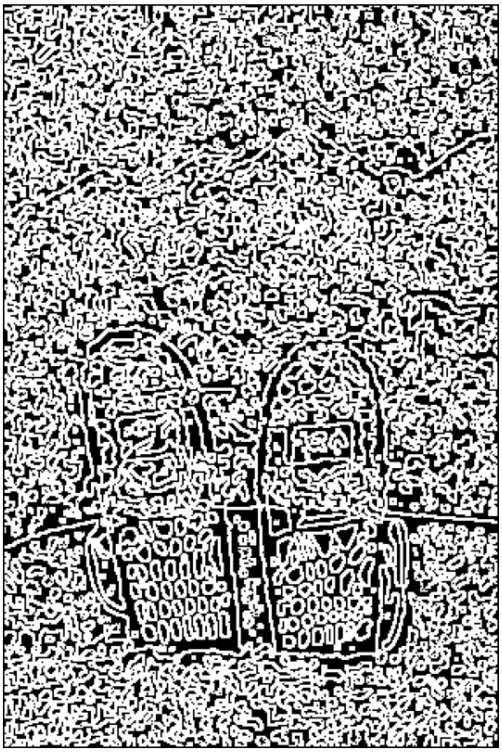
Example

From the output folder:

Original Image

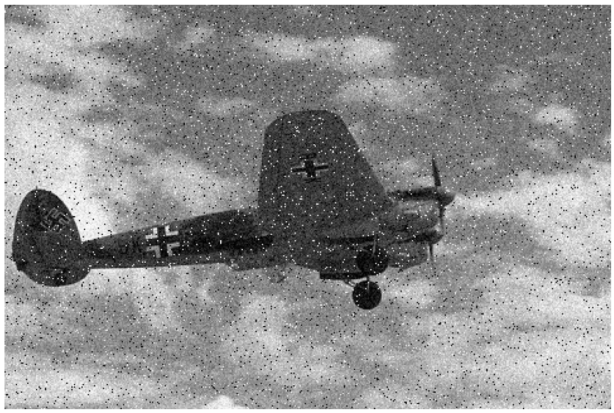
Canny Edge Detection
P=0.027, R=0.214, F1=0.047

Marr-Hildreth (LoG) Edge Detection
P=0.011, R=0.509, F1=0.022

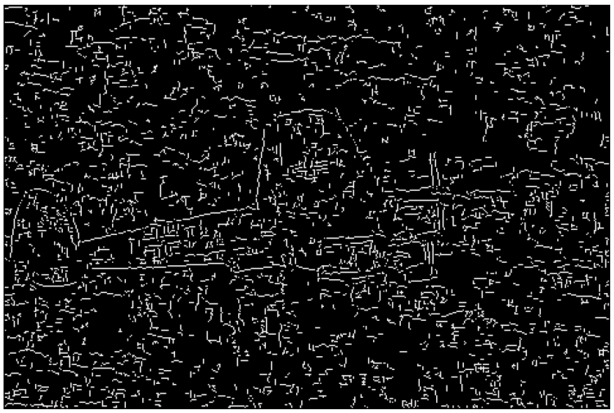


Ground Truth

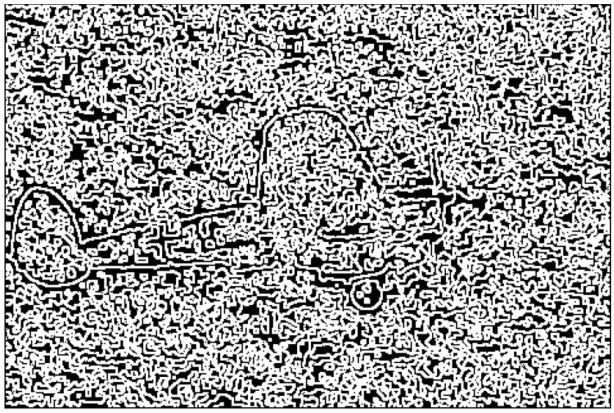
Original Image



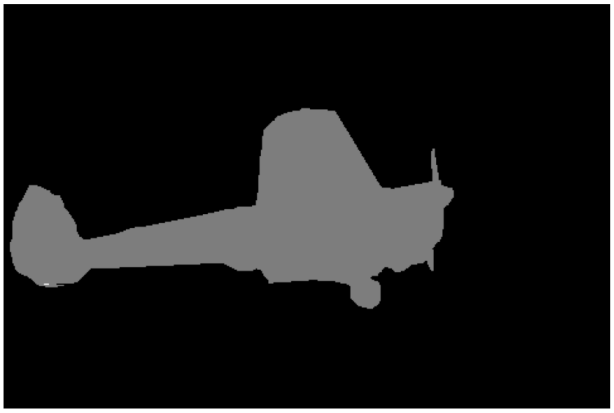
Canny Edge Detection
P=0.232, R=0.124, F1=0.161



Marr-Hildreth (LoG) Edge Detection
P=0.151, R=0.606, F1=0.242



Ground Truth



Metrics comparison