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MSAI 495

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## Machine Problem 5

### Introduction:

The goal of this assignment was to create a canny edge detection algorithm for detecting edges in images.

### Algorithm:

1. Gaussian Smoothing:
  - a. Smooth Image: Gaussian smoothing (blurring) is applied to the grayscale image. This step uses a Gaussian kernel with specified dimensions and standard deviation (sigma), which helps in reducing image noise and detail.
2. Gradient Calculation:
  - a. Calculate Gradients: The gradient of the smoothed image is computed using the Sobel operator, which approximates the derivative in the horizontal (x) and vertical (y) directions.
  - b. Magnitude and Direction: The magnitude and direction (angle) of the gradient at each pixel are calculated.
3. Threshold Determination:
  - a. Determine High and Low Thresholds: Based on the gradient magnitudes, thresholds are determined dynamically. The high threshold is set to exclude the highest gradient magnitudes that correspond to non-edge areas, using a specified percentile. The low threshold is set to half the high threshold.
4. Non-Maxima Suppression:
  - a. Suppress Non-Maxima: This step thins the edges by retaining only the maximum gradient values in the direction of the gradient, reducing the thickness and improving the definition of edges.
5. Edge Linking:
  - a. Link Edges: Using the thresholds determined earlier, edges are linked through a process of hysteresis. Pixel above the high threshold are confirmed as edge pixels, and pixels below are considered for edge inclusion if they are connected to strong edges. The process iterates until no new edges are added.

### Results:

Overall, I was able to successfully detect edges in all of the images. Most of them could be quite a bit cleaner, however you can make out the subject in all of the output edge images. Additionally, my results are very similar to the edge detection output from OpenCV. This indicates that my algorithm is working well.

Gun1.bmp:



Input Image



Smoothed Image



Gradient Magnitude Hi Threshold



Gradient Magnitude Low Threshold



Edge Detection Output



CV2 Edge Detection Output (for comparison)

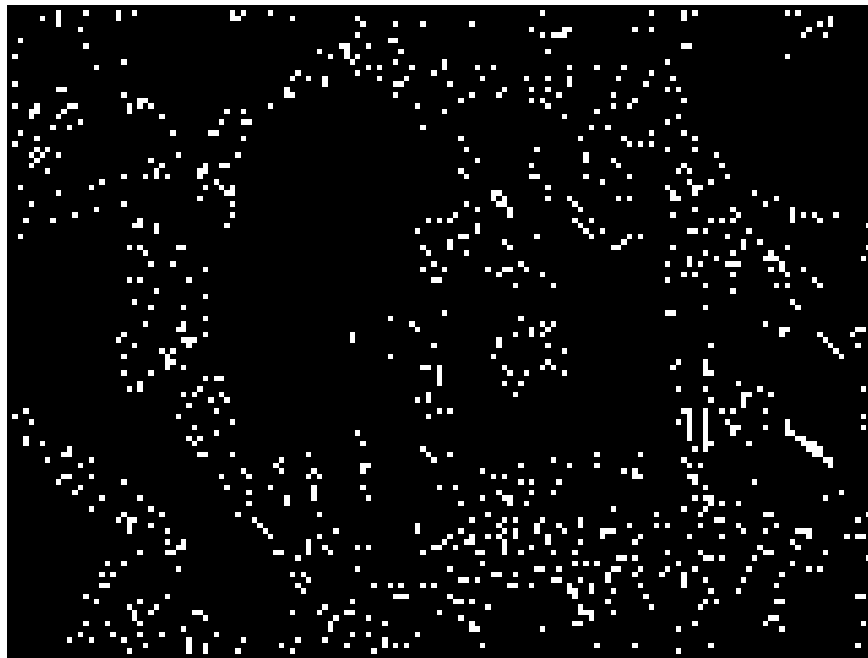
Joy1.bmp



Input Image



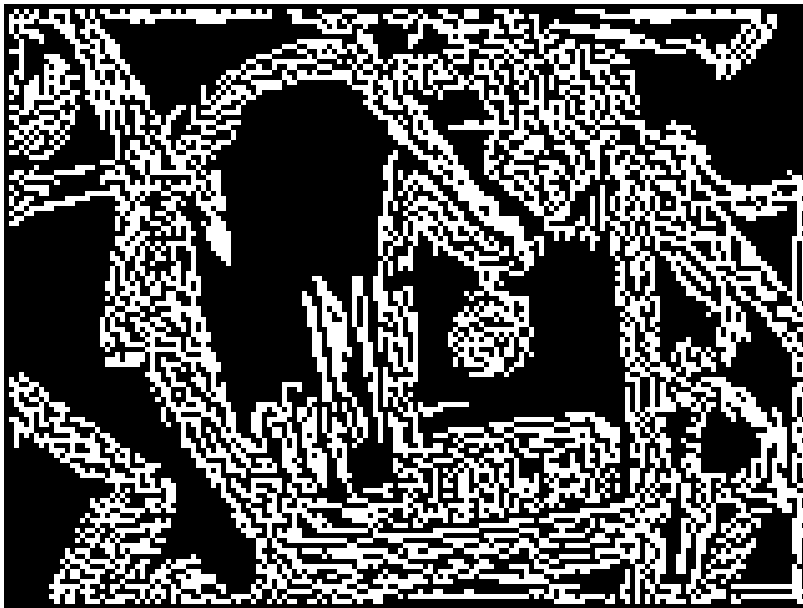
Smoothed Image



Gradient Magnitude Hi Threshold



Gradient Magnitude Low Threshold



Edge Detection Output

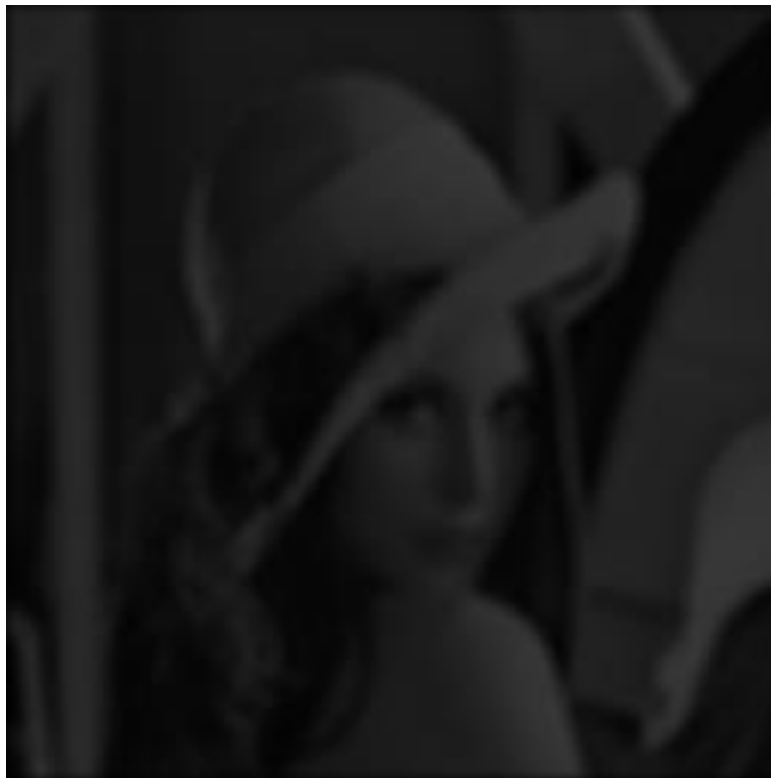


CV2 Edge Detection Output (for comparison)

Lena.bmp

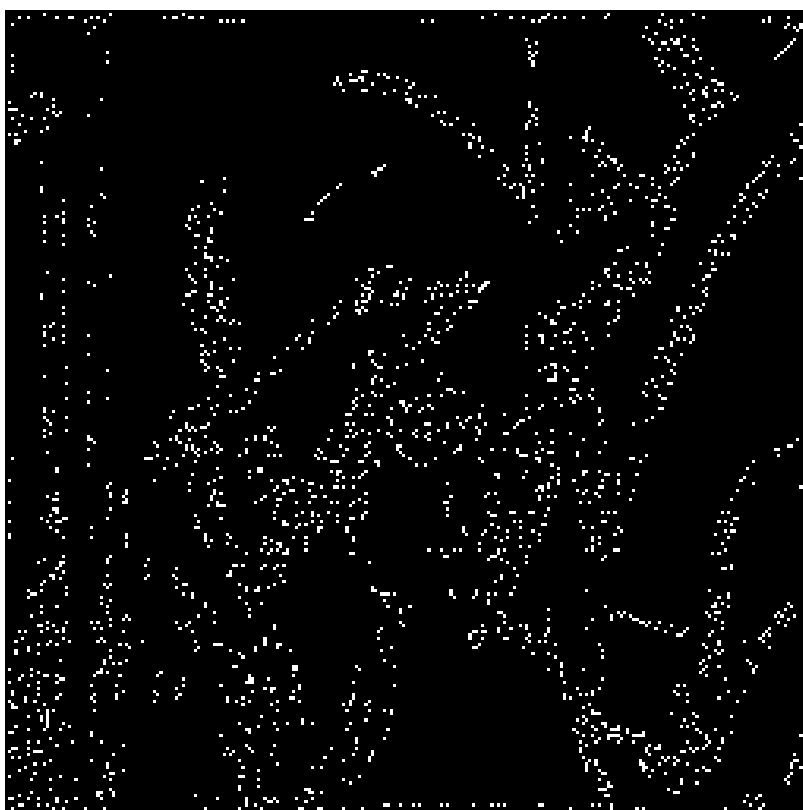


Input Image

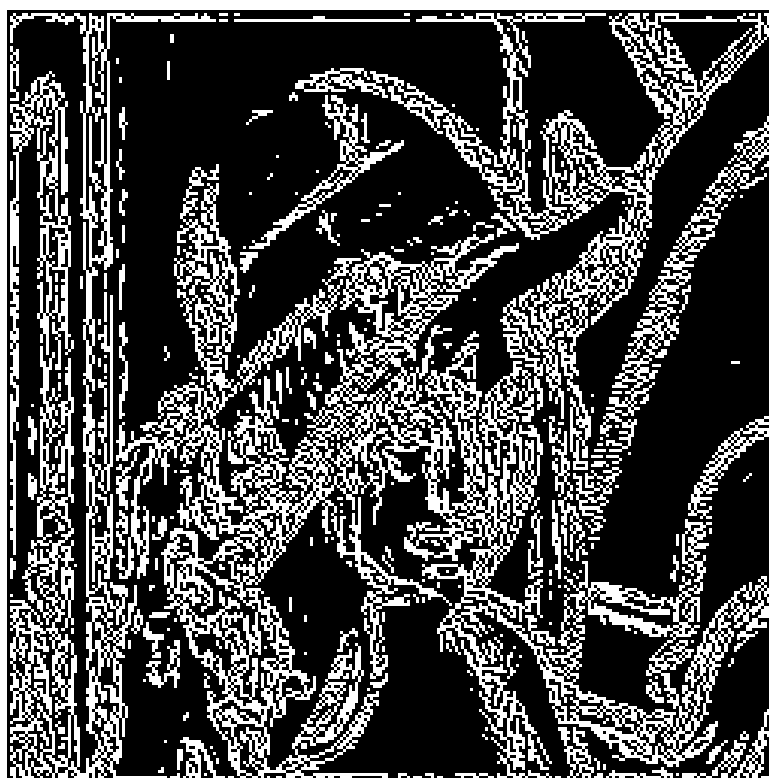


Smoothed Image

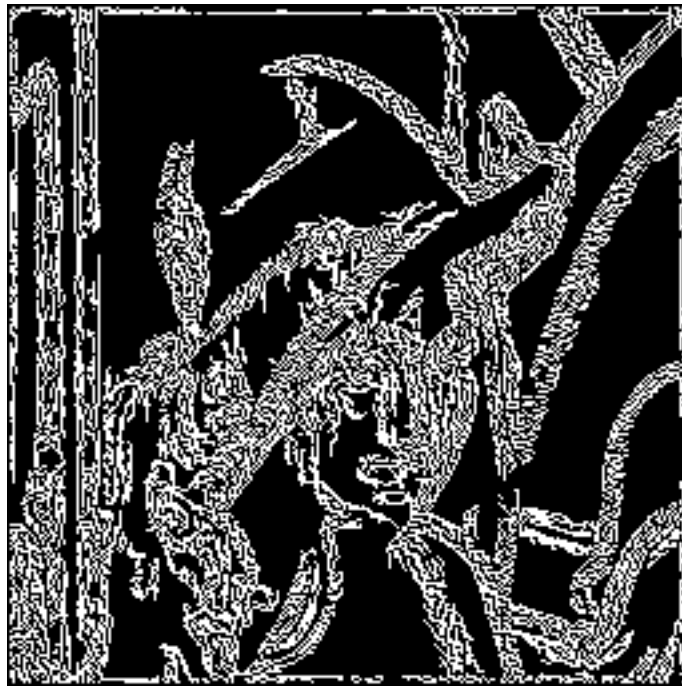




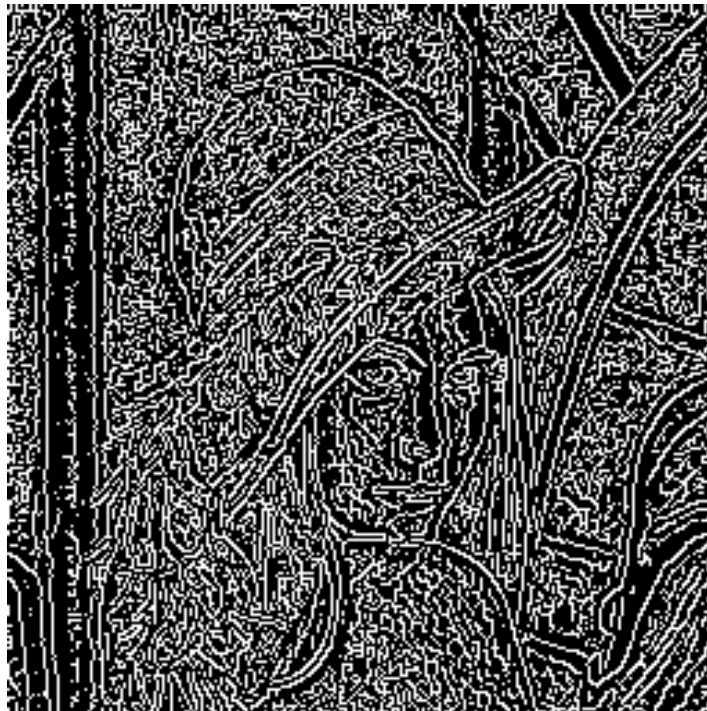
Gradient Magnitude Hi Threshold



Gradient Magnitude Low Threshold



Edge Detection Output



CV2 Edge Detection Output (for comparison)

Pointer1.bmp



Input Image



Smoothed Image



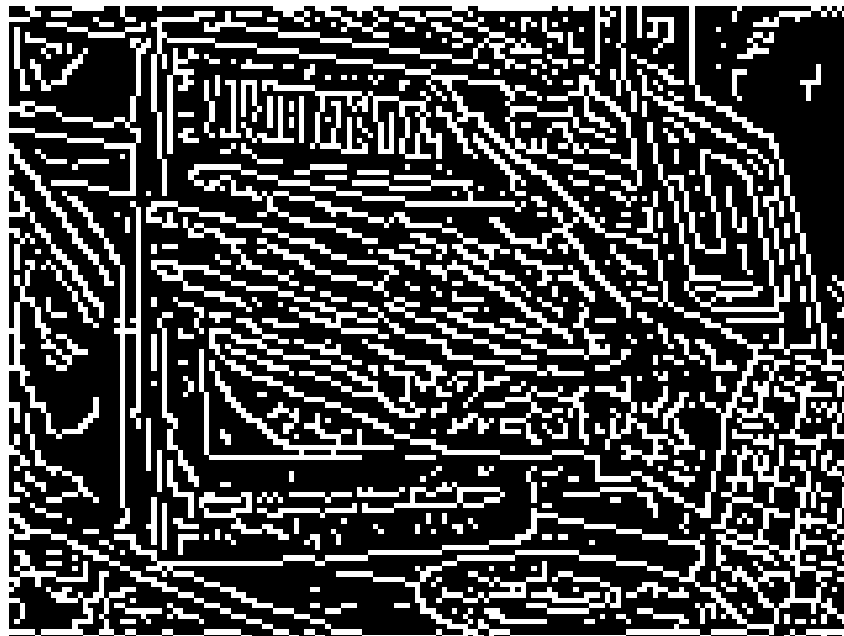
Gradient Magnitude Hi Threshold



Gradient Magnitude Low Threshold

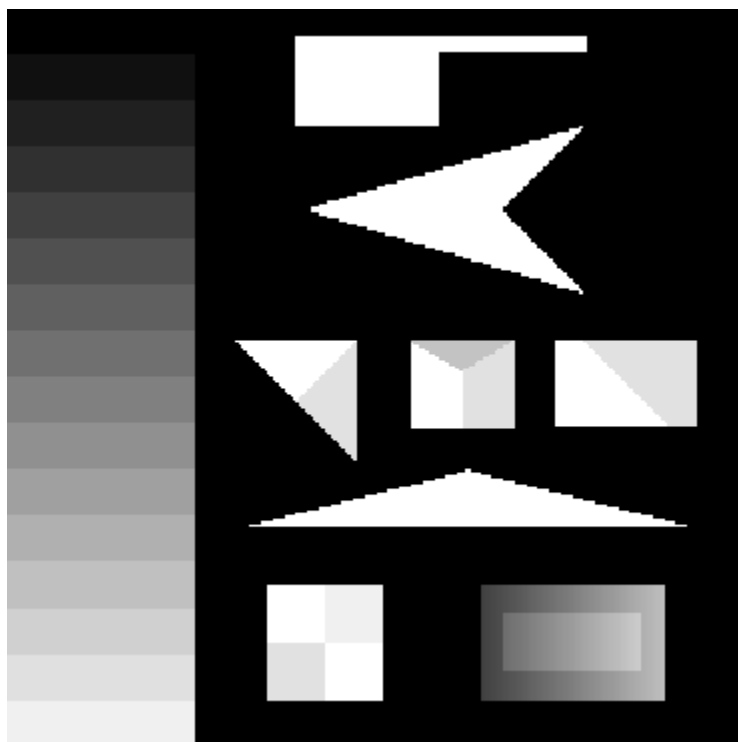


Edge Detection Output



CV2 Edge Detection Output (for comparison)

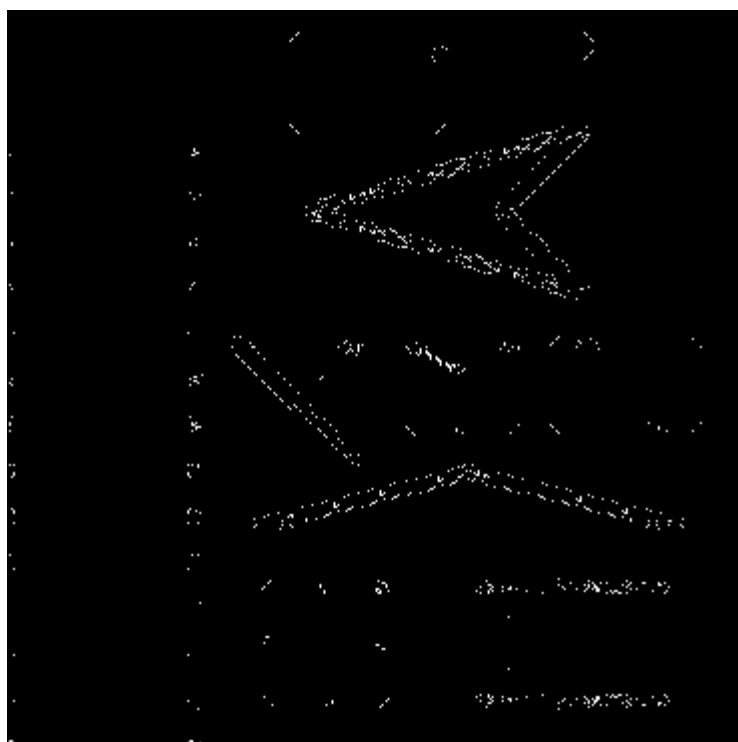
Test1.bmp



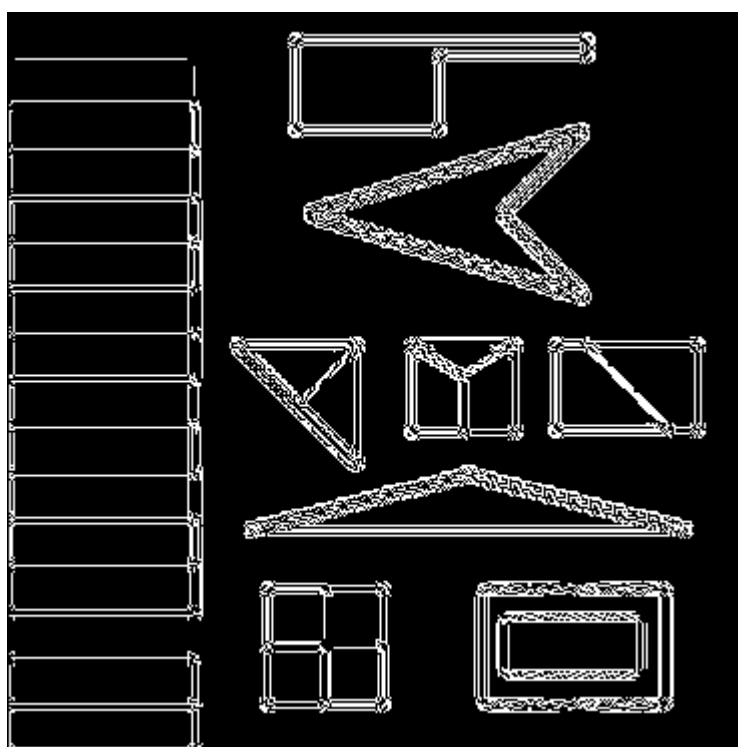
Input Image



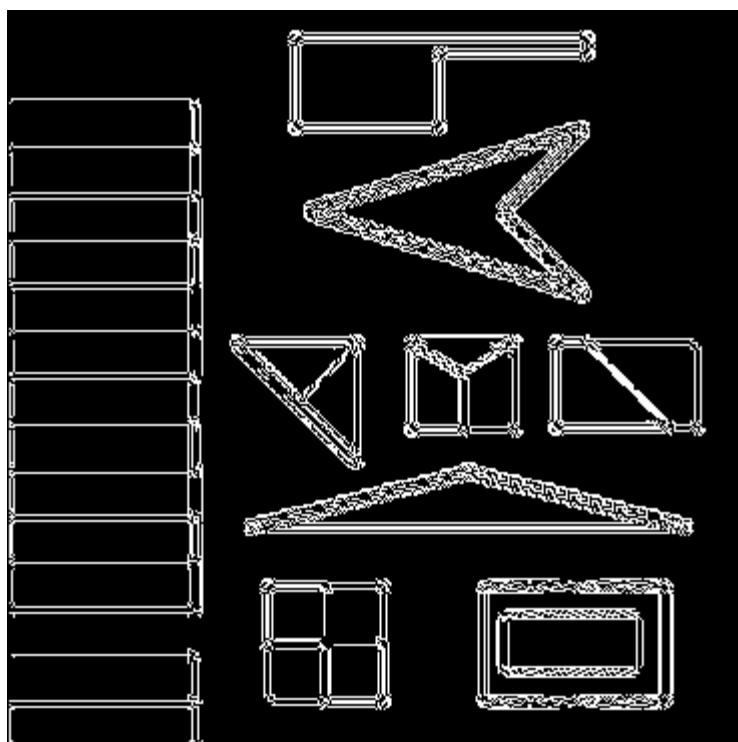
Smoothed Image



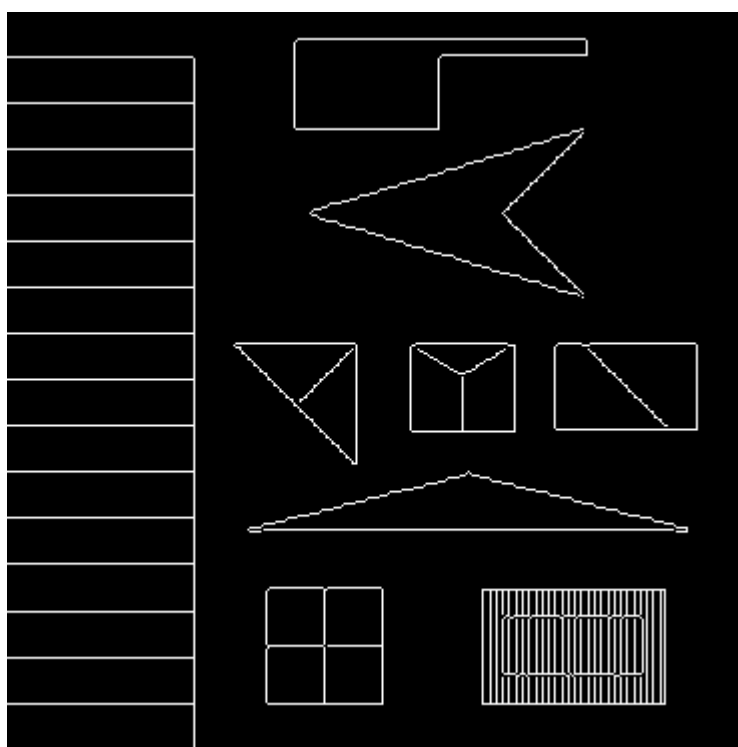
Gradient Magnitude Hi Threshold



Gradient Magnitude Low Threshold



Edge Detection Output



CV2 Edge Detection Output (for comparison)