CDS Assignment 1 Report

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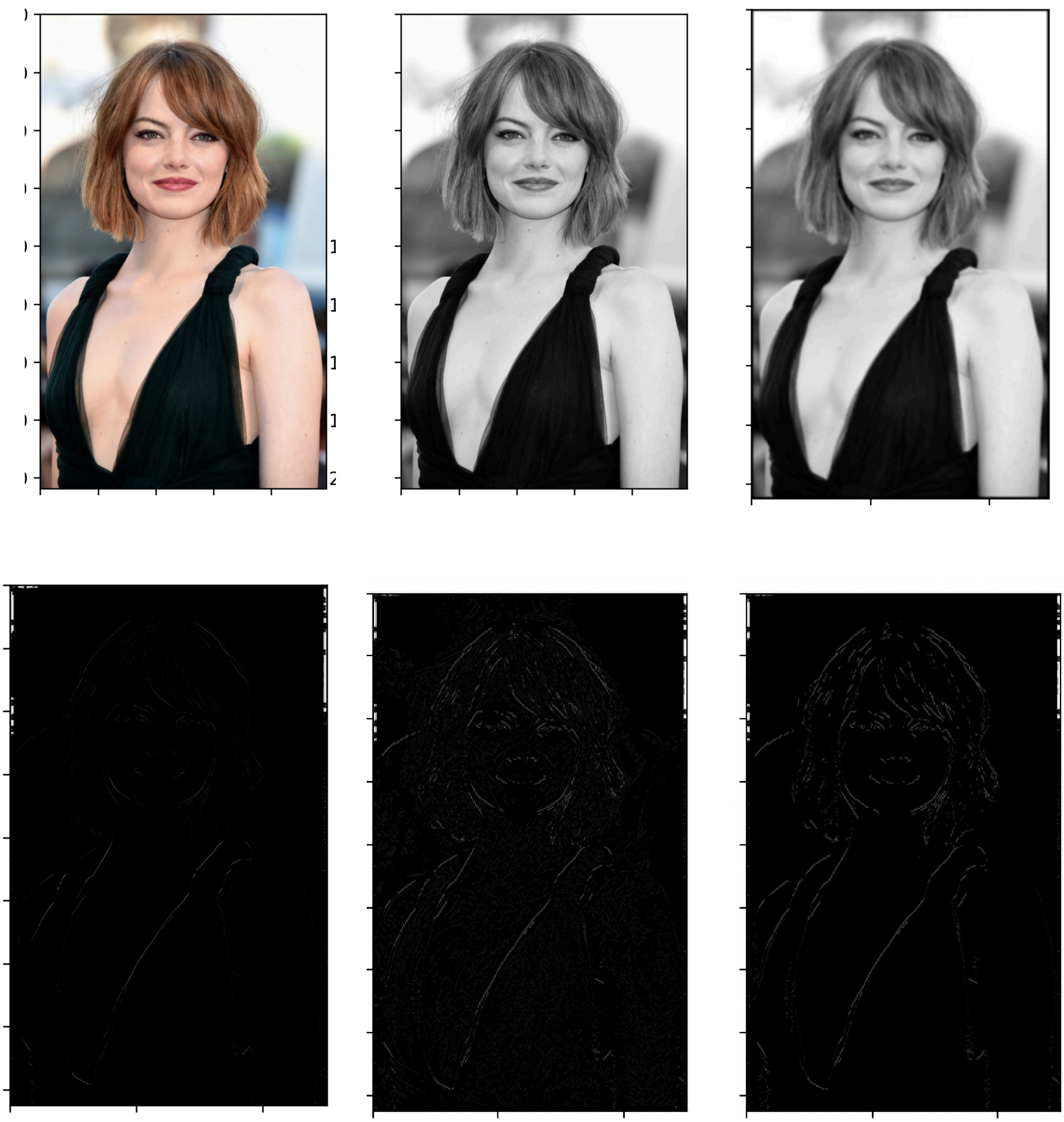
Overview:

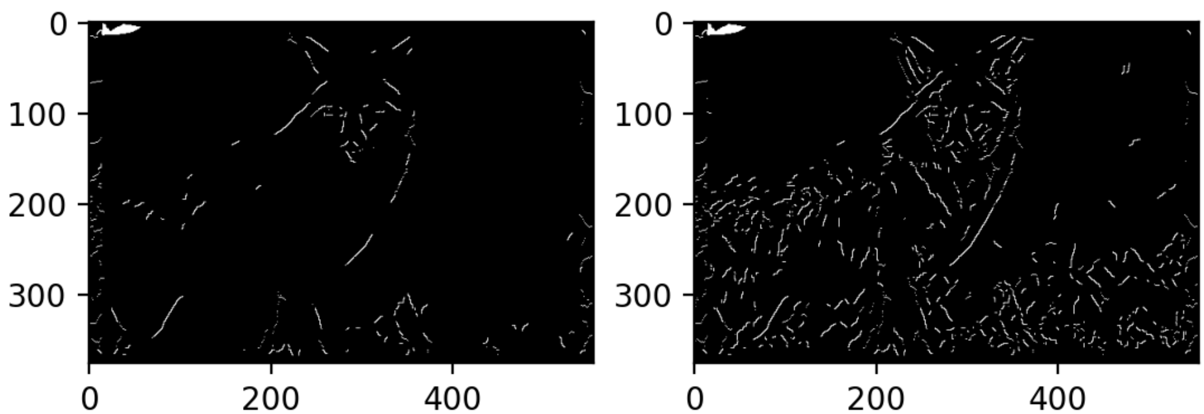
A basic method of image processing called edge detection is used to locate boundaries in images. Because of its accuracy, the Canny edge detection algorithm—which was first presented by John F. Canny in 1986—is a widely used technique. An overview of the Canny algorithm and its implementation is given in this report, which also covers each step and offers visual examples to assess the algorithm's effectiveness. We followed the following steps:

- Grayscale Conversion: The color image input is converted into a single-channel image that solely contains intensity values. We used the grayscale Intensity Conversion: I = 0.299 * R + 0.587 * G + 0.114 * B.
- Noise Reduction (Gaussian Filter): This step involves convolving the image with a Gaussian kernel matrix, smoothing out high-frequency noise while preserving the edges. A convolution method is used as a helper for the overall operation.
- Gradient Calculation: Convolution with Sobel operators, which is a discrete approximation of the derivative, is used to compute the X and Y gradients. At each pixel, the rate of change in intensity in both the horizontal and vertical directions is determined.
- Non-Maximum Suppression: For each pixel in the gradient image, the algorithm determines pixel magnitude represents a local maximum in comparison to two other adjacent pixels in the positive and negative gradient directions. The pixel is suppressed if it is not; otherwise, it is kept.
- Double threshold: Strong edges are defined as pixels with gradient magnitudes higher than a high threshold; pixels with gradient magnitudes below the low threshold are eliminated. Pixels between these ranges are considered weak edges.
- Hysteresis: Based on threshold results, this step transforms weak pixels into strong ones if they are adjacent to a strong pixel. Effectively removing isolated weak edges brought on by noise, making sure that the final result only contains significant, continuous edges.

Evaluation: (images)

Original - Grayscale - Gaussian Blurring - Non-Maximum Suppression - Double Thresholding - Hysteresis





Within this example both a high threshold and a low threshold negatively impact edge detection performance. The high threshold (left) is missing out on many details while the low threshold (right) has too many details being counted as edges, stressing the importance of a balanced threshold.

<u>Challenges:</u>

1. When we tried to determine strong and weak edges, we tried different arbitrary numbers as thresholds and visualized the difference through the displayed image. It was hard to adjust the value because sometimes the image doesn't clearly show a difference.
2. In noise reduction, we searched up for Gaussian Filter and realized that a convolution method needs to be used as a helper function.

3. Understanding the loop conditions and theta boundaries for non-maximum suppression. Had to look and compare different explanations, examples, and diagrams of the concept
4. Manipulation of whole 2d arrays through numpy, needed to gain greater familiarity with syntax and output evaluation.