# Image Processing Report: Filters and Edge Detection

## Sobel Filter

The Sobel filter is a widely used edge detection algorithm in image processing. It works by calculating the gradient of the image intensity at each pixel, which provides a measure of the rate of change in the pixel's intensity. The Sobel filter uses two 3x3 kernels, one for the horizontal gradient and one for the vertical gradient, to approximate the gradient magnitude and direction. This allows the Sobel filter to detect edges in both the x and y directions, making it effective at identifying the boundaries of objects within an image. The Sobel filter is known for its ability to enhance edges while suppressing noise, making it a valuable tool for a variety of image processing applications.

**Pseudocode:**

1. Load the image.

2. Convert the image to grayscale.

3. Define the Sobel kernels for x and y directions.

4. Convolve the image with each kernel.

5. Calculate the gradient magnitude using the x and y gradients.

## Laplacian Filter

The Laplacian filter is a second-order derivative-based edge detection algorithm that is used to identify the edges in an image. Unlike the Sobel filter, which calculates the gradient of the image intensity, the Laplacian filter calculates the second derivative of the image intensity, which can be used to identify points where the intensity changes rapidly. The Laplacian filter is particularly effective at detecting edges that are not oriented in a specific direction, making it a useful complement to the Sobel filter. The Laplacian filter is also known for its ability to enhance high-frequency details in an image, which can be useful for applications such as image sharpening and noise reduction.

**Pseudocode:**

1.Load the image.

2.Convert the image to grayscale.

3.Apply the Laplacian filter.

4.Display or save the edge-detected image.

## Canny Edge Detector

The Canny edge detector is a sophisticated edge detection algorithm that is widely used in image processing. It works by first smoothing the image to reduce noise, then calculating the gradient magnitude and direction of the image intensity. The Canny edge detector then applies a series of steps to identify and thin the edges, including non-maximum suppression and hysteresis. This results in a set of thin, continuous edges that accurately represent the boundaries of objects within the image. The Canny edge detector is known for its ability to detect a wide range of edge types, including weak and strong edges, and is often used in applications such as object recognition, image segmentation, and feature extraction.

**Pseudocode:**

1. **Load the image.**
2. **Convert the image to grayscale.**
3. **Apply Gaussian blur to reduce noise.**
4. **Apply the Canny edge detector using low and high thresholds.**
5. **Display or save the edge-detected image.**

## Contours in Image Processing

Contours in image processing refer to the lines or curves that define the boundaries of objects within an image. Contour detection is a fundamental task in many image processing applications, as it allows for the identification and analysis of the shapes and structures present in an image. Contours can be detected using a variety of algorithms, including the Canny edge detector and the Laplacian filter, and can be used for a wide range of applications, such as object recognition, image segmentation, and shape analysis. Contour detection is particularly useful in applications where the shape and structure of objects are important, such as in medical imaging, industrial inspection, and computer vision.

**Pseudocode:**

1. Load the image.
2. Convert the image to grayscale.
3. Apply edge detection (e.g., Canny).
4. Find contours in the edge-detected image.
5. Draw and display contours.