Palawan State University
College of Sciences
Computer Studies Department

DIGITAL IMAGE PROCESSING LABORATORY EXERCISE #13

Canny edge detection Algorithm

The Canny edge detection algorithm is a popular technique in digital image processing used to identify and detect the edges within an image. Developed by John F. Canny in 1986, this algorithm is known for its optimal performance in detecting a wide range of edges in images. It is designed to be robust to noise and capable of detecting true edge points while minimizing the number of false edges. Here are the main steps involved in the Canny edge detection process:

Steps in the Canny Edge Detection Algorithm

1. **Noise Reduction:** Gaussian Blur: The algorithm begins by applying a Gaussian filter to smooth the image and reduce noise. This step is crucial because edge detection can be highly sensitive to noise. The Gaussian filter helps in blurring the image to remove small variations and details.

2. **Gradient Calculation:** Intensity Gradient: The next step is to compute the intensity gradients of the image. This is typically done using Sobel operators to find the gradient magnitude and direction at each pixel. The gradient magnitude represents the strength of the edge, and the gradient direction indicates the orientation of the edge.

3. **Non-Maximum Suppression:** Thinning the Edges: After computing the gradient magnitudes and directions, the algorithm applies non-maximum suppression to thin the edges. This step involves iterating over the gradient magnitudes and preserving only local maxima in the direction of the gradient. This means that for each pixel, if its gradient magnitude is the largest among the pixels in its immediate neighborhood in the direction of the gradient, it is preserved; otherwise, it is suppressed.

4. **Double Thresholding:** Thresholding: To identify potential edges, the algorithm uses two thresholds: a high threshold and a low threshold. Pixels with gradient magnitudes above the high threshold are considered strong edges. Pixels with gradient magnitudes below the low threshold are discarded. Pixels with gradient magnitudes between the two thresholds are considered weak edges.

5. **Edge Tracking by Hysteresis:** Connecting Edges: The final step is edge tracking by hysteresis, which involves connecting weak edges to strong edges if they are adjacent to each other. This step ensures that edges are continuous and helps in reducing the number of false positives.

Key Characteristics of the Canny Edge Detection Algorithm

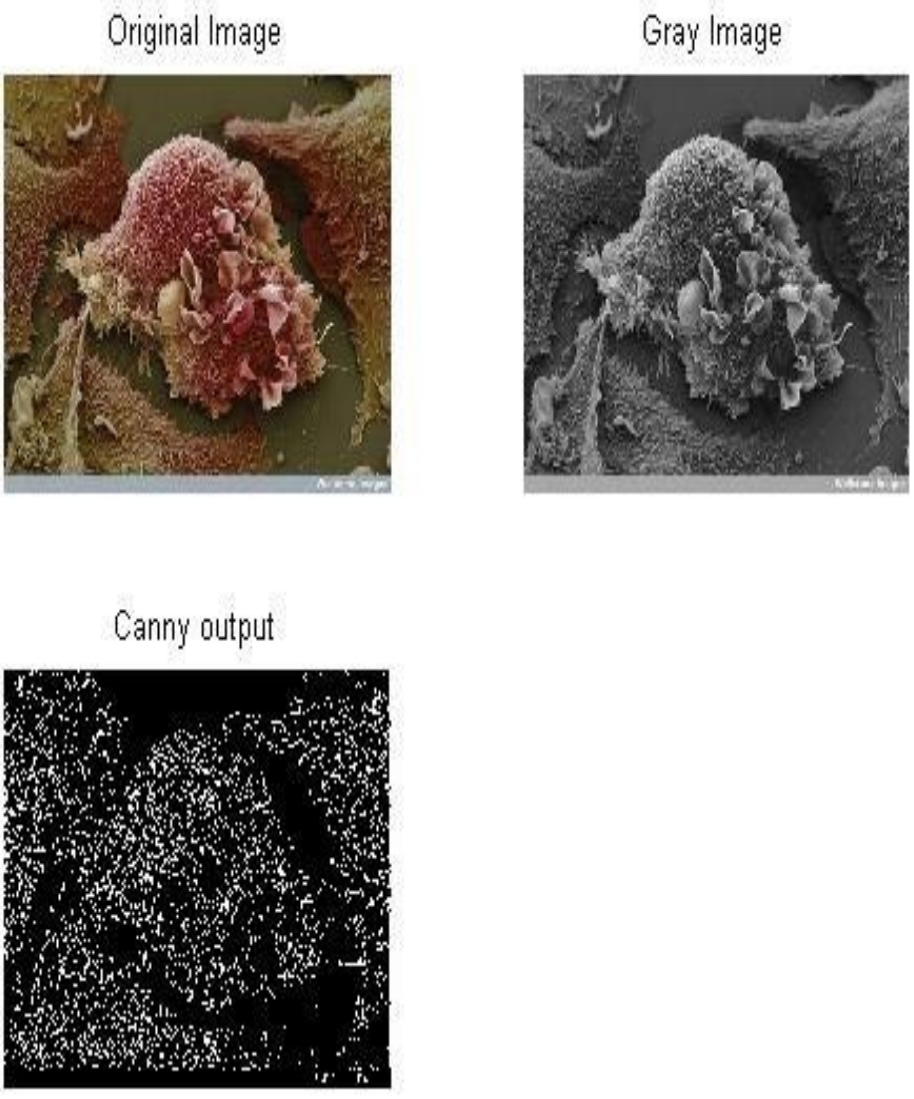
- **Good Detection:** The algorithm ensures that edges are detected effectively and that the detected edges are close to the true edges.
- **Good Localization:** The algorithm aims to minimize the distance between the detected edge and the actual edge.
- **Minimal Response:** It ensures that a given edge in the image corresponds to a single edge in the output, reducing the likelihood of multiple responses to a single edge.

Applications: Canny edge detection is widely used in various applications, such as:

- **Object Recognition:** Detecting objects within images based on their edges.
- **Image Segmentation:** Dividing an image into meaningful regions.
- **Feature Extraction:** Identifying important features within an image for further analysis.

Overall, the Canny edge detection algorithm is a foundational tool in image processing, valued for its robustness and accuracy in edge detection.

```
i= imread('cancercell.jpg'); g=rgb2gray(i); subplot(2,2,1);
imshow(i); title('Original Image'); subplot(2,2,2);
imshow(g); title('Gray Image'); c=edge(g,'canny');
subplot(2,2,3); imshow(c); title('Canny output');
```



Exercise #13
Canny edge detection Algorithm

Name:
Year/Block:
Application/Software:

1. Codes
2. Output
3. Answer the following questions:

   A. What are the key advantages of using the Canny edge detection algorithm compared to other edge detection techniques in digital image processing?

   B. Explain the role of non-maximum suppression in the Canny edge detection algorithm and how it contributes to the detection of thin, continuous edges in images.

   C. Discuss the significance of selecting appropriate threshold values in the double thresholding step of the Canny edge detection algorithm, and how these thresholds impact the trade-off between edge detection sensitivity and noise suppression.