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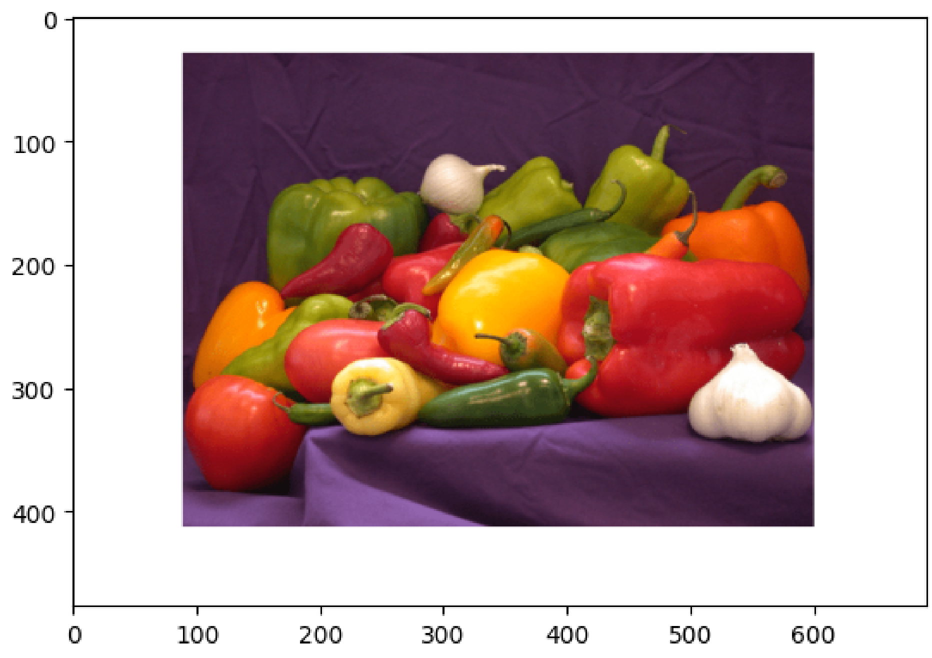
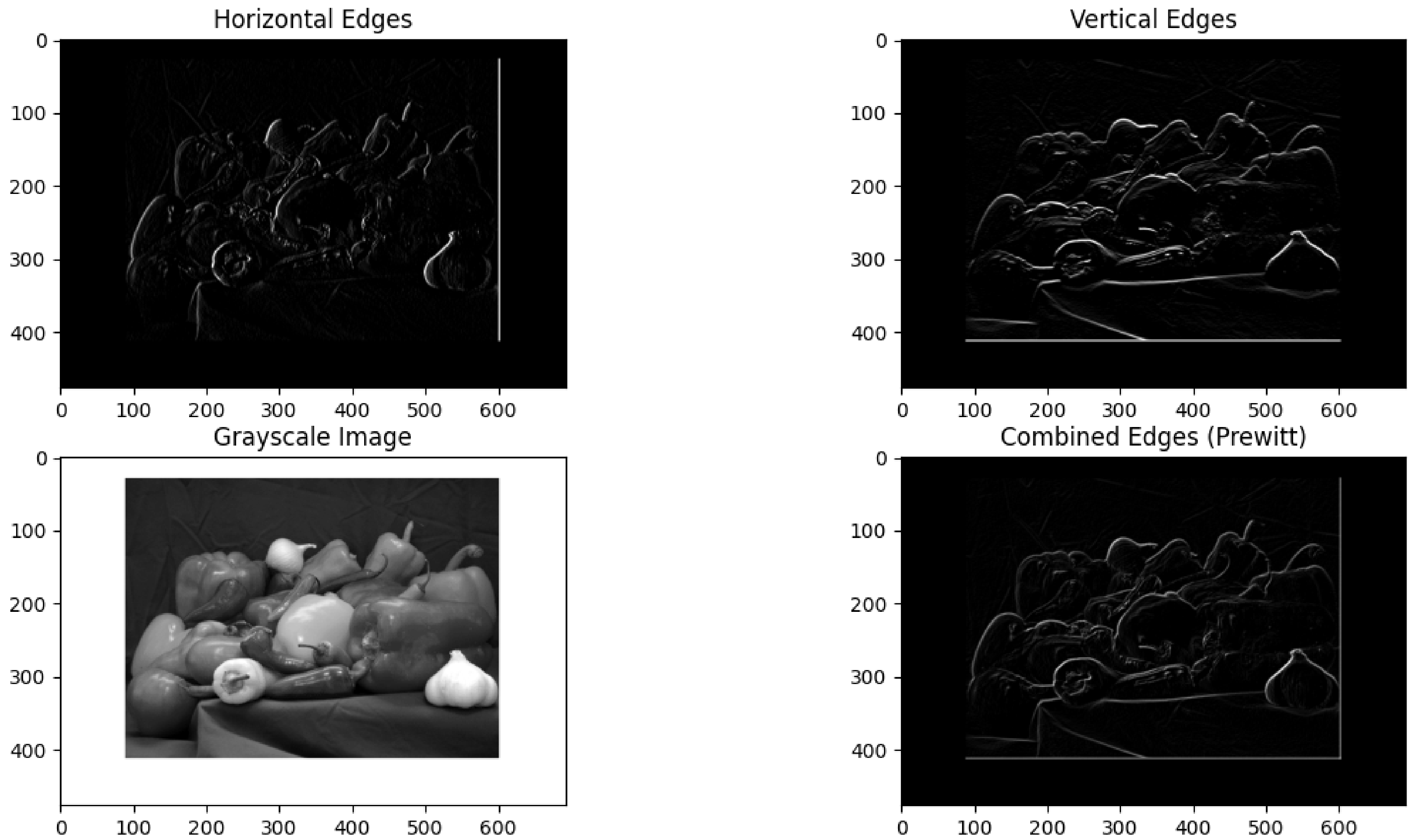
In [57]:
```
#Reading Image:
import matplotlib.pyplot as plt
import numpy as np

# Load the image
vegetable_image = np.array(plt.imread('Vegetable Image.png'))

# Display the image
plt.imshow(vegetable_image)
plt.show()
```



A. Edge Detection using Prewitt filter

In [58]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Step 1: Read the image data
image_path = "Vegetable Image.png"
image = cv2.imread(image_path)

# Step 2: Convert the image to grayscale
gray_image = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

# Step 3: Perform Prewitt operation for horizontal mask
prewitt_horizontal = np.array([[-1, 0, 1],
                               [-1, 0, 1],
                               [-1, 0, 1]])
horizontal_edge = cv2.filter2D(gray_image, -1, prewitt_horizontal)

# Step 4: Perform Prewitt operation for the vertical mask
prewitt_vertical = np.array([[-1, -1, -1],
                             [0, 0, 0],
                             [1, 1, 1]])
vertical_edge = cv2.filter2D(gray_image, -1, prewitt_vertical)

# Step 5: Provide a single output for the input image
combined_edges = cv2.addWeighted(horizontal_edge, 0.5, vertical_edge, 0.5, 0)

# Display the original image and the edge-detected image
plt.figure(figsize=(14, 7))
plt.subplot(221), plt.imshow(horizontal_edge, cmap='gray'), plt.title('Horizontal Edges')
plt.subplot(222), plt.imshow(vertical_edge, cmap='gray'), plt.title('Vertical Edges')
plt.subplot(223), plt.imshow(gray_image, cmap='gray'), plt.title('Grayscale Image')
plt.subplot(224), plt.imshow(combined_edges, cmap='gray'), plt.title('Combined Edges (Prewitt)')
plt.show()
```

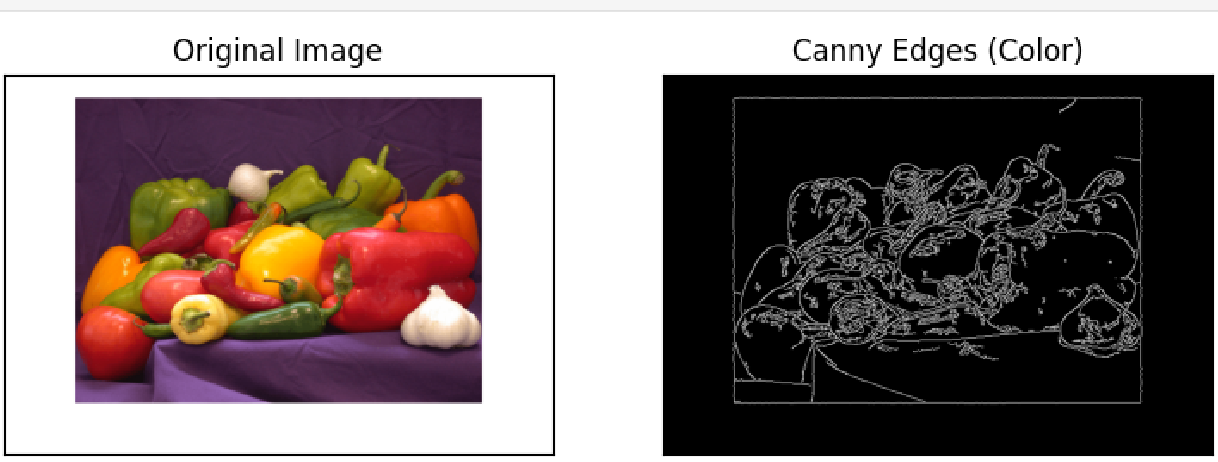


Observation:

- Grayscale Conversion: The image is converted to grayscale for edge detection.
- Horizontal Edges: Prewitt with a horizontal mask highlights horizontal edges in the image.
- Vertical Edges: Prewitt with a vertical mask emphasizes vertical edges.
- Combined Edges: The final output combines horizontal and vertical edges. -Edge Strength: Bright regions indicate strong edges, while dark areas represent weaker or no edges. -Edge Enhancement: Prewitt filter enhances object boundaries and contours.

B. Canny edge detection.

In [59]:
```
# Load the image
image101 = cv2.imread('Vegetable Image.png')

# Convert the image to grayscale
gray = cv2.cvtColor(image101, cv2.COLOR_BGR2GRAY)

# Apply Gaussian blur to reduce noise
blurred = cv2.GaussianBlur(gray, (9, 9), 0)

# Apply Canny edge detection to the grayscale image
edges_gray = cv2.Canny(blurred, threshold1=30, threshold2=100)  # You can adjust the thresholds

# Apply Canny edge detection to the original image
edges_color = cv2.Canny(image101, 50, 150)

# Display the results
import matplotlib.pyplot as plt
plt.figure(figsize=(14, 7))
plt.subplot(131), plt.imshow(cv2.cvtColor(image101, cv2.COLOR_BGR2RGB), cmap='gray')
plt.title('Original Image'), plt.xticks([]), plt.yticks([])
plt.subplot(132), plt.imshow(edges_color, cmap='gray')
plt.title('Canny Edges (Color)'), plt.xticks([]), plt.yticks([])

plt.show()
```



Observation:

- Gaussian blur smooths the image, reducing noise for a cleaner edge detection result.
- The Sobel filter calculates gradient magnitude and direction, essential for edge detection.
- Non-maximum suppression thins edges to improve their accuracy and precision.
- Double thresholding helps classify pixels into strong and weak edges, providing better edge clarity.

- Hysteresis edge tracking strengthens weak edges connected to strong edges, enhancing edge continuity.

C. Laplacian of Gaussian:

In [60]:
```python
# Step 1: Read the image data
image_path = 'Vegetable Image.png'
image = cv2.imread(image_path)

# Step 2: Remove noise by applying a Gaussian blur
blurred_image = cv2.GaussianBlur(image, (5, 5), 0)

# Step 3: Convert the image to grayscale
gray_image = cv2.cvtColor(blurred_image, cv2.COLOR_BGR2GRAY)

# Step 4: Apply a Laplacian operator to the grayscale image
laplacian = cv2.Laplacian(gray_image, cv2.CV_64F)

# Step 5: Display the result in a window
plt.figure(figsize=(26, 12))
plt.subplot(131), plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB)), plt.title('Original Image'), plt.axis('off')
plt.subplot(132), plt.imshow(laplacian, cmap='gray'), plt.title('Laplacian of Gaussian'), plt.axis('off')
plt.show()
```

Observation:

Laplacian of Gaussian (LoG):

- Gaussian blur smooths the image and reduces noise.
- Laplacian operator highlights regions of rapid intensity change (edges or transitions).
- LoG combines Gaussian smoothing and Laplacian for edge enhancement.
- Output image (LoG result) enhances edge visibility. Comparison between Gradient-based (Canny) and Gaussian-based (LoG) Operators:

Canny (gradient-based) detects sharp, high-contrast edges with thin lines. LoG (Gaussian-based) provides smoother, slightly thicker, and more continuous edges. Choice depends on image characteristics, edge type, and sensitivity to noise. Canny for sharp edges, LoG for varying edges and noise robustness.

Comparison between Gradient-based and Gaussian-based operators:

In [61]:
```python
import cv2
import numpy as np
import matplotlib.pyplot as plt

# Load the image
image = cv2.imread('Vegetable Image.png', cv2.IMREAD_GRAYSCALE)

# Apply the Sobel filter (Gradient-based)
sobel_x = cv2.Sobel(image, cv2.CV_64F, 1, 0, ksize=5)
sobel_y = cv2.Sobel(image, cv2.CV_64F, 0, 1, ksize=5)
gradient_magnitude_sobel = np.sqrt(sobel_x**2 + sobel_y**2)

# Apply Gaussian blur (Gaussian-based)
blurred = cv2.GaussianBlur(image, (9, 9), 0)

# Apply Canny edge detection (Gaussian-based)
edges_canny = cv2.Canny(blurred, threshold1=30, threshold2=100)  # You can adjust the thresholds

# Display the results
plt.figure(figsize=(14, 7))
plt.subplot(221), plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
plt.title('Original Image'), plt.xticks([]), plt.yticks([])
plt.subplot(222), plt.imshow(image, cmap='gray')
plt.title('Grayscale Image'), plt.xticks([]), plt.yticks([])

plt.subplot(223), plt.imshow(gradient_magnitude_sobel, cmap='gray')
plt.title('Edge Detection (Sobel)'), plt.xticks([]), plt.yticks([])

plt.subplot(224), plt.imshow(edges_canny, cmap='gray')
plt.title('Edge Detection (Canny)'), plt.xticks([]), plt.yticks([])

plt.show()
```

Original Image

Grayscale Image

Edge Detection (Sobel)

Edge Detection (Canny)

Observation:

- Sobel tends to produce thicker and more continuous edges, suitable for some applications.
- Canny produces thinner and precise edges, useful in tasks like object recognition.
- Canny edge detection is more robust to noise due to the Gaussian blur.
- The choice between Sobel and Canny depends on the specific requirements of the image analysis or processing task.
