Image Segmentation

Aim:- To process gray scale image with different gradient operators like Robert, Prewitt & Sobel

Theory:- Image segmentation divides an image into regions that are connected and have some similarity within the region and some difference between adjacent regions.

The goal is usually to find individual objects in an image.

For the most part there are fundamentally two kinds of approaches to segmentation: discontinuity and similarity.

-Similarity may be due to pixel intensity, color or texture.

-Differences are sudden changes (discontinuities) in any of these, but especially sudden changes in intensity along a boundary line, which is called an edge.

Detection of Discontinuities

Gradient Operators

- First-order derivatives:

The gradient of an image $f(x,y)$ at location (x,y) is defined as the vector:

$$\nabla \mathbf{f} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

The magnitude of this vector:

$$\nabla f = \text{mag}(\nabla \mathbf{f}) = \left[G_x^2 + G_y^2\right]^{1/2}$$

The direction of this vector:

$$\alpha(x,y) = \tan^{-1}\left(\frac{G_x}{G_y}\right)$$

Gradient Mask:

−1	0	0	−1
0	1	1	0

Roberts

−1	−1	−1	−1	0	1
0	0	0	−1	0	1
1	1	1	−1	0	1

Prewitt

−1	−2	−1	−1	0	1
0	0	0	−2	0	2
1	2	1	−1	0	1

Sobel

(a) Original image. (b) $|G_x|$, component of the gradient in the x-direction. (c) $|G_y|$, component in the y-direction. (d) Gradient image, $|G_x| + |G_y|$.

Implementation Instructions:-

Consider any gray scale image & perform convolution with different gradient operators like Robert, Prewitt & Sobel & observe the result.

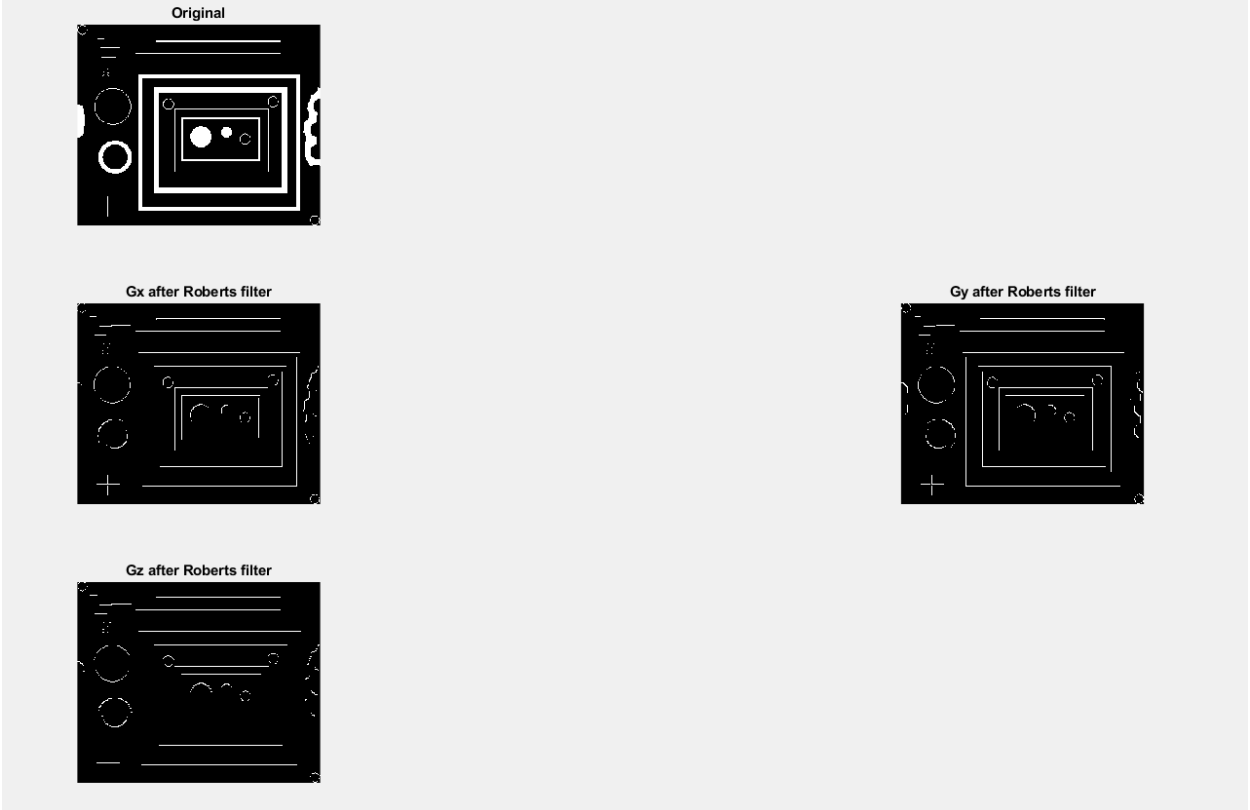
Code

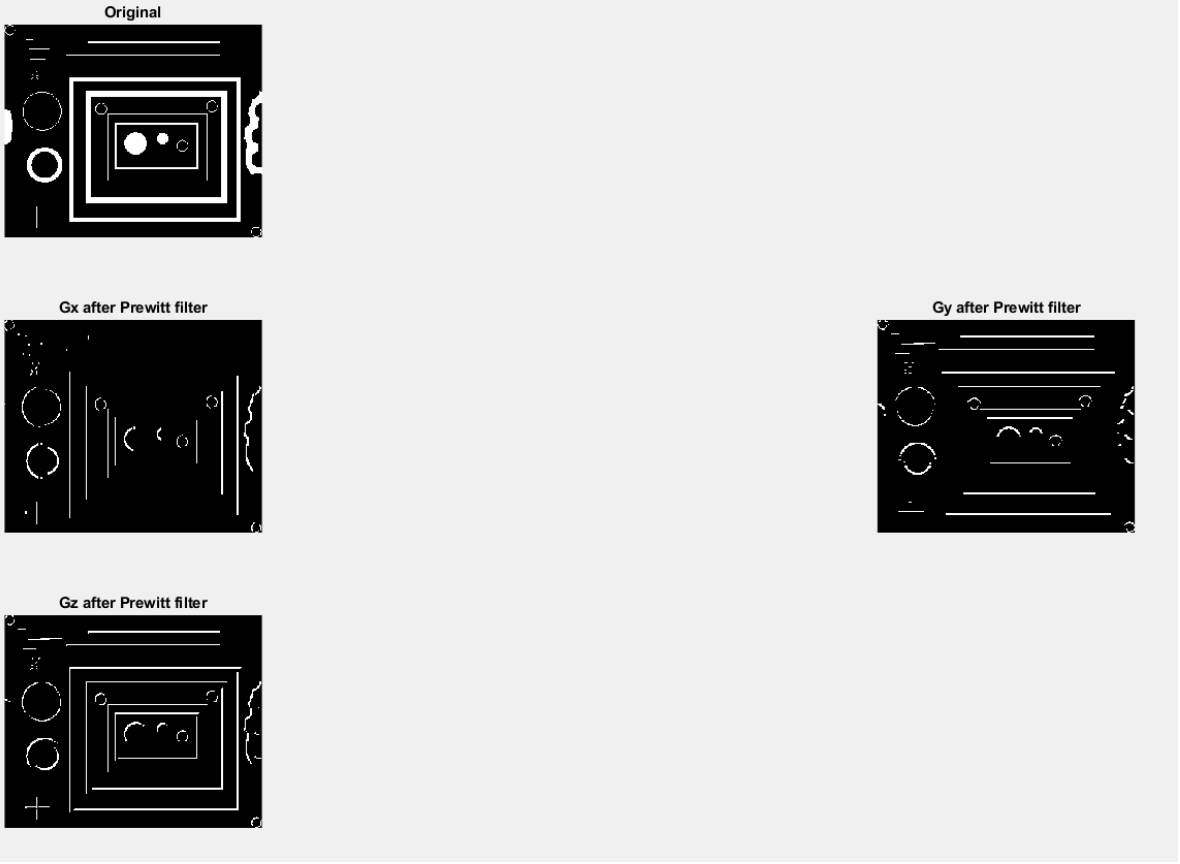
```
%Experiment 5 - Image Segmentation
%Krisha Lakhani - 60001200097
clc;
clear all;
close all;
a = imread("blobs.png");
figure(1);
subplot(3,2,1);
imshow(a);
title("Original");
[x,y,z] = size(a);

%Robert
robertsX = [-1,0,0,1];
robertsY = [0,-1,1,0];
robertsZ = robertsX + robertsY;
for i = 1:x-1
    for j = 1:y-1
        Rrx = a(i,j)*robertsX(1) + a(i,j+1)*robertsX(2) + a(i+1,j)*robertsX(3) + a(i+1,j+1)*robertsX(4);
        Rry = a(i,j)*robertsY(1) + a(i,j+1)*robertsY(2) + a(i+1,j)*robertsY(3) + a(i+1,j+1)*robertsY(4);
        Rrz = a(i,j)*robertsZ(1) + a(i,j+1)*robertsZ(2) + a(i+1,j)*robertsZ(3) + a(i+1,j+1)*robertsZ(4);
        Gx(i, j) = Rrx;
        Gy(i, j) = Rry;
        Gz(i, j) = Rrz;
    end
end
subplot(3,2,3);
imshow(Gx);
title("Gx after Roberts filter");
subplot(3,2,4);
imshow(Gy);
title("Gy after Roberts filter");
subplot(3,2,5);
imshow(Gz);
title("Gz after Roberts filter");
```

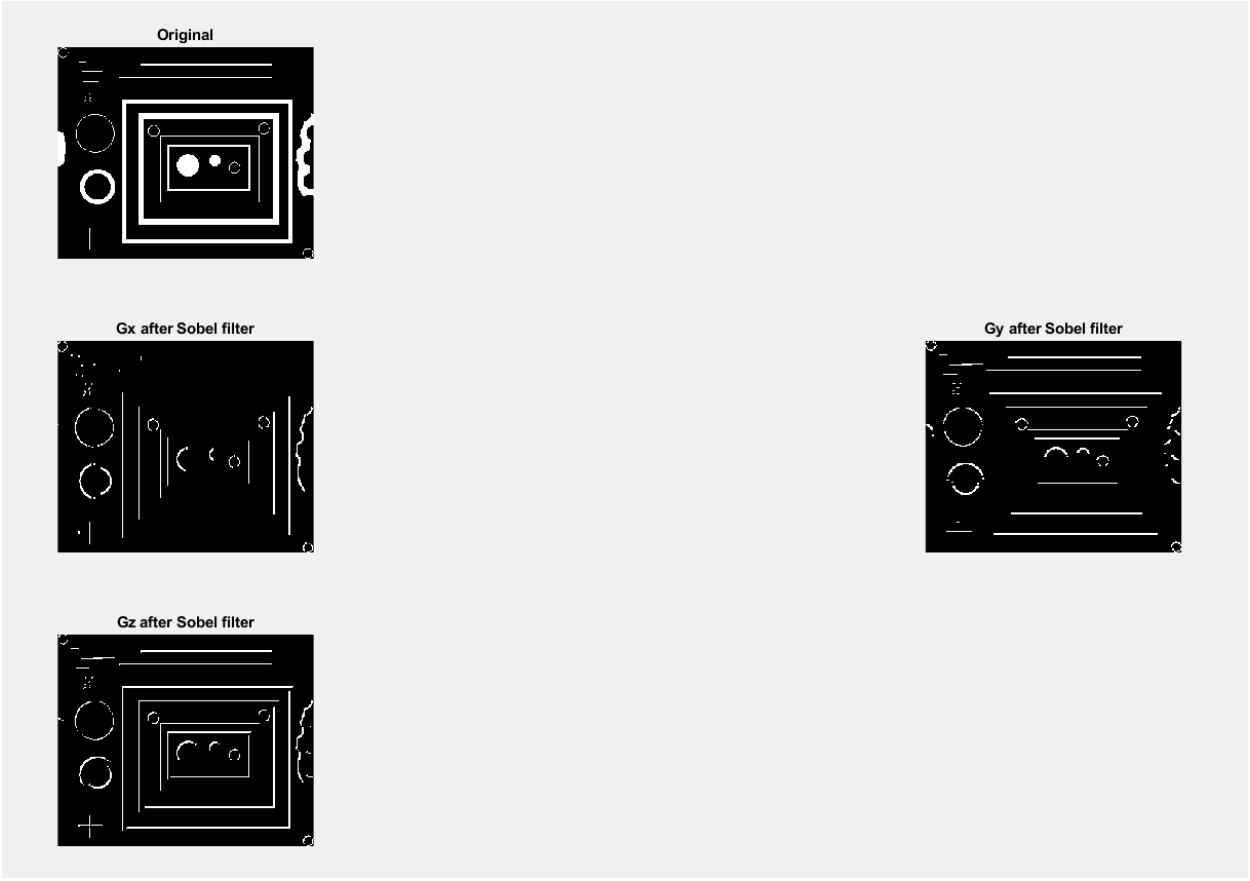
```
%Krisha Lakhani - 60001200097
%Prewitt
a = imread("blobs.png");
figure(2);
subplot(3,2,1);
imshow(a);
title("Original");
[x,y,z] = size(a);
prewittX = [-1,0,1,-1,0,1,-1,0,1];
prewittY = [-1,-1,-1,0,0,0,1,1,1];
prewittZ = prewittX + prewittY;
for i = 2:x-2
    for j = 2:y-2
        Prx = a(i-1,j-1,1)*prewittX(1) + a(i-1,j,1)*prewittX(2) + a(i-1,j+1,1)*prewittX(3) + a(i,j-1,1)*prewittX(4) + a(i,j,1)*prewittX(5) + a(i,j+1,1)*prewittX(6) + a(i+1,j-1,1)*prewittX(7) + a(i+1,j,1)*prewittX(8) + a(i+1,j+1,1)*prewittX(9);
        Pry = a(i-1,j-1,1)*prewittY(1) + a(i-1,j,1)*prewittY(2) + a(i-1,j+1,1)*prewittY(3) + a(i,j-1,1)*prewittY(4) + a(i,j,1)*prewittY(5) + a(i,j+1,1)*prewittY(6) + a(i+1,j-1,1)*prewittY(7) + a(i+1,j,1)*prewittY(8) + a(i+1,j+1,1)*prewittY(9);
        Prz = a(i-1,j-1,1)*prewittZ(1) + a(i-1,j,1)*prewittZ(2) + a(i-1,j+1,1)*prewittZ(3) + a(i,j-1,1)*prewittZ(4) + a(i,j,1)*prewittZ(5) + a(i,j+1,1)*prewittZ(6) + a(i+1,j-1,1)*prewittZ(7) + a(i+1,j,1)*prewittZ(8) + a(i+1,j+1,1)*prewittZ(9);
        Gx(i, j) = Prx;
        Gy(i, j) = Pry;
        Gz(i, j) = Prz;
    end
end
subplot(3,2,3);
imshow(Gx);
title("Gx after Prewitt filter");
subplot(3,2,4);
imshow(Gy);
title("Gy after Prewitt filter");
subplot(3,2,5);
imshow(Gz);
title("Gz after Prewitt filter");
```

```
%Krisha Lakhani - 60001200097
%Sobel
a = imread("blobs.png");
figure(3);
subplot(3,2,1);
imshow(a);
title("Original");
[x,y,z] = size(a);
sobelX = [-1,0,1,-2,0,2,-1,0,1];
sobelY = [-1,-2,-1,0,0,0,1,2,1];
sobelZ = sobelX + sobelY;
for i = 2:x-2
    for j = 2:y-2
        Srx = a(i-1,j-1,1)*sobelX(1) + a(i-1,j,1)*sobelX(2) + a(i-1,j+1,1)*sobelX(3) + a(i,j-1,1)*sobelX(4) + a(i,j,1)*sobelX(5) + a(i,j+1,1)*sobelX(6) + a(i+1,j-1,1)*sobelX(7) + a(i+1,j,1)*sobelX(8) + a(i+1,j+1,1)*sobelX(9);
        Sry = a(i-1,j-1,1)*sobelY(1) + a(i-1,j,1)*sobelY(2) + a(i-1,j+1,1)*sobelY(3) + a(i,j-1,1)*sobelY(4) + a(i,j,1)*sobelY(5) + a(i,j+1,1)*sobelY(6) + a(i+1,j-1,1)*sobelY(7) + a(i+1,j,1)*sobelY(8) + a(i+1,j+1,1)*sobelY(9);
        Srz = a(i-1,j-1,1)*sobelZ(1) + a(i-1,j,1)*sobelZ(2) + a(i-1,j+1,1)*sobelZ(3) + a(i,j-1,1)*sobelZ(4) + a(i,j,1)*sobelZ(5) + a(i,j+1,1)*sobelZ(6) + a(i+1,j-1,1)*sobelZ(7) + a(i+1,j,1)*sobelZ(8) + a(i+1,j+1,1)*sobelZ(9);
        Gx(i, j) = Srx;
        Gy(i, j) = Sry;
        Gz(i, j) = Srz;
      end
end
subplot(3,2,3);
imshow(Gx);
title("Gx after Sobel filter");
subplot(3,2,4);
imshow(Gy);
title("Gy after Sobel filter");
subplot(3,2,5);
imshow(Gz);
title("Gz after Sobel filter");
```

Output




Original
Gx after Prewitt filter
Gy after Prewitt filter
Gz after Prewitt filter



Conclusion:

In summary, we have performed image segmentation on a greyscale using Robert, Prewitt, and Sobel (x and y gradients of each) operators and obtained the segmented output.