EX.NO : **DATE :**

FUZZY LOGIC – IMAGE PROCESSING

An edge is a boundary between two uniform regions. You can detect an edge by comparing the intensity of neighbouring pixels. However, because uniform regions are not crisply defined, small intensity differences between two neighbouring pixels do not always represent an edge. Instead, the intensity difference might represent a shading effect. The fuzzy logic approach for image processing allows you to use membership functions to define the degree to which a pixel belongs to an edge or a uniform region.
Import RGB Image and Convert to Grayscale

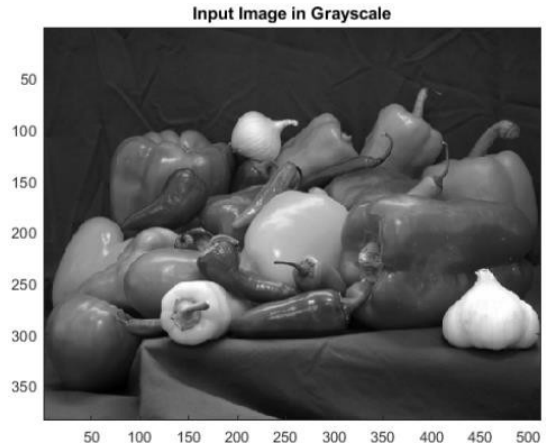
Import the image.

```
Irgb = imread('peppers.png');
```

Irgb is a 384 x 512 x 3 uint8 array. The three channels of Irgb (third array dimension) represent the red, green, and blue intensities of the image.

Convert Irgb to grayscale so that you can work with a 2-D array instead of a 3-D array. To do so, use the rgb2gray function.

```
Igray = rgb2gray(Irgb);
figure
image(Igray,'CDataMapping','scaled')
colormap('gray')
title('Input Image in Grayscale')
```



Convert Image to Double-Precision Data

The evalfis function for evaluating fuzzy inference systems supports only single-precision and double-precision data.
Therefore, convert Igray to a double array using the im2double function.

```
I = im2double(Igray);
```

Obtain Image Gradient

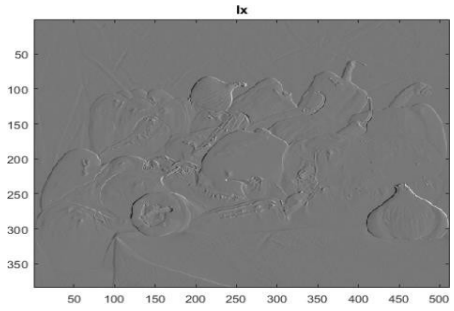
The fuzzy logic edge-detection algorithm for this example relies on the image gradient to locate breaks in uniform regions. Calculate the image gradient along the x-axis and y-axis.

Gx and Gy are simple gradient filters. To obtain a matrix containing the x-axis gradients of I, you convolve I with Gx using the conv2 function. The gradient values are in the [-1 1] range. Similarly, to obtain the y-axis gradients of I, convolve I with
Gy.

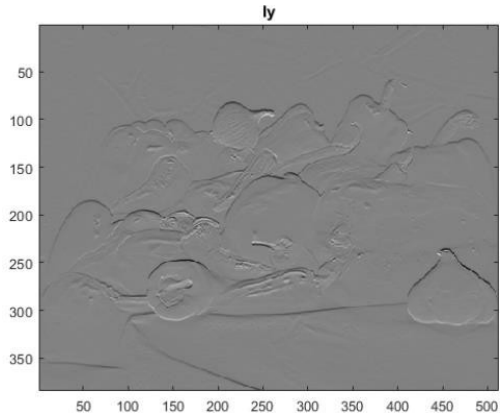
```
Gx = [-1 1];
Gy = Gx';
Ix = conv2(I,Gx,'same');
Iy = conv2(I,Gy,'same');
```

Plot the image gradients.

```
figure
image(Ix,'CDataMapping','scaled')
colormap('gray')
title('Ix')
```




```
figure
image(Iy,'CDataMapping','scaled')
colormap('gray')
title('Iy')
```



Define Fuzzy Inference System (FIS) for Edge Detection
Create a fuzzy inference system (FIS) for edge detection, edgeFIS.

```
edgeFIS = mamfis('Name','edgeDetection');
```
Specify the image gradients, Ix and Iy, as the inputs of edgeFIS.
```
edgeFIS = addInput(edgeFIS,[-1 1],'Name','Ix');
edgeFIS = addInput(edgeFIS,[-1 1],'Name','Iy');
```

Specify a zero-mean Gaussian membership function for each input. If the gradient value for a pixel is 0, then it belongs to
the zero membership function with a degree of 1.
```
sx = 0.1;
sy = 0.1;
edgeFIS = addMF(edgeFIS,'Ix','gaussmf',[sx 0],'Name','zero');
edgeFIS = addMF(edgeFIS,'Iy','gaussmf',[sy 0],'Name','zero');
```
sx and sy specify the standard deviation for the zero membership function for the Ix and Iy inputs.

To adjust the edge detector performance, you can change the values of sx and sy. Increasing the values makes the algorithm less sensitive to the edges in the image and decreases the intensity of the detected edges.

Specify the intensity of the edge-detected image as an output of edgeFIS.
```
edgeFIS = addOutput(edgeFIS,[0 1],'Name','Iout');
```

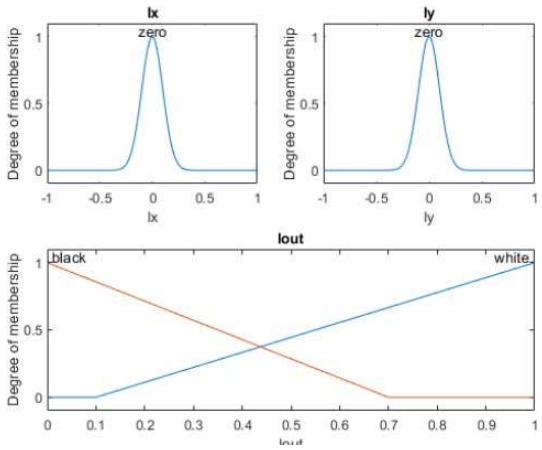
Specify the triangular membership functions, white and black, for Iout.
```
wa = 0.1;
wb = 1;
wc = 1;
ba = 0;
bb = 0;
bc = 0.7;

edgeFIS = addMF(edgeFIS,'Iout','trimf',[wa wb wc],'Name','white');
```

```
edgeFIS = addMF(edgeFIS,'Iout','trimf',[ba bb bc],'Name','black');
```

As you can with sx and sy, you can change the values of wa, wb, wc, ba, bb, and bc to adjust the edge detector performance. The triplets specify the start, peak, and end of the triangles of the membership functions. These parameters influence the intensity of the detected edges.

Plot the membership functions of the inputs and outputs of edgeFIS.

```
figure
subplot(2,2,1)
plotmf(edgeFIS,'input',1)
title('Ix')
subplot(2,2,2)
plotmf(edgeFIS,'input',2)
title('Iy')
subplot(2,2,[3 4])
plotmf(edgeFIS,'output',1)
title('Iout')
```



Specify FIS Rules

Add rules to make a pixel white if it belongs to a uniform region and black otherwise. A pixel is in a uniform region when the image gradient is zero in both directions. If either direction has a nonzero gradient, then the pixel is on an edge.

```
r1 = "If Ix is zero and Iy is zero then Iout is white";
r2 = "If Ix is not zero or Iy is not zero then Iout is black";
edgeFIS = addRule(edgeFIS,[r1 r2]);
edgeFIS.Rules
ans =
1x2 fisrule array with properties:
```

Description
Antecedent
Consequent
Weight
Connection
Details:
Description

---

1 "Ix==zero & Iy==zero => Iout=white (1)"
2 "Ix~=zero | Iy~=zero => Iout=black (1)"

Evaluate FIS

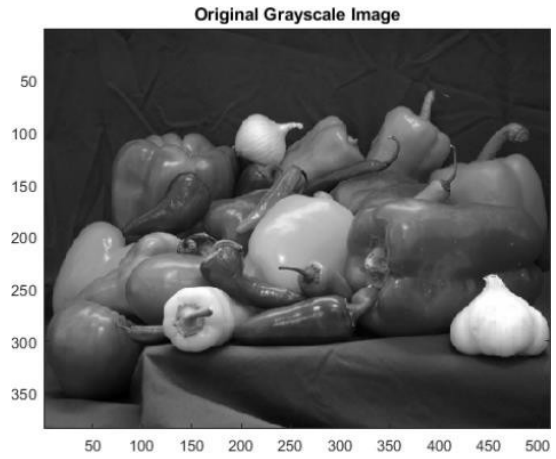
Evaluate the output of the edge detector for each row of pixels in I using corresponding rows of Ix and Iy as inputs.

```
Ieval = zeros(size(I));
for ii = 1:size(I,1)
Ieval(ii,:) = evalfis(edgeFIS,[(Ix(ii,:));(Iy(ii,:))]');
end
```

Plot Results

Plot the original grayscale image.

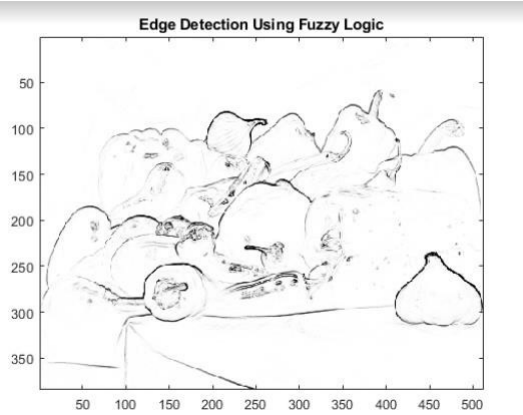
```
figure
image(I,'CDataMapping','scaled')
colormap('gray')
title('Original Grayscale Image')
```



Plot the detected edges.

```
figure
image(Ieval,'CDataMapping','scaled')
colormap('gray')
```

title('Edge Detection Using Fuzzy Logic')



CODE:

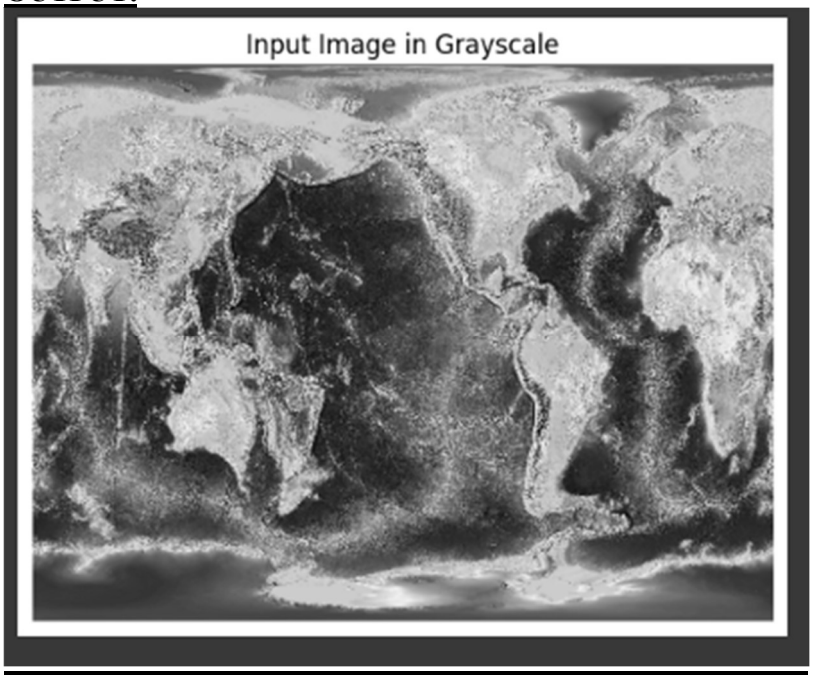
```
[ ] from google.colab import files
    uploaded = files.upload()
```

```
Choose Files  No file chosen    Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.
Saving 242624_vegetables-png.png to 242624_vegetables-png.png
```

```
[ ] Irgb = io.imread('242624_vegetables-png.png')  # Replace 'peppers.png' with the name of the uploaded file if different
```

```
import numpy as np
import skfuzzy as fuzz
from skfuzzy import control as ctrl
import matplotlib.pyplot as plt
from skimage import color, io
import cv2
import urllib

# Download the image from a URL
url = 'https://upload.wikimedia.org/wikipedia/commons/3/3d/LARGE_elevation.jpg'  # URL of a sample image
image_path = '/content/sample_image.jpg'
urllib.request.urlretrieve(url, image_path)

# Load and process the image
Irgb = io.imread(image_path)  # Load image from URL path
Igray = color.rgb2gray(Irgb)     # Convert RGB to grayscale
Igray = cv2.resize(Igray, (512, 384))  # Resize to ensure dimensions are 384x512

# Continue with the rest of the code
plt.figure()
plt.imshow(Igray, cmap='gray')
plt.title('Input Image in Grayscale')
plt.axis('off')
plt.show()

# The rest of the code remains the same
```

OUTPUT:



RESULT:

Thus Program is Executed Successfully And Output is Verified.