Aim: Image Segmentation

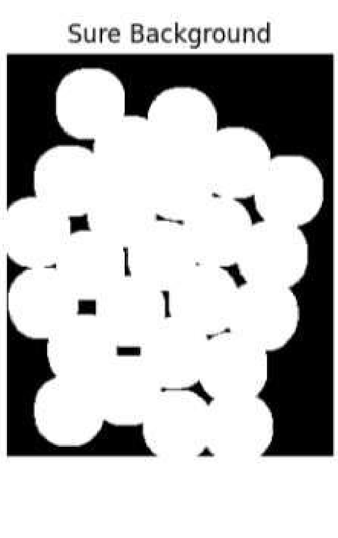
Objective : Image segmentation is the process of dividing an image into several disjoint small local areas or cluster sets according to certain rules and principles. The watershed algorithm is a computer vision technique used for image region segmentation.

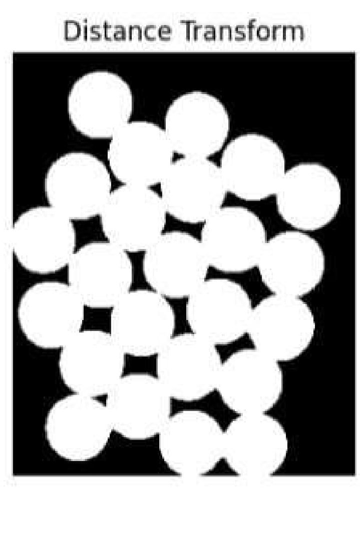
Theory :
The watershed algorithm uses topographic information to divide an image into multiple segments or regions. The algorithm views an image as a topographic surface, each pixel representing a different height. The watershed algorithm uses this information to identify catchment basins, similar to how water would collect in valleys in a real topographic map. The watershed algorithm identifies the local minima, or the lowest points, in the image. These points are then marked as markers. The algorithm then floods the image with different colors, starting from these marked markers. As the color spreads, it fills up the catchment basins until it reaches the boundaries of the objects or regions in the image.

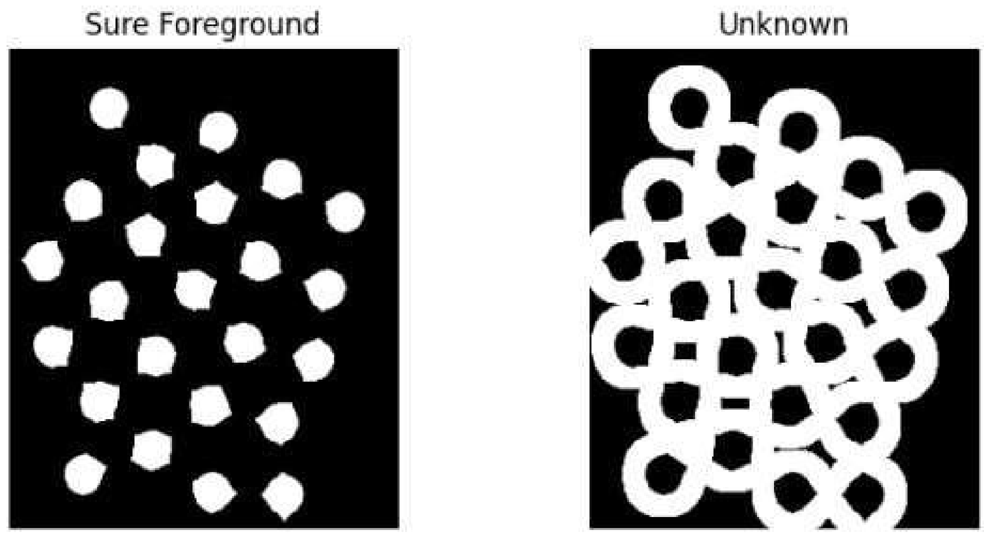
The catchment basin in the watershed algorithm refers to a region in the image that is filled by the spreading color starting from a marker. The catchment basin is defined by the boundaries of the object or region in the image and the local minima in the intensity values of the pixels. The algorithm uses the catchment basins to divide the image into separate regions and then identifies the boundaries between the basins to create a segmentation of the image for object recognition, image analysis, and feature extraction tasks.

The whole process of the watershed algorithm can be summarized in the following steps:

- Marker placement: The first step is to place markers on the local minima, or the lowest points, in the image. These markers serve as the starting points for the flooding process.
- Flooding: The algorithm then floods the image with different colors, starting from the markers. As the color spreads, it fills up the catchment basins until it reaches the boundaries of the objects or regions in the image.
- Catchment basin formation: As the color spreads, the catchment basins are gradually filled, creating a segmentation of the image. The resulting segments or regions are assigned unique colors, which can then be used to identify different objects or features in the image.
- Boundary identification: The watershed algorithm uses the boundaries between the different colored regions to identify the objects or regions in the image. The resulting segmentation can be used for object recognition, image analysis, and feature extraction tasks.





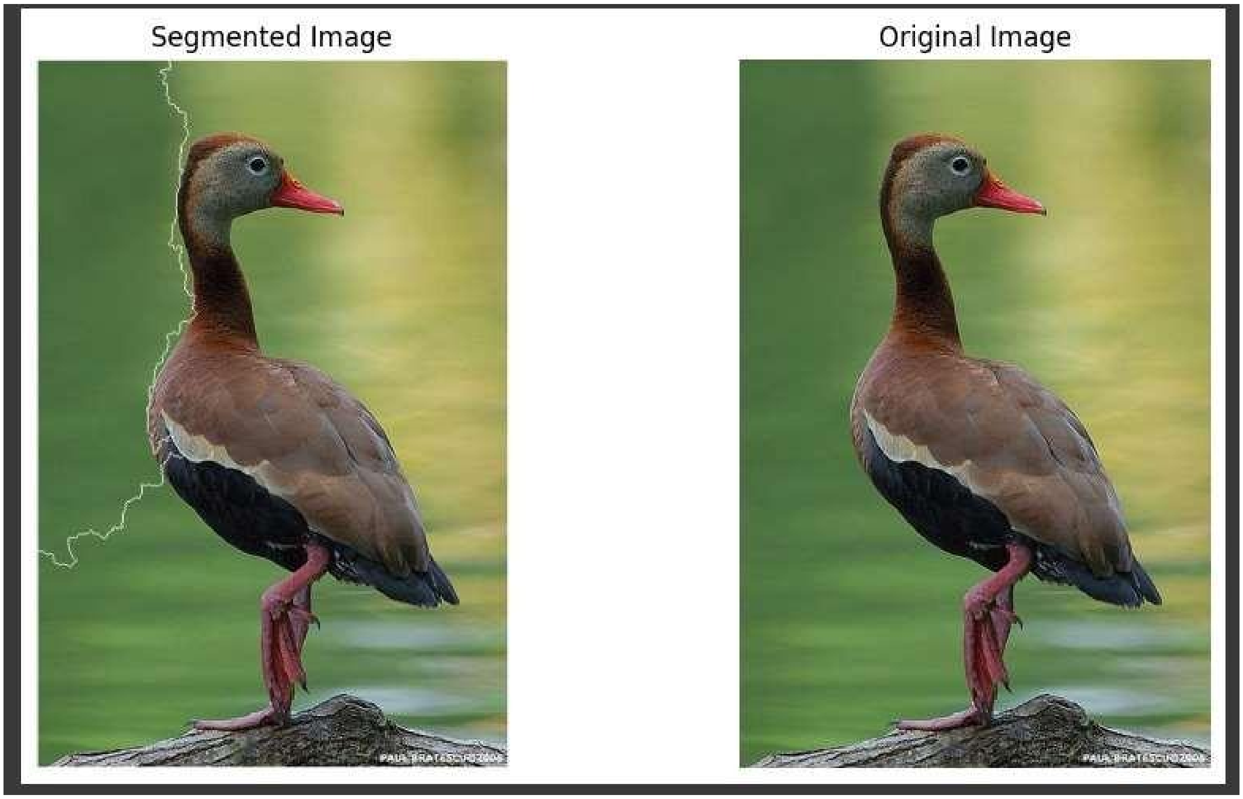

Sure Foreground
Unknown


Input
GrabCut Mask
Output

Code:-

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
image_path = '777.jpg'
image = cv2.imread(image_path)
gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

# Apply thresholding to create a binary image
ret, thresh = cv2.threshold(gray, 0, 255, cv2.THRESH_BINARY_INV + cv2.THRESH_OTSU)

# Noise removal
kernel = np.ones((3, 3), np.uint8)
opening = cv2.morphologyEx(thresh, cv2.MORPH_OPEN, kernel, iterations=2)

# Sure background area
sure_bg = cv2.dilate(opening, kernel, iterations=2)

# Finding sure foreground area
dist_transform = cv2.distanceTransform(opening, cv2.DIST_L2, 5)
ret, sure_fg = cv2.threshold(dist_transform, 0.7 * dist_transform.max(), 255, 0)

# Finding unknown region
sure_fg = np.uint8(sure_fg)
unknown = cv2.subtract(sure_bg, sure_fg)

# Marker labelling
ret, markers = cv2.connectedComponents(sure_fg)
markers = markers + 1
markers[unknown == 255] = 0
markers = cv2.watershed(image, markers)
image[markers == -1] = [255, 255, 255]
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 2)
plt.imshow(cv2.cvtColor(cv2.imread(image_path), cv2.COLOR_BGR2RGB))
plt.title('Original Image')
plt.axis('off')
plt.subplot(1, 2, 1)
plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
plt.title('Segmented Image')
plt.axis('off')
plt.tight_layout()
plt.show()
```

Output:-



Conclusion:-

In conclusion, our research has centered on the watershed algorithm's application in image segmentation. This innovative approach treats images as topographical maps, providing an effective solution for separating objects from backgrounds and segmenting intricate images with irregular shapes and structures. It is important to note that achieving optimal results necessitates meticulous parameter adjustment and pre-processing steps. The watershed algorithm's key strengths lie in its capacity to harness gradient information and local minima as markers, resulting in precise segmentation outcomes.

As we look ahead, future investigations should be dedicated to enhancing the algorithm's robustness and adaptability to diverse image types and conditions. This could involve the development of automated marker selection methods and addressing challenges associated with noisy or low-contrast images. In summary, the watershed algorithm holds significant promise across a wide range of applications in computer vision and medical imaging, presenting opportunities for further refinement and advancement in the field.