Aim: To study object segmentation.

Objective: Object segmentation using the Watershed and GrabCut algorithms, Example of foreground detection with GrabCut, Image segmentation with the Watershed algorithm.

Theory:

- 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. It is an algorithm that correctly determines the "outline of an object".
- The algorithm used for foreground extraction is GrabCut Algorithm. In this algorithm, the region is drawn in accordance with the foreground, and a rectangle is drawn over it. This is the rectangle that encases our main object. The region coordinates are decided over understanding the foreground mask. But this segmentation is not perfect, as it may have marked some foreground region as background and vice versa. This problem can be avoided manually. This foreground extraction technique functions just like a green screen in cinematics.
- 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.

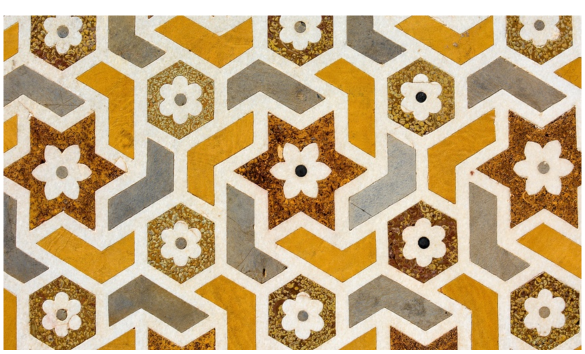
The whole process of the watershed algorithm can be summarized in the following steps:

- 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.

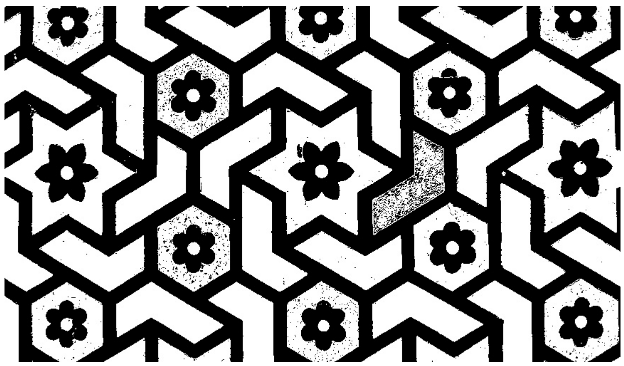
- Catchment basin formation: As the color spreads, the catchment basins are gradually filled, creating a segmentation of the image. The resulting segments or regions are assigned unique colors, which can then be used to identify different objects or features in the image.
- Boundary identification: The 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.

Code :

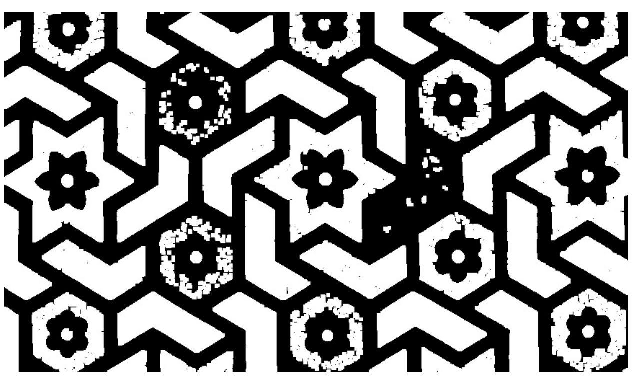
```
import cv2
import numpy as np
from IPython.display import Image, display
from matplotlib import pyplot as plt
# Plot the image
def imshow(img, ax=None):
    if ax is None:
        ret, encoded = cv2.imencode(".jpg", img)
        display(Image(encoded))
    else:
        ax.imshow(cv2.cvtColor(img, cv2.COLOR_BGR2RGB))
        ax.axis('off')

#Image loading
img = cv2.imread("/content/img.jpg")
#image grayscale conversion
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Show image
imshow(img)
```



```
#Threshold Processing
ret, bin_img = cv2.threshold(gray,0, 255,cv2.THRESH_BINARY_INV + cv2.THRESH_OTSU)
imshow(bin_img)
```

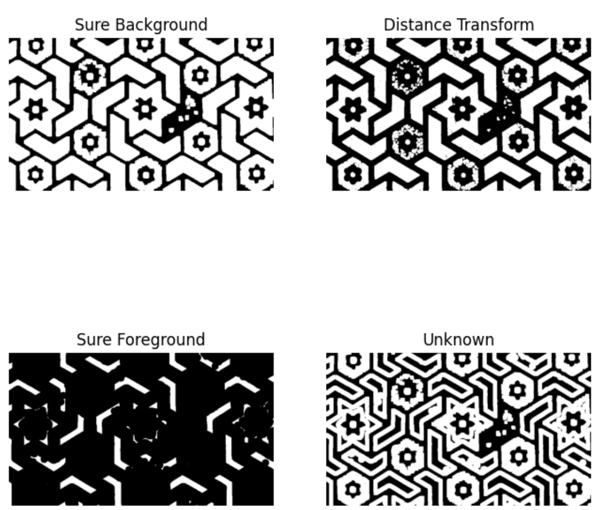


```
# noise removal
kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (3, 3))
bin_img = cv2.morphologyEx(bin_img,cv2.MORPH_OPEN,kernel,iterations=2)
imshow(bin_img)
```

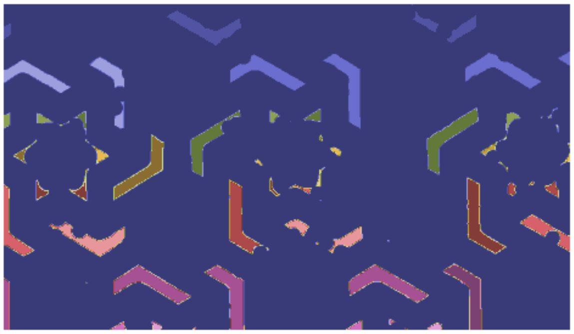


```
# Create subplots with 1 row and 2 columns
fig, axes = plt.subplots(nrows=2, ncols=2, figsize=(8, 8))
# sure background area
sure_bg = cv2.dilate(bin_img, kernel, iterations=3)
```

```
imshow(sure_bg, axes[0,0])
axes[0, 0].set_title('Sure Background')


# Distance transform
dist = cv2.distanceTransform(bin_img, cv2.DIST_L2, 5)
imshow(dist, axes[0,1])
axes[0, 1].set_title('Distance Transform')
#foreground area
ret, sure_fg = cv2.threshold(dist, 0.5 * dist.max(), 255, cv2.THRESH_BINARY)
sure_fg = sure_fg.astype(np.uint8)
imshow(sure_fg, axes[1,0])
axes[1, 0].set_title('Sure Foreground')
# unknown area
unknown = cv2.subtract(sure_bg, sure_fg)
imshow(unknown, axes[1,1])
axes[1, 1].set_title('Unknown')
plt.show()
```

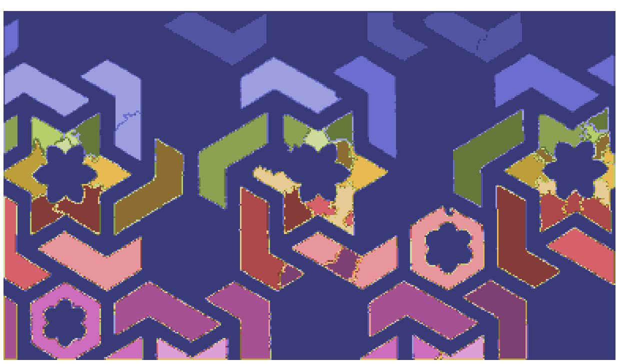


```
# Marker labelling
# sure foreground
ret, markers = cv2.connectedComponents(sure_fg)

# Add one to all labels so that background is not 0, but 1
markers += 1
# mark the region of unknown with zero
markers[unknown == 255] = 0

fig, ax = plt.subplots(figsize=(6, 6))
ax.imshow(markers, cmap="tab20b")
ax.axis('off')
plt.show()
```



```
# watershed Algorithm
markers = cv2.watershed(img, markers)
fig, ax = plt.subplots(figsize=(5,5))
ax.imshow(markers, cmap="tab20b")
ax.axis('off')
plt.show()
labels = np.unique(markers)
```

```
coins = []
for label in labels[2:]:
# Create a binary image in which only the area of the label is in the foreground
#and the rest of the image is in the background
    target = np.where(markers == label, 255, 0).astype(np.uint8)
# Perform contour extraction on the created binary image
    contours, hierarchy = cv2.findContours(
        target, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE
    )
    coins.append(contours[0])
# Draw the outline
img = cv2.drawContours(img, coins, -1, color=(0, 23, 223), thickness=2)
imshow(img)
```



Conclusion:

The GrabCut algorithm is a flexible and precise method for segmenting images that lets users input for separating objects from their backgrounds. Applications like image editing, object detection, and interactive picture segmentation tools all frequently use it.When there are obvious intensity variations between objects and the background, the Watershed method is a potent tool for segmenting items in an image. The program loads the image, converts it to grayscale, goes through a few preprocessing stages, marks the local minima, floods the image with various colors, and then determines where the areas' borders are. The segmented image that results is then shown.