

Morphological Operations

Morphology: a branch of biology that deals with the form and structure of animals and plants.

Morphological image processing: is used to extract image components for representation and description of region shape, such as boundaries, skeletons, and the convex hull.

Fundamental morphological operations are:

1. Erosion and dilation.
2. Opening and Closing.

Structuring Element

To process an image according to a given shape, we need to first define the shape, or structuring element. The Image Processing Toolbox provides a function for creating a structuring element that can be used the following syntax:

```
SE = strel (shape,parameters)
```

Where:

SE: Structuring element.

shape : Flat ['arbitrary' 'pair' 'diamond' 'periodicline' 'disk' 'rectangle' 'line' 'square' 'octagon'],
Nonflat ['arbitrary' 'ball'].

Parameters: Associated with the selected shape.

Dilation & Erosion (التعريض والتقليص)

Dilation operation: The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

Dilation adds pixels to the boundaries of objects in an image, dilation expands an image, to **dilate** an image, use the following function:

```
IM2 = imdilate (IM,SE)
```

Where:

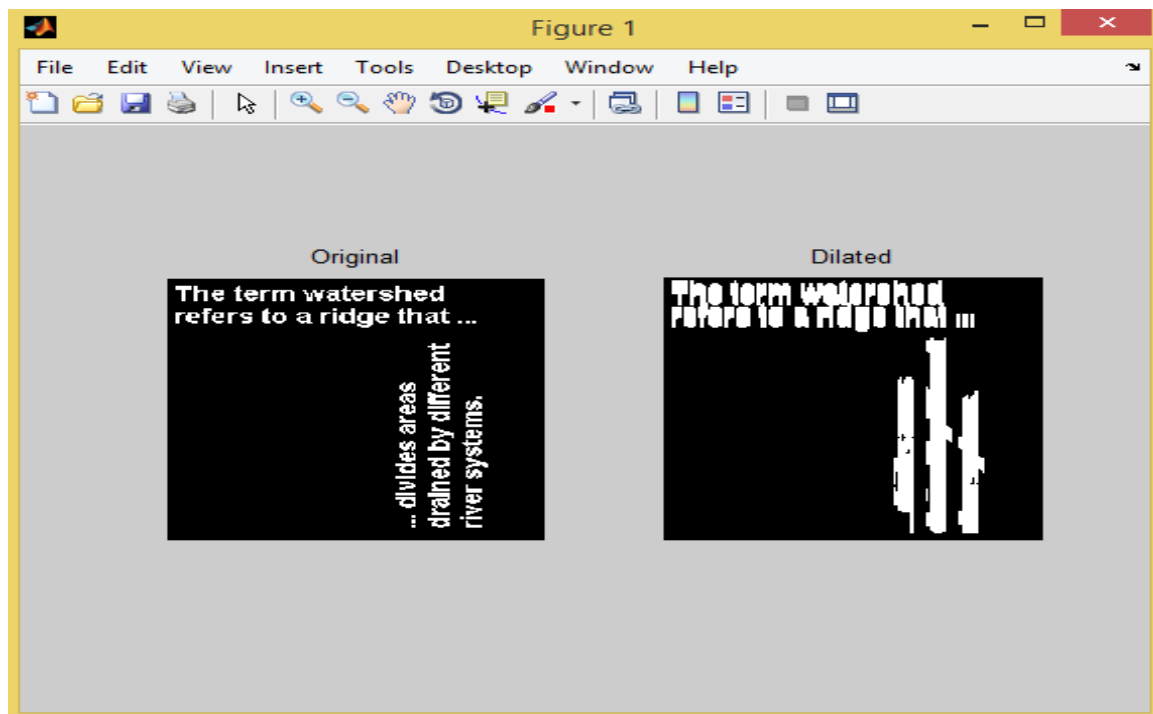
IM2: The dilated image.

IM: The image to dilate.

SE: The structuring element.

Example to apply a dilate operation on binary image with a vertical line structuring element:

```
clear all;
clc;
bw = imread('text.png');
se = strel('line',11,90);
bw2 = imdilate(bw,se);
subplot(1,2,1),imshow(bw), title('Original')
subplot(1,2,2), imshow(bw2), title('Dilated')
```



Example to apply a dilate operation on grayscale image with a rolling ball structuring element:

```
clear all;  
clc;  
I = imread('cameraman.tif');  
se = strel('ball',5,5);  
I2 = imdilate(I,se);  
subplot(1,2,1),imshow(I), title('Original')  
subplot(1,2,2), imshow(I2), title('Dilated')
```



Erosion operation: The value of the output pixel is the minimum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0.

Erosion removes pixels on object boundaries in an image, erosion shrinks an image, to **erode** an image, use the following function:

$$\mathbf{IM2} = \text{imerode}(\mathbf{IM}, \mathbf{SE})$$

Where:

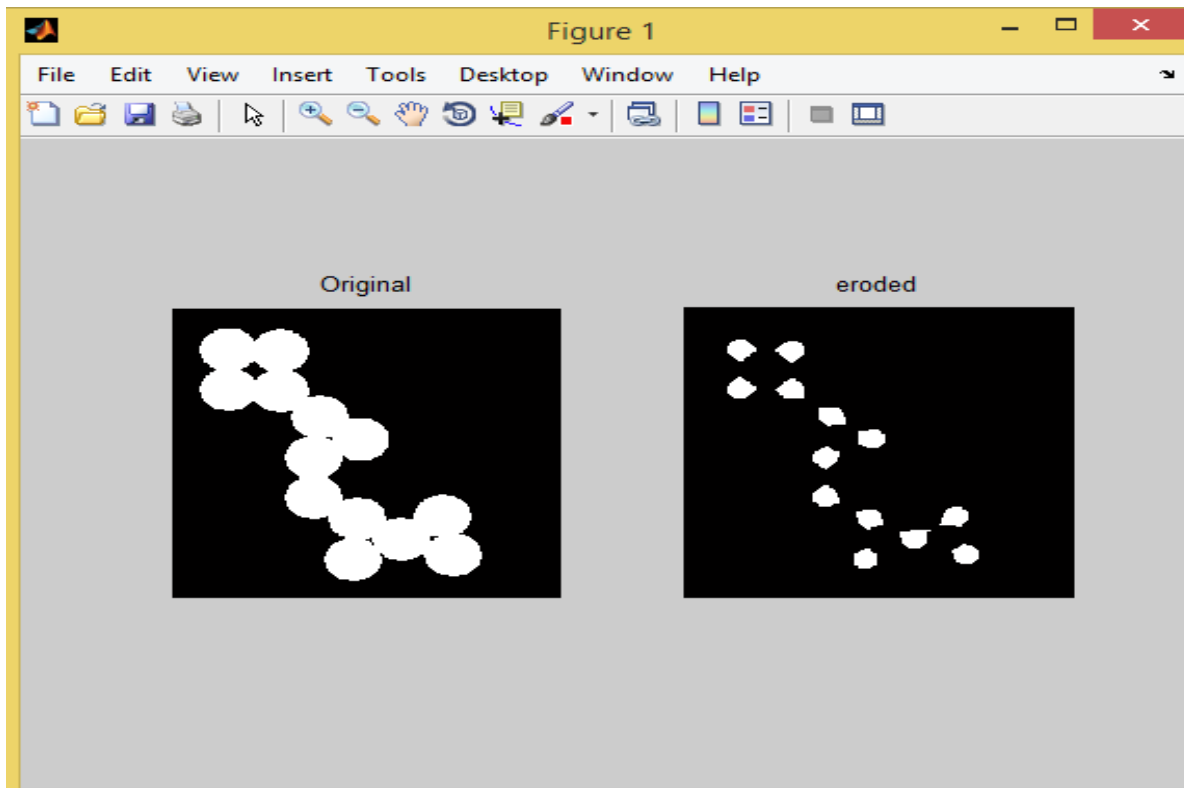
IM2: The eroded image.

IM: The image to erode.

SE: The structuring element.

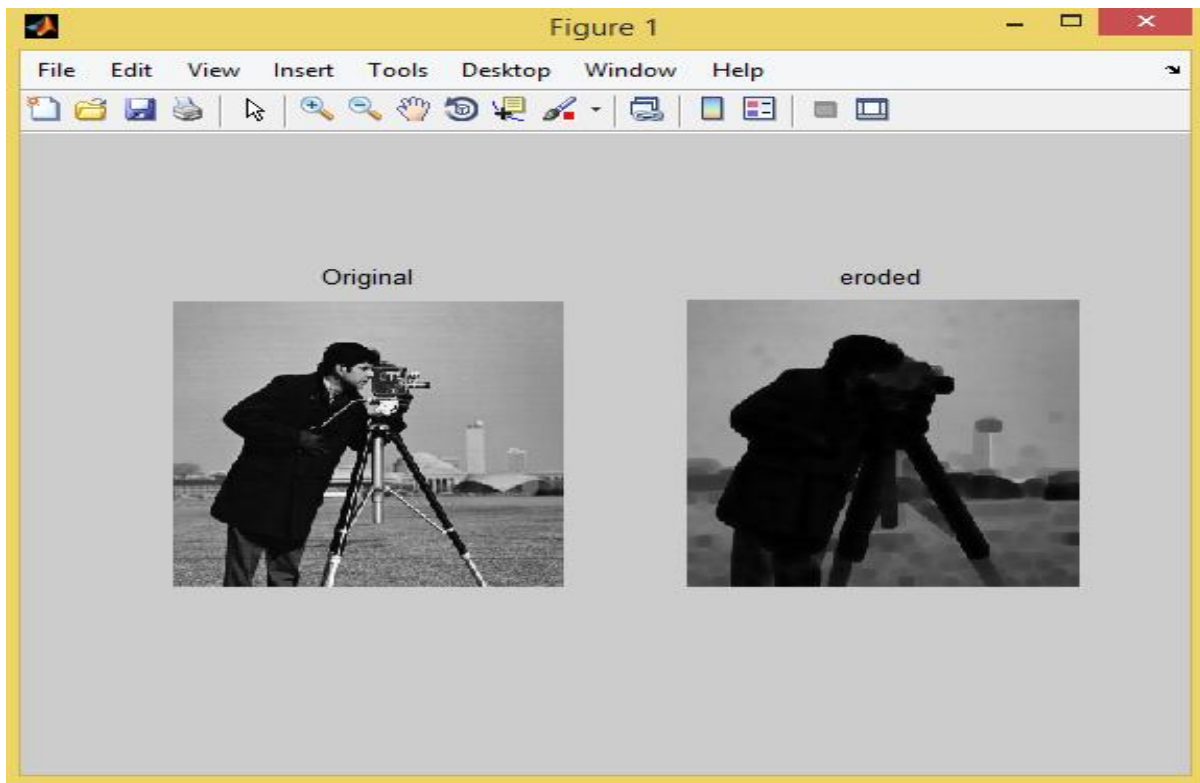
Example to apply an erode operation on binary image with a disk structuring element:

```
clear all;  
clc;  
BW = imread('circles.png');  
se = strel('disk',11);  
erodedBW = imerode(BW,se);  
subplot(1,2,1),imshow(BW), title('Original')  
subplot(1,2,2), imshow(erodedBW), title('eroded')
```



Example to apply an erode operation on a grayscale image with a ball structuring element:

```
clear all;  
clc;  
I = imread('cameraman.tif');  
se = strel('ball',5,5);  
I2 = imerode(I,se);  
subplot(1,2,1),imshow(I), title('Original')  
subplot(1,2,2), imshow(I2), title('eroded')
```



Opening and closing (الفتح والغلق)

Opening operation generally smoothes the contour of an object, breaks narrow isthmuses, eliminates thin protrusions and removing stray foreground pixels in background.

Opening operations can be done by combination of erosion and dilation in different sequence.

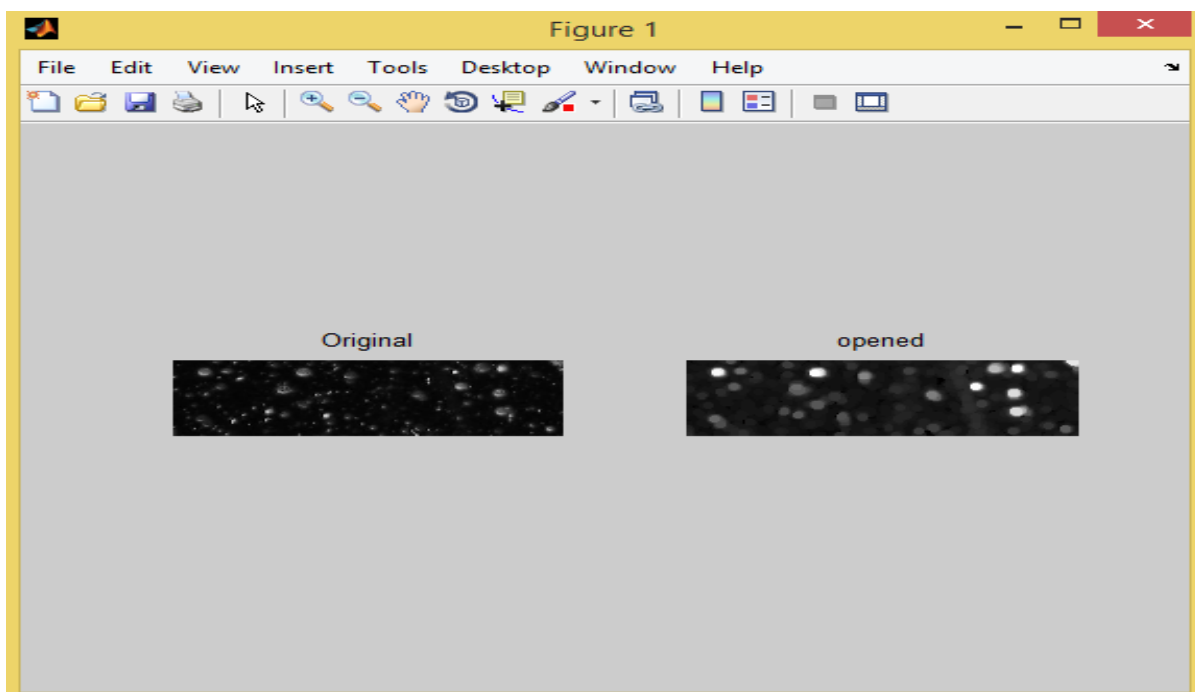
To apply **opening operations** on image, use the following function:

IM2 = imopen (IM,SE)

Performs morphological opening on the grayscale or binary image **IM** with the structuring element **SE**. **SE** must be a single structuring element object, as opposed to an array of objects. The morphological open operation is erosion followed by dilation, using the same structuring element for both operations.

Example to remove the smaller objects in an image:

```
clear all;
clc;
I = imread('snowflakes.png');
se = strel('disk',5);%Create a disk-shaped structuring element with a radius of 5 pixels.
I_opened = imopen(I,se);%Remove snowflakes having a radius less than 5 pixels by
opening it with the disk-shaped structuring element created in step 2.
subplot(1,2,1),imshow(I), title('Original')
subplot(1,2,2),imshow(I_opened,[]), title('opened')
```



Closing operation tends to smooth sections of contours but, as opposed to opening, it generally fuses narrow breaks and long thin gulfs, eliminates small holes, fills gaps in the contour and Removing holes in the foreground.

Closing operations can be done by combination of erosion and dilation in different sequence. To apply **closing operations** on image, use the following function:

$$\mathbf{IM2} = \text{imclose}(\mathbf{IM}, \mathbf{SE})$$

Performs morphological closing on the grayscale or binary image **IM**, returning the closed image **IM2**. The structuring element **SE** must be a single structuring element object, as opposed to an array of objects. The morphological close operation is a dilation followed by erosion, using the same structuring element for both operations.

Example to apply closing operation to join the circles in the image together by filling in the gaps between them and by smoothing their outer edges:

```
clear all;
clc;
BW = imread('circles.png');
se = strel('disk',10);%create a disk-shaped structuring element. Use a disk structuring
element to preserve the circular nature of the object. Specify a radius of 10 pixels so that the
largest gap gets filled.
closeBW = imclose(BW,se);%Perform a morphological close operation on the image.
subplot(1,2,1),imshow(BW), title('Original')
subplot(1,2,2),imshow(closeBW), title('closed')
```

