



## Department of Electronics Engineering

### Image Morphological Operations

**Aim:-** To perform Dilation, Erosion, Opening & Closing operations & boundary extraction using morphological operation.

#### Theory:-



[Dilation](#) - grow image regions

$$X \oplus B = \left\{ z \mid \left[ (\hat{B})_z \cap X \right] \neq \emptyset \right\}$$



[Erosion](#) - shrink image

$$X \ominus B = \left\{ z \mid (B)_z \subseteq X \right\}$$



[Opening](#) - structured removal of image region boundary pixels



[Closing](#) - structured filling in of image region boundary pixels



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Opening and closing are two important operators from mathematical morphology. They are both derived from the fundamental operations of erosion and dilation. As with other morphological operators, the exact operation is determined by a structuring element.

Opening:  $OPEN(A,B)=D(E(A))$

Closing:  $CLOSE(A,B)=E(D(A))$

D: Dilation

E: Erosion

Opening generally soothes the contours of the image breaks down narrow bridges and eliminates the protrusions. Thus opening isolates objects which may be just touching one another

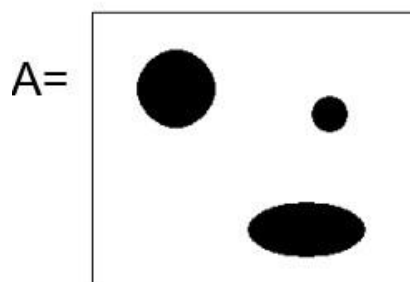
Morphological closing of an image is basically followed by Erosion using the same structuring element. Closing generally tends to fuse narrow breaks and eliminates small holes. This simplifies the process of assessing the separation of particles.

## Boundary Extraction

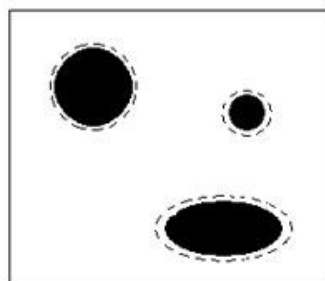
Boundary(A) = A  $\ominus$  B, If B = 

1	1	1
1	1	1
1	1	1

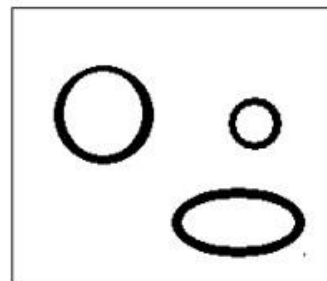
 then  $A \ominus B$  would be same as A except one pixel less from all the sides.



$A \ominus B =$



$A - (A \ominus B) =$





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**Implementation Instructions: -**

- 1) Read the given binary image.
- 2) Select appropriate structuring element.
- 3) Perform dilation, Erosion, opening & closing operations as described in theory.
- 4) Display the result of all the above operations.

**Boundary Extraction:**

- 5) Read the given binary image as A.
- 6) Select proper structuring element B.
- 7) Perform Erosion operation on given image A with structuring element B.
- 8) Subtract the result of above operation from main image
- 9) Display the extracted boundary of the object.

DJSCE ELEX DIP SAK



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### Dilation and Erosion

```
exp7_1.m  X  +
1  %Experiment 7 - Morphological Operations (Dilation and Erosion)
2  %Krisha Lakhani - 60001200097
3  clc;
4  clear all;
5  a = [
6      0 0 0 0 0 0 0;
7      1 1 0 0 1 1 0;
8      1 1 0 0 1 1 0;
9      1 1 1 1 1 1 0;
10     1 1 1 1 1 1 0;
11     1 1 0 0 1 1 0;
12     1 1 0 0 1 1 0;
13     0 0 0 0 0 0 0
14 ];
15 st = [
16     1 1;
17     0 0
18 ];
19 [x,y] = size(a);
20 dilation = zeros(x,y);
21 erosion = zeros(x,y);
22 for i = 1:x-1
23     for j = 1:y-1
24         if (a(i,j) == st(1,1) || a(i,j+1) == st(1,2))
25             dilation(i,j) = 1;
26         end
27     end
28 end
29 for m = 1:x-1
30     for n = 1:y-1
31         if (a(m,n) == st(1,1) && a(m,n+1) == st(1,2))
32             erosion(m,n) = 1;
33         end
34     end
35 end
36 disp("Krisha Lakhani - 60001200097");
37 disp("Original:");
38 disp(a);
39 disp("Structuring element:");
40 disp(st);
41 disp("Dilation:");
42 disp(dilation);
43 disp("Erosion:");
44 disp(erosion);
```



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Krishna Lakhani - 60001200097

Original:

0	0	0	0	0	0	0
1	1	0	0	1	1	0
1	1	0	0	1	1	0
1	1	1	1	1	1	0
1	1	1	1	1	1	0
1	1	0	0	1	1	0
1	1	0	0	1	1	0
0	0	0	0	0	0	0

Structuring element:

1	1
0	0

Dilation:

0	0	0	0	0	0	0
1	1	0	1	1	1	0
1	1	0	1	1	1	0
1	1	1	1	1	1	0
1	1	1	1	1	1	0
1	1	0	1	1	1	0
1	1	0	1	1	1	0
0	0	0	0	0	0	0

Erosion:

0	0	0	0	0	0	0
1	0	0	0	1	0	0
1	0	0	0	1	0	0
1	1	1	1	1	0	0
1	1	1	1	1	0	0
1	0	0	0	1	0	0
1	0	0	0	1	0	0
0	0	0	0	0	0	0

**Department of Electronics Engineering****Opening**

```
exp7_1.m  exp7_2.m  +
1  %Experiment 7 - Morphological Operations (Opening)
2  %Krisha Lakhani - 60001200097
3  clc;
4  clear all;
5  a = [
6      0 0 0 0 0 0 0 0 0;
7      0 0 0 0 0 0 0 0 0;
8      0 1 1 1 0 0 1 1 1;
9      0 1 1 1 0 0 1 1 1;
10     0 1 1 1 1 1 1 1 1;
11     0 1 1 1 0 0 1 1 1;
12     0 1 1 1 0 0 1 1 1;
13     0 0 0 0 0 0 0 0 0;
14     0 0 0 0 0 0 0 0 0;
15     0 0 0 0 0 0 0 0 0;
16 ];
17 st = [
18     1;
19     1;
20 ];
21 [x,y] = size(a);
22 e_a = zeros(x,y);
23 opening = zeros(x,y);
24 for m = 1:x-1
25     for n = 1:y
26         if (a(m,n) == st(1,1) && a(m+1,n) == st(2,1))
27             e_a(m,n) = 1;
28         end
29     end
30 end
31 for i = 1:x-1
32     for j = 1:y
33         if (e_a(i,j) == st(1,1) || e_a(i+1,j) == st(2,1))
34             opening(i,j) = 1;
35         end
36     end
37 end
38 disp("Krisha Lakhani - 60001200097");
39 disp("Original:");
40 disp(a);
41 disp("Structuring element:");
42 disp(st);
43 disp("E(A):");
44 disp(e_a);
45 disp("After Opening:");
46 disp(opening);
```



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Krishna Lakhani - 60001200097

Original:

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	1	1	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Structuring element:

1  
1

E (A) :

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

After Opening:

0	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	1	1	1	0	0	1	1	1	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0



**Department of Electronics Engineering****Closing**

```
exp7_1.m x exp7_2.m x exp7_3.m x +
1 %Experiment 7 - Morphological Operations (Closing)
2 %Krisha Lakhani - 60001200097
3 clc;
4 clear all;
5 a = [
6     0 0 0 0 0 0 0 0 0 0;
7     0 0 0 0 0 0 0 0 0 0;
8     1 1 1 1 0 1 1 1 1 1;
9     1 1 0 1 0 1 1 0 1 1;
10    1 1 1 0 1 1 1 1 1 1;
11    1 1 1 1 0 1 1 1 1 1;
12    1 1 1 1 0 1 1 1 1 1;
13    0 0 0 0 0 0 0 0 0 0;
14    0 0 0 0 0 0 0 0 0 0;
15    0 0 0 0 0 0 0 0 0 0;
16 ];
17 st = [
18     1;
19     1
20 ];
21 [x,y] = size(a);
22 d_a = zeros(x,y);
23 closing = zeros(x,y);
24 for m = 1:x-1
25     for n = 1:y
26         if (a(m,n) == st(1,1) || a(m+1,n) == st(2,1))
27             d_a(m,n) = 1;
28         end
29     end
30 end
31 for i = 1:x-1
32     for j = 1:y
33         if (d_a(i,j) == st(1,1) && d_a(i+1,j) == st(2,1))
34             closing(i,j) = 1;
35         end
36     end
37 end
38 disp('Krisha Lakhani - 60001200097');
39 disp('Original:');
40 disp(a);
41 disp('Structuring element:');
42 disp(st);
43 disp('D(A):');
44 disp(d_a);
45 disp('After Closing:');
46 disp(closing);
```



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Original:

0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	1	1	1	1	1
1	1	0	1	0	1	1	0	1	1
1	1	1	0	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

Structuring element:

1  
1

D(A) :

0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

After Closing:

0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
1	1	1	1	0	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0



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### Boundary Extraction

```
exp7_1.m exp7_2.m exp7_3.m exp7_4.m +
1 %Experiment 7 - Morphological Operations (Boundary Extraction)
2 %Krisha Lakhani - 60001200097
3 clc;
4 clear all;
5 a = [
6     0 0 0 0 0 0 0;
7     0 0 0 0 0 0 0;
8     0 0 1 1 1 1 0;
9     0 1 1 1 1 1 0;
10    0 1 1 1 1 1 1;
11    0 1 1 1 1 1 1;
12    0 0 1 1 1 1 1;
13    0 0 0 0 0 0 0;
14 ];
15 st = [
16     0 1 0;
17     1 1 1;
18     0 1 0;
19 ];
20 [x,y] = size(a);
21 e_a = zeros(x,y);
22 be = zeros(x,y);
23 for m = 1:x-2
24     for n = 1:y-2
25         if (a(m,n+1) == st(1,2) && a(m+1,n) == st(2,1) && a(m+1,n+1) == st(2,2) && a(m+1,n+2) == st(2,3) && a(m+2,n+1) == st(3,2))
26             e_a(m+1,n+1) = 1;
27         end
28     end
29 end
30 be = a - e_a;
31 disp("Krisha Lakhani - 60001200097");|
32 disp("Original:");
33 disp(a);
34 disp("Structuring element:");
35 disp(st);
36 disp("E(A):");
37 disp(e_a);
38 disp("After Boundary Extraction:");
39 disp(be);
```

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Krisha Lakhani - 60001200097

Original:

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	1	1	1	1	0	0
0	1	1	1	1	1	0	0
0	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1
0	0	1	1	1	1	1	1
0	0	0	0	0	0	0	0

Structuring element:

0	1	0
1	1	1
0	1	0

E (A) :

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0
0	0	1	1	1	1	0	0
0	0	1	1	1	1	1	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

After Boundary Extraction:

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	1	1	1	1	0	0
0	1	0	0	0	1	0	0
0	1	0	0	0	0	1	1
0	1	0	0	0	0	0	1
0	0	1	1	1	1	1	1
0	0	0	0	0	0	0	0

**Conclusion:**

The experiment demonstrated the effectiveness of morphological operations such as dilation, erosion, opening, and closing in image processing.

Additionally, boundary extraction showcased their utility in enhancing and manipulating image features.