# Computer Image Processing

*Classes 9 - morphological operations*

## Example 1

Predefined structuring elements, that can be used in morphological operations.
```
se1=strel('pair',[3,-2]); %translate within central pixel by a vector [3,-2]
figure; imshow(getnhood(se1),'InitialMagnification', 'fit');
se2=strel('line',10,60); %number of pixels creating the line, degree of inclinance to x axis
figure; imshow(getnhood(se2),'InitialMagnification', 'fit');
se3=strel('disk',10); %radius
figure; imshow(getnhood(se3),'InitialMagnification', 'fit');
se4=strel('diamond',3); %radius
figure; imshow(getnhood(se4),'InitialMagnification', 'fit');
se5=strel('periodicline',2,[-2,1]);
%repeating the translating operation by a [-2,1] vector twice
figure; imshow(getnhood(se5),'InitialMagnification', 'fit');
se6=strel('ball',15,3); %radius
figure; imshow(getnhood(se4),'InitialMagnification', 'fit');
```

## Example 2

Erosion of the monochrome image.
```
L=imread('bacteria.bmp');
figure; imshow(L);
SE=ones([3, 3]);
E=imerode(L,SE);
figure; imshow(E)
L2=L-E; %difference between original image and image after erosion (pixels removed as a result of erosion)
figure;
imshow(L2);
```

## Exercise 1

**Dilation of the image could be performed by the use of *imdilate* function. Binarize the image *bacteria.bmp*, perform the dilation operation and display removed pixels.**

*L=imread('bacteria.bmp');*
*figure; imshow(L);*
*SE=ones([3, 3]);*
*E=imdilate(L,SE);*
*figure; imshow(E)*
*L2=E-L;*
*figure;*
*imshow(L2);*

## Exercise 2

**Perform the erosion operation and afterwards dilation of the image *bacteria.bmp*. Then perform these operations in reverse order. Are erosion and dilation inverse?**
*L=imread('bacteria.bmp');*
*figure; imshow(L);*
*SE=ones([3, 3]);*

```
res = imerode(imdilate(L,SE),SE);
figure; imshow(res)
res_2 = imdilate(imerode(L,SE),SE);
figure;
imshow(res_2);
figure;
imshow(imabsdiff(res,L));
title('Difference between original and dilate+erode');
figure;
imshow(imabsdiff(res_2,L));
title('Difference between original and erode+dilate');
```

## Exercise 3

**Perform the erosion and dilation operation on any colour image and repeat it five times.**

```
L=imread('Cracow_3.jpg');
figure; imshow(L);
SE=ones([3, 3]);
L1 = L;
for i=1:5
    L1 = imdilate(L1,SE);
end
imshow(L1);
figure;
imshow(L1-L);
title('Difference');
```

## Example 3

Closing of the binary image.

```
L1 = imread('kpo.gif');

L1=L1<128;

figure; imshow(L1);
SE=strel('disk',3);
L2=imclose(L1,SE);
figure; imshow(L2);
```

## Exercise 4

**Perform the opening operation on the same image (*imopen*) and compare achieved result with the result obtained by the use of closing.**

```
L1 = imread('kpo.gif');
L1=L1<128;
figure; imshow(L1);
SE=strel('disk',3);
L2=imclose(L1,SE);
figure; imshow(L2);
L2=imopen(L1,SE);
figure; imshow(L2);
```

## Example 4

Morphological shrinking.

```
L1=imread('vessels1.jpg');
L1=(L1)<150;
figure; imshow(L1);
L2a=bwmorph(L1,'shrink',5);
figure; imshow(L2a);
L2b=bwmorph(L1,'shrink',10);
figure; imshow(L2b);
L2c=bwmorph(L1,'shrink',40);
figure; imshow(L2c);
```

## Exercise 5

**Shrinking operation could also be performed with the use of '*thin*' parameter of the *bwmorph* function and the thickening with the use of '*thicken*'. Analyze if these parameters give inverse results.**

## Example 5

Skeletonization with the pruning transform and removing of isolated pixels.

```
L1=imread('vessels1.jpg');
L1=(L1)<150;
figure; imshow(L1);
L2=bwmorph(L1,'skel',Inf);
figure; imshow(L2);
L3=bwmorph(L2,'spur',Inf);
figure; imshow(L3);
L4=bwmorph(L3,'clean',Inf);
figure; imshow(L4);
```

Another useful parameters of *bwmorph* are: 'bridge' (joining pixels with a „bridge"), 'hbreak' (removing H-shaped connections), 'remove' (removing internal pixels), 'fill' (filling the holes with a size of 1 pixel – removing isolated pixels with a value of 0). Try their effect on some picture  e.g. wheel.bmp

## Example 6

Detecting of certain image fragments (here - horizontal lines with the length of 10 pixels).

```
L1=imread('wheel.bmp');
figure; imshow(L1);
SE=ones([1 10]);
L2=bwhitmiss(L1,SE);
figure; imshow(L2);
```

## Example 7

Example of structuring element, that can be used with a hit-or-miss operation to detect corners:

| 0 | 1 | 0 |
|---|---|---|
| -1 | 1 | 1 |
| -1 | -1 | 0 |

```
L1=imread('vessels3.bmp');
figure; imshow(L1, 'InitialMagnification', 'fit');
SE=[0,1,0;-1,1,1;-1,-1,0]
L2=bwhitmiss(L1,SE);
figure; imshow(L2, 'InitialMagnification', 'fit');
```

Try to detect three other corner directions.