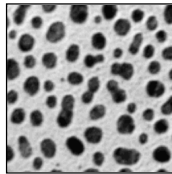




# Morphology

## Gray scale



# Grayscale Morphology

```
g2 = ordfilt2(g1,n,se);
```

**Order filter:** replace the central pixel by the n-th element of the sorted image neighborhood pixel list.

**M = sum(se(:) > 0);** % number of positive elements

**n = 1:** minimum (erosion)

**n = M:** maximum (dilation)

**n = M/2:** median

	0	0	1	1	0	0
	0	1	1	1	1	0
<b>se</b>	1	1	1	1	1	1
	1	1	1	1	1	1
	0	1	1	1	1	0
	0	0	1	1	0	0



# Grayscale Morphology main functions

<b>imbothat</b>	Perform bottom-hat filtering
<b>imclose</b>	Close image
<b>imdilate</b>	Dilate image
<b>imerode</b>	Erode image
<b>imfill</b>	Fill image regions
<b>imopen</b>	Open image
<b>imreconstruct</b>	Perform morphological reconstruction
<b>imtophat</b>	Perform tophat filtering
<b>watershed</b>	Find image watershed regions
<b>strel</b>	structuring element



# Strel: structure element

## Creation and Manipulation

<b>getheight</b>	Get the height of a structuring element
<b>getneighbors</b>	Get structuring element neighbor locations and heights (coordinate list)
<b>getnhood</b>	Get structuring element neighborhood (matrix)
<b>getsequence</b>	Extract sequence of decomposed structuring elements
<b>isflat</b>	Return true for flat structuring element
<b>reflect</b>	Reflect structuring element
<b>strel</b>	Create morphological structuring element
<b>Translate</b>	Translate structuring element



# Strel shapes

se = strel(shape,parameters);

## Flat Structuring Elements

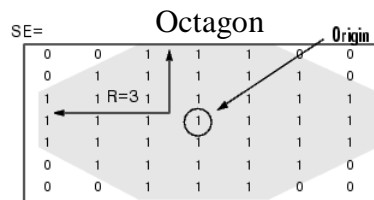
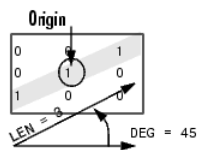
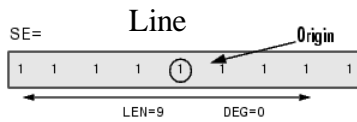
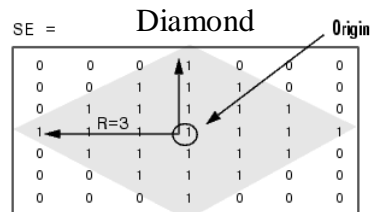
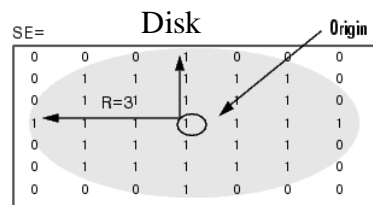
- 'arbitrary'
- 'pair'
- 'diamond'
- 'periodicline'
- 'disk'
- 'rectangle'
- 'line'
- 'square'
- 'octagon'

## Nonflat Structuring Elements

- 'arbitrary'
- 'ball'

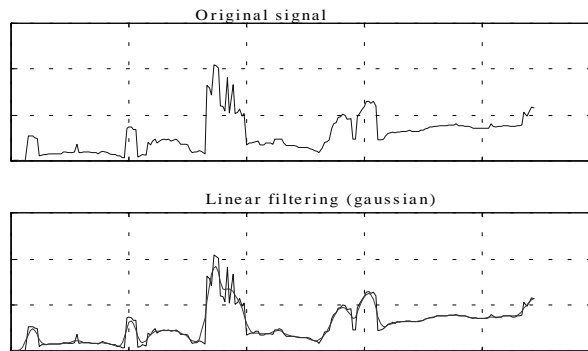


# Strel shapes





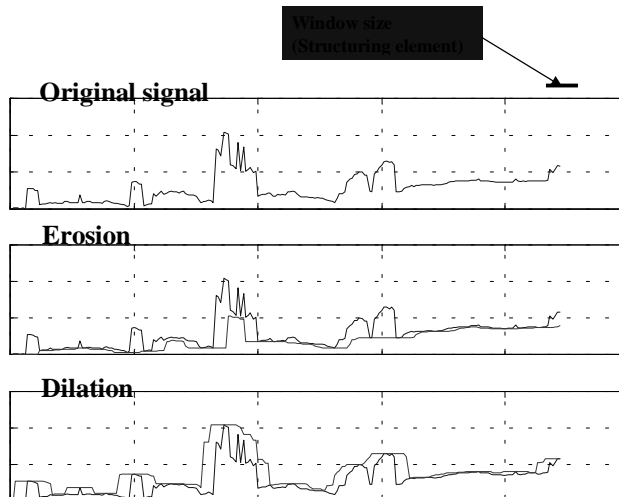
## Grayscale Morphology - 1D example



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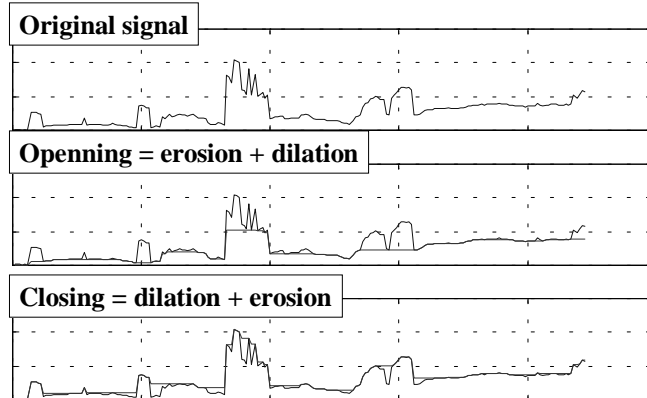


## Grayscale Morphology - 1D example (2)





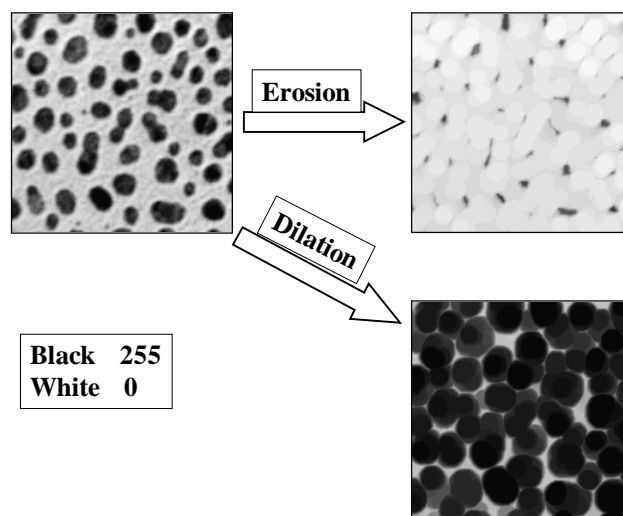
## Grayscale Morphology - 1D example (3)



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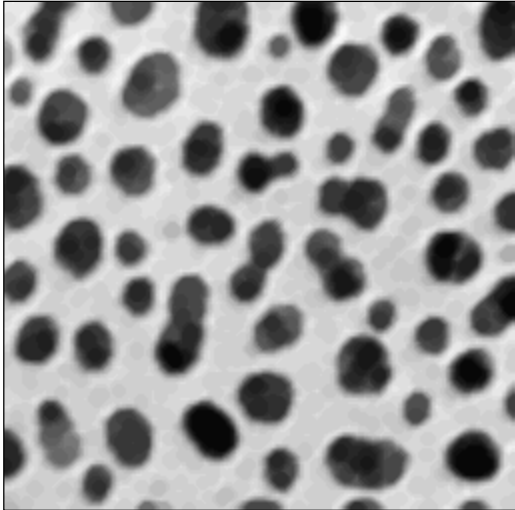
## Grayscale Morphology



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# Grayscale Opening

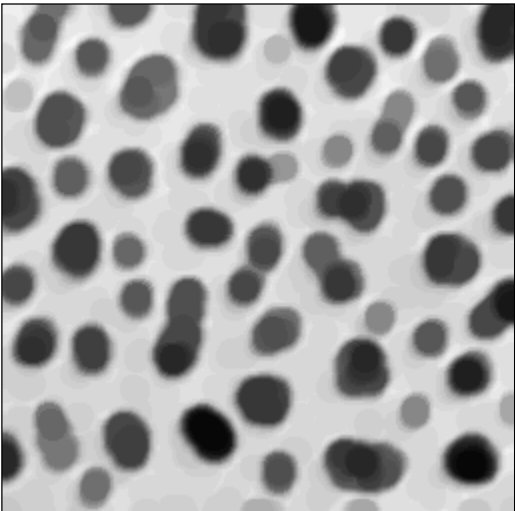


The diagram shows a grayscale image of a porous material with dark spots on a light background. A smaller version of the same image is shown in the top right corner. Below the smaller image is a box labeled "Structuring Element" containing a single black pixel.

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# Grayscale Opening

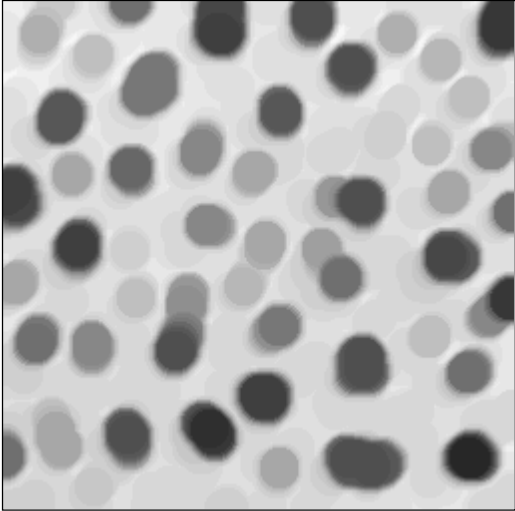
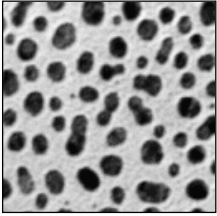


The diagram shows a grayscale image of a porous material with dark spots on a light background. A smaller version of the same image is shown in the top right corner. Below the smaller image is a box labeled "Structuring Element" containing a single black pixel.


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# Grayscale Opening

Structuring Element



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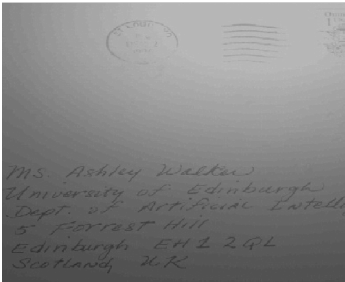
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# Grayscale example (1)

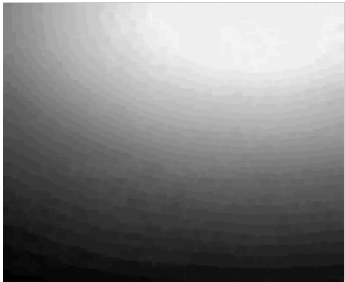
Step 1: background reconstruction via closing operation

```
x = ordfilt2(Letter,49,ones(7),symm); % dilation
y = ordfilt2(x,1,ones(7),'symm'); % erosion
```

**Letter**



**y**



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## Grayscale example (2)

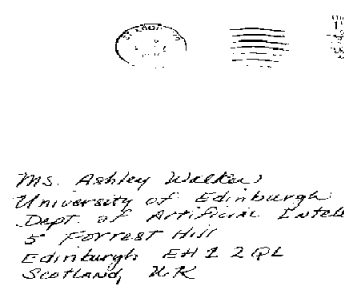
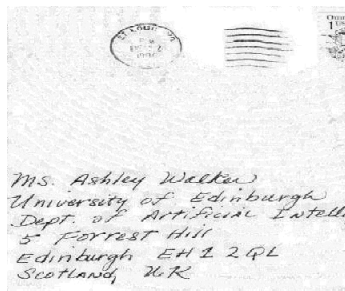
Step 2: background subtraction

Step 3: Thresholding

Top hat (bottom hat) operation:

$Z = \text{Letter} \ominus y$ ;

$Z > \text{Threshold}$



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## Grayscale example (3)

Example taken from the demo files of the  
SDC Morphology toolbox v0.13

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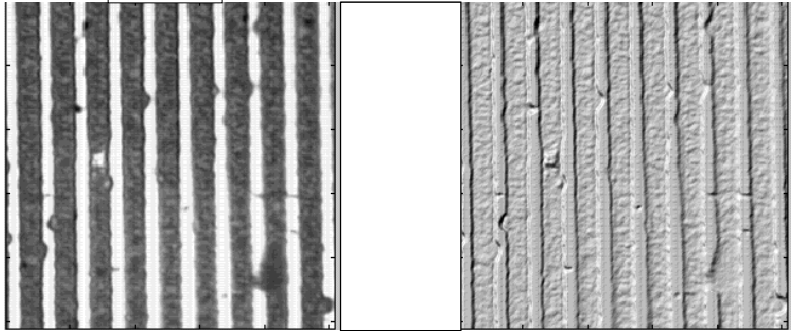


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# Defect Detection

The input image is a gray-scale image of a microelectronic circuit. The relevant objects in this image are vertical metal stripes. These stripes have some irregularities that should be detected.

**Source** **gradient projection**

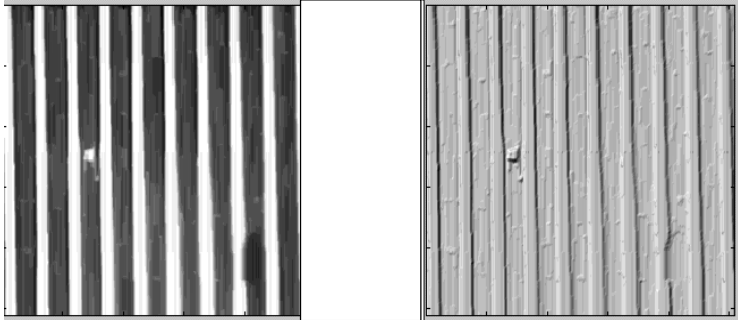


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# Closing

Closing of the image by a vertical line of length 25 pixels.

**Close** **surf**



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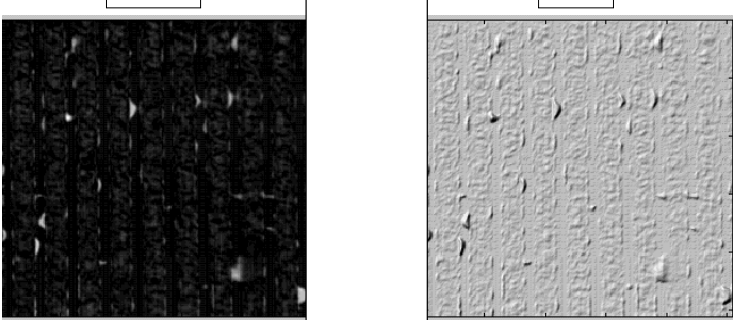
Dr. Yoram Tal

# Closing Top-Hat

Subtraction of the closing from the original is called closing top-hat. It shows the discrepancies of the image where the structuring element cannot fit the surface. In this case, it highlights vertical depression with length longer than 25 pixels.

Close

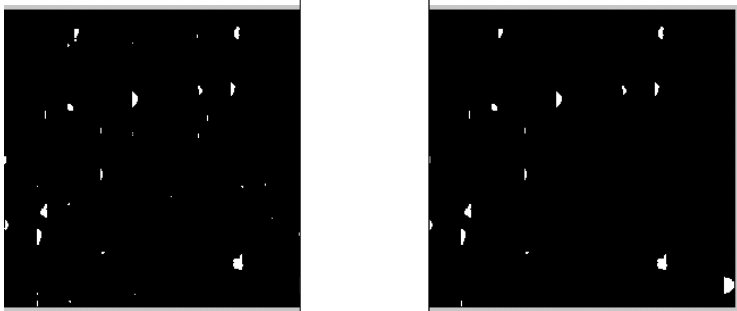
surf



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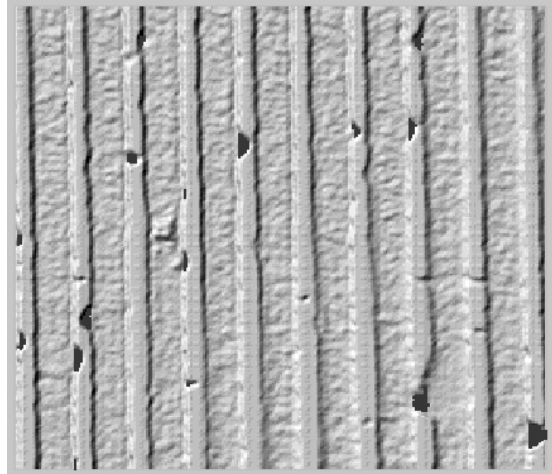
# Thresholding & Cleaning



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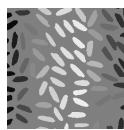
## Result



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## Segmentation



*The idea of segmentation has its roots in work by Gestalt psychologist (e.g. Kohler) who studied the preferences exhibited by human beings in grouping or organizing sets of shapes arranged in the visual field. (Ballard & Brown)*

*Segmentation is the first essential and important step of low-level vision (Marr, Rosenfeld, Hall, Gonzalez, in Pal & Pal).*

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