HW 5, Problems 5.8
EECS 203A, UCI, Fall 2004

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■ Question

TextBook: Digital Image Processing, 2nd edition. By Gonzalez and Woods.

The white bars in the test pattern shown below are 7 pixels wide and 210 pixels high. The separation between bars is 17 pixels. What would this image look like after application of
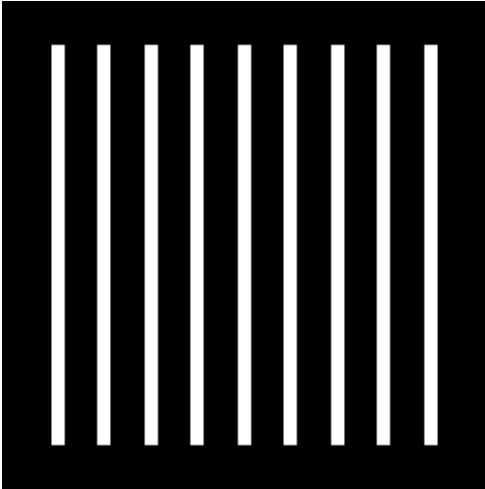(a) 3x3 Min filter?
(b) 7x7 ?
(c) 9x9 ?

■ Answer

Median filter is given by $f(x, y) = \text{Min}(g(x, y)$ where $g(x, y)$ is the image data under the filter.

Load the original Image and display it first. I downloaded the image from the text book website, and used InfranView to get the image information to find how many pixels the whole image is, then read in into *Mathematica* to display it.

```
In[3]:=  Clear["Global`*"];
         nma`cd;
         nRow = 256;
         nCol = 256;
         data = nma`imread["Prob5.01.raw", 256, 256];
         nma`imshow[data, "problem 5.1 image"]
```

problem 5.1 image


```
Out[8]=  ▪ DensityGraphics ▪
```

In the original image,the vertical white bars look like this (displaying the top end of the white bar) we see that the white bar top starts at row number 24,we see that the strip is 7 pixels wide.

```
         Take[data, {23, 27}, {26, 34}] // MatrixForm
```

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 255 & 255 & 255 & 254 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \end{pmatrix}$$

▪ 3x3 Filter

Now construct each filter, and apply them to the above image

```
In[12]:=  F[n_] := Table[1, {i, 1, n}, {j, 1, n}]
          F3 = F[3];
          MatrixForm[F3]
```

```
Out[14]//MatrixForm=
```

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$
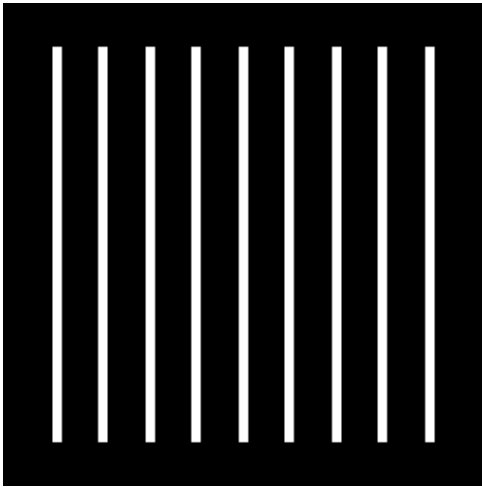
Filter the image with Min 3x3 and display result

In[15]:=
```
    nImage3 = nma`filterMin[data, F3];
    nma`imshow[Round[N[nImage3]], "Min 3x3"]
```

```
startingRow = 2endingRow = 255 startingCol=2 endingCol=255

ncol= 256 nRow= 256 n=3

Dimension of new image is ={254, 254}
```

Min 3x3

Out[16]= ▪ DensityGraphics ▪

Show the top edge of the white bar BEFORE processing

In[17]:= **nma`imshow[Round[N[Take[data, {23, 27}, {26, 34}]]], ""]**

Out[17]= ▪ DensityGraphics ▪

Show the top edge of the white bar AFTER processing

In[18]:= **nma`imshow[Round[N[Take[nImage3, {21, 27}, {23, 34}]]], ""]**

Out[18]= ▪ DensityGraphics ▪

Look at the data before:

Take[Round[N[data]], {23, 27}, {26, 34}] // MatrixForm

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 255 & 255 & 255 & 254 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 \end{pmatrix}$$

Look at the data after filtering

In[26]:=

Take[Round[N[nImage3]], {23, 27}, {26, 32}] // MatrixForm

Out[26]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 255 & 254 & 254 & 254 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 0 \\ 0 & 255 & 255 & 255 & 255 & 255 & 0 \end{pmatrix}$$
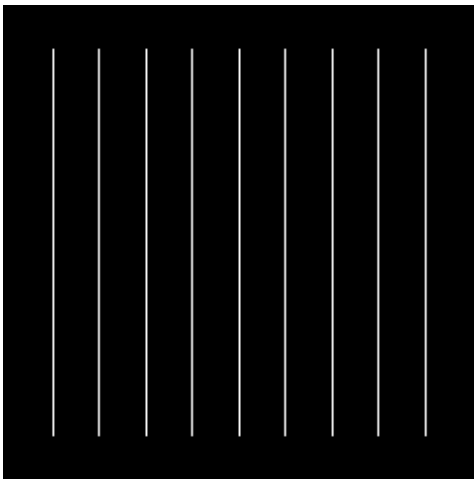
So we see that the white bar is now is thinner it is **5 pixels wide**. And will be **4 rows** less, it will be **206 pixels high**

■ **7x7 Filter**

```
In[27]:=  F7 = F[7];
           nImage7 = nma`filterMin[data, F7];
           nma`imshow[Round[N[nImage7]], "Min 7x7"]
```

```
startingRow = 4endingRow = 253 startingCol=4 endingCol=253

ncol= 256 nRow= 256 n=7

Dimension of new image is ={250, 250}
```

Min 7x7


```
Out[29]=  - DensityGraphics -
```

Now show the top of the white strip. Look now how much more wide it is

```
In[30]:=  nma`imshow[Round[N[Take[nImage7, {17, 30}, {19, 35}]]], ""]
```



```
Out[30]=  - DensityGraphics -
```

In[37]:= **Take[Round[N[nImage7]], {22, 26}, {25, 28}] // MatrixForm**

Out[37]//MatrixForm=
$$\begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 254 & 0 \\ 0 & 0 & 255 & 0 \\ 0 & 0 & 255 & 0 \end{pmatrix}$$

So we see that the white bar is now is thinner, it is **1 pixels wide**. and will be 8 rows shorter, so **202 pixels high**

■ 9x9 Filter

In[38]:= **F9 = F[9];**
nImage9 = nma`filterMin[data, F9];
nma`imshow[Round[N[nImage9]], "Min 9x9"]

```
startingRow = 5endingRow = 252 startingCol=5 endingCol=252

ncol= 256 nRow= 256 n=9

Dimension of new image is ={248, 248}
```

Min 9x9

Out[40]= ▪ DensityGraphics ▪

In[41]:= **nma`imshow[Round[N[Take[nImage9, {15, 26}, {18, 35}]]], ""]**

Out[41]= ▪ DensityGraphics ▪

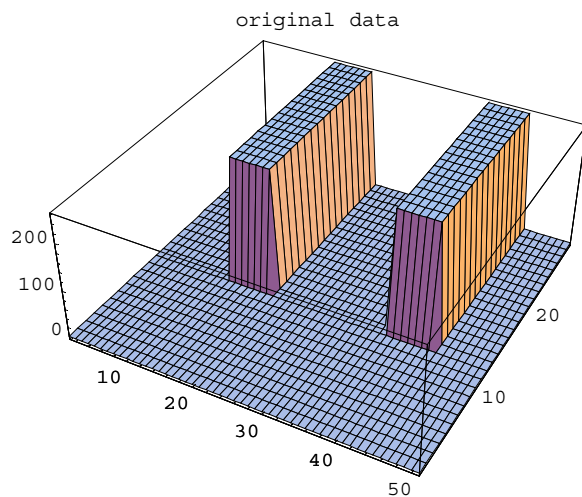*In[45]:=* **Take[Round[N[nImage9]], {13, 20}, {17, 30}] // MatrixForm**

Out[45]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

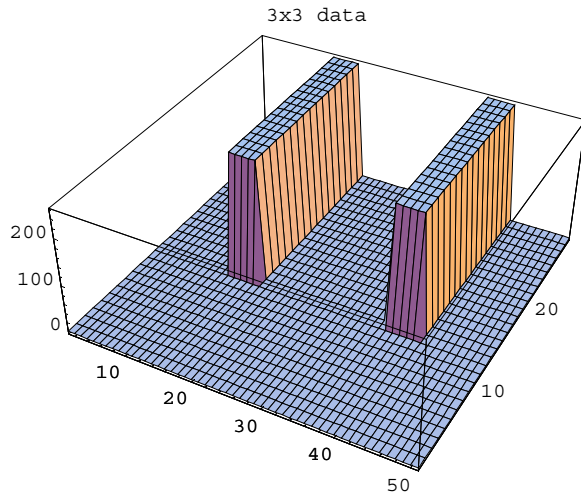So we see that the white bars are all disappered.

■ 3D plots

I'll now display the 3 images in 3D to better illustrate the filter result. I will only plot the region near the ends of the top of the first white strips.
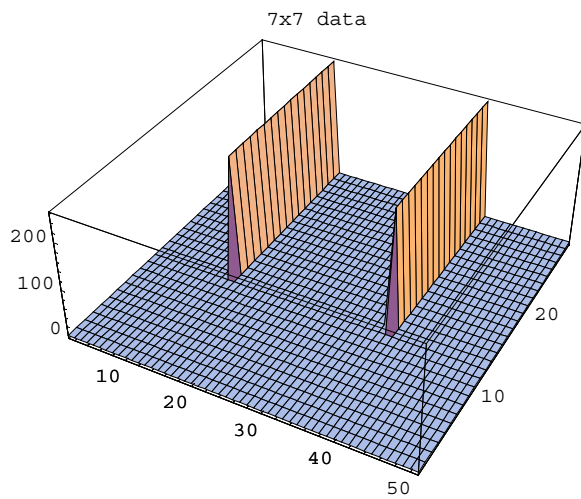
In[46]:= **ListPlot3D[Take[data, {12, 40}, {15, 65}], PlotLabel → "original data"]**
       ListPlot3D[Take[nImage3, {12, 40}, {15, 65}], PlotLabel → "3x3 data"]
       ListPlot3D[Take[nImage7, {12, 40}, {15, 65}], PlotLabel → "7x7 data"]
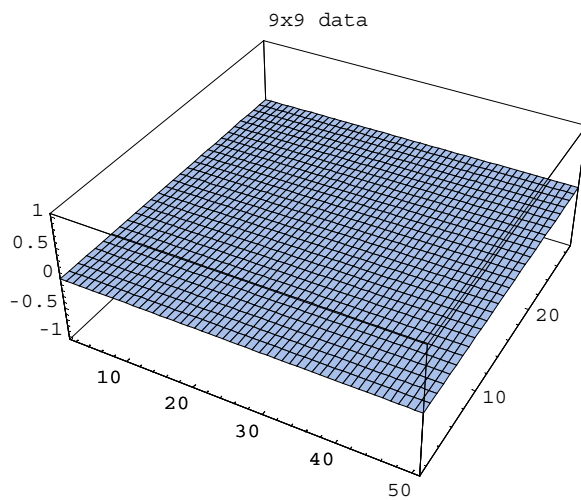   **ListPlot3D[Take[nImage9, {12, 40}, {15, 65}], PlotLabel → "9x9 data"]**

Out[46]= ▪ SurfaceGraphics ▪

3x3 data

Out[47]= **-** SurfaceGraphics **-**

7x7 data

Out[48]= **-** SurfaceGraphics **-**

9x9 data

Out[49]= **-** SurfaceGraphics **-**