

HW 5, Problems 5.7

EECS 203A, UCI, Fall 2004

by Nasser Abbasi

■ 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 Max filter?
- (b) 7x7 ?
- (c) 9x9 ?

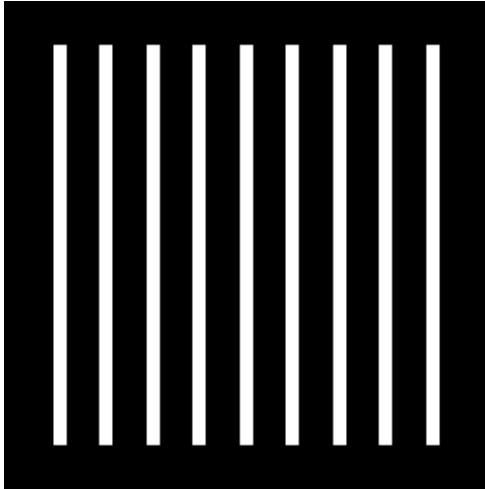
■ Answer

Median filter is given by $f(x, y) = \text{Max}(g(x, y))$ 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[27]:= 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[32]= - 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[33]:= F[n_] := Table[1, {i, 1, n}, {j, 1, n}]
         F3 = F[3];
         MatrixForm[F3]
```

```
Out[35]//MatrixForm=
```

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$$

Filter the image with Median 3x3 and display result

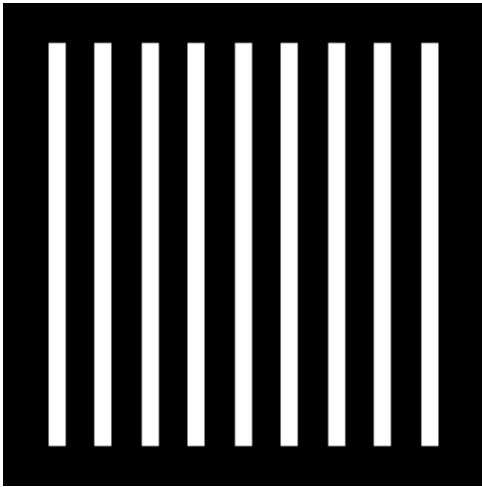
```
In[36]:=
  nImage3 = nma`filterMax[data, F3];
  nma`imshow[Round[N[nImage3]], "Max 3x3"]

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

ncol= 256 nRow= 256 n=3

Dimension of new image is ={254, 254}

Max 3x3
```



```
Out[37]= - DensityGraphics -
```

Show the top edge of the white bar BEFORE processing

```
In[38]:= nma`imshow[Round[N[Take[data, {23, 27}], {26, 34}]]], ""]
```



```
Out[38]= - DensityGraphics -
```

Show the top edge of the white bar AFTER processing

```
In[39]:= nma`imshow[Round[N[Take[nImage3, {21, 27}, {23, 34}]]], ""]
```



```
Out[39]= - DensityGraphics -
```

Look at the data before:

```
In[40]:= Take[Round[N[data]], {23, 27}, {26, 34}] // MatrixForm
```

```
Out[40]//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[41]:=
```

```
Take[Round[N[nImage3]], {19, 27}, {23, 35}] // MatrixForm
```

```
Out[41]//MatrixForm=
```

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 0 & 0 \end{pmatrix}$$

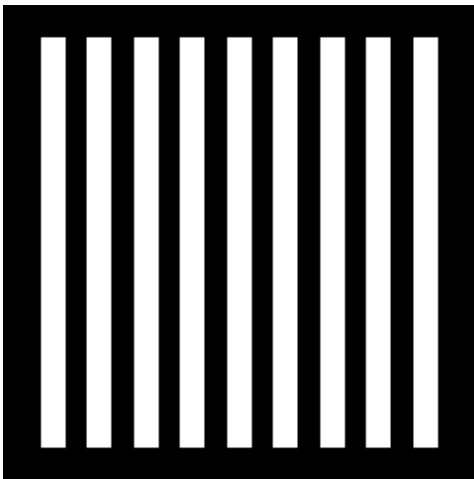
So we see that the white bar is now is wider, it is **9 pixels wide**. And will be **4 rows** longer, it will be 214 pixels high

■ 7x7 Filter

```
In[42]:= F7 = F[7];
nImage7 = nma`filterMax[data, F7];
nma`imshow[Round[N[nImage7]], "Max 7x7"]

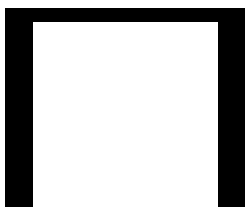
startingRow = 4 endingRow = 253 startingCol=4 endingCol=253
ncol= 256 nRow= 256 n=7
Dimension of new image is ={250, 250}
```

Max 7x7



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

```
In[45]:= nma`imshow[Round[N[Take[nImage7, {17, 30}, {19, 35}]]], ""]
```



Out[45]= - DensityGraphics -

```
In[54]:= Take[Round[N[nImage7]], {13, 23}, {20, 36}] // MatrixForm
```

```
Out[54]//MatrixForm=
```

```
( 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 1 1 1
 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1
 0 0 0 1 1 1 1 1 1 1 0 0 0 0 1 1 1
 0 0 0 1 1 1 1 1 1 1 0 0 0 0 1 1 1
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 1 1 1
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 1 1 1
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 1 1 1
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 0 0 0
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 0 0 0
 0 255 255 255 255 255 255 255 255 255 255 255 255 255 0 0 0)
```

So we see that the white bar is now wider, it is **13 pixels wide**, and will be 12 rows longer, so **222 pixels high**

■ 9x9 Filter

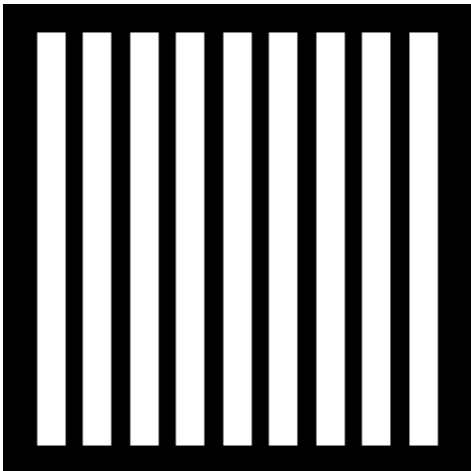
```
In[55]:= F9 = F[9];
nImage9 = nma`filterMax[data, F9];
nma`imshow[Round[N[nImage9]], "Max 9x9"]
```

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

```
ncol= 256 nRow= 256 n=9
```

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

```
Max 9x9
```



```
Out[57]= - DensityGraphics -
```

```
In[58]:= nma`imshow[Round[N[Take[nImage9, {15, 26}, {18, 35}]]], ""]
```



```
Out[58]= - DensityGraphics -
```

```
In[67]:= Take[Round[N[nImage9]], {13, 20}, {17, 34}] // MatrixForm
```

```
Out[67]//MatrixForm=
```

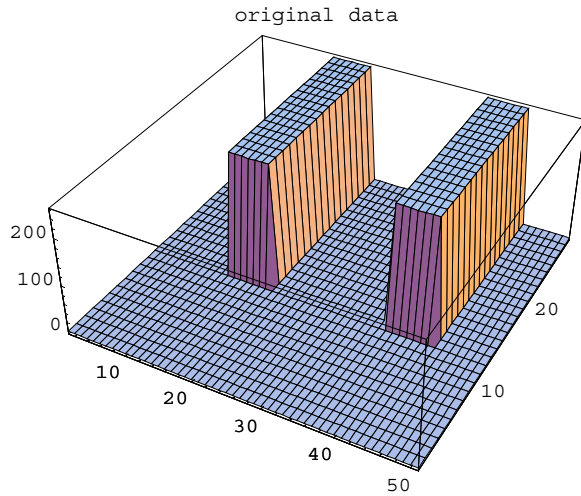
$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 1 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 1 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 1 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 1 \\ 0 & 0 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 255 & 1 \end{pmatrix}$$

So we see that the white bar is now is wider, it is **15 pixels wide**. and will be 16 rows longer, so **226 pixels high**

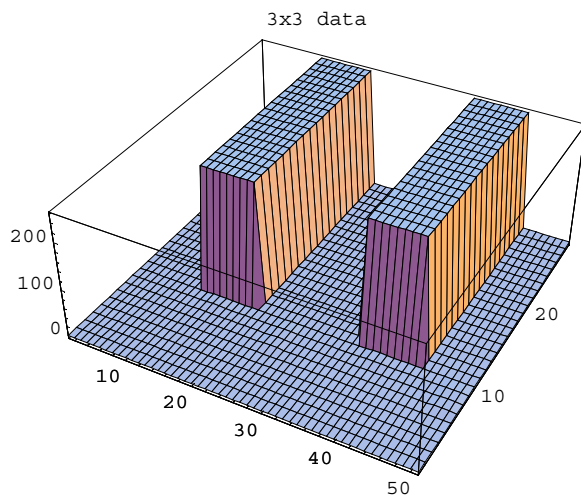
■ 3D plots

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.

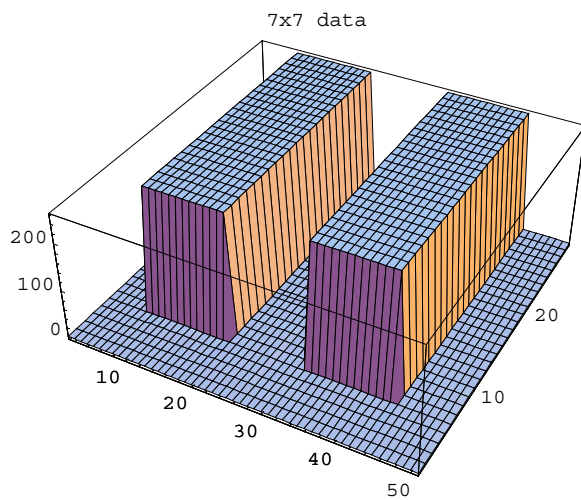
```
In[68]:= ListPlot3D[Take[data, {12, 40}, {15, 65}], PlotLabel -> "original data"]
ListPlot3D[Take[nImage3, {12, 40}, {15, 65}], PlotLabel -> "3x3 data"]
ListPlot3D[Take[nImage7, {12, 40}, {15, 65}], PlotLabel -> "7x7 data"]
ListPlot3D[Take[nImage9, {12, 40}, {15, 65}], PlotLabel -> "9x9 data"]
```



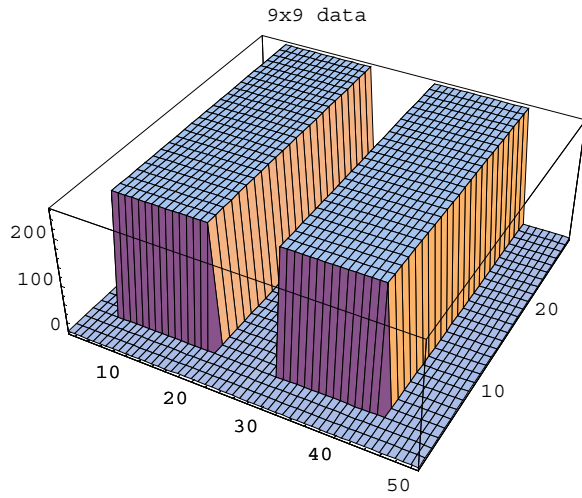
Out [68]= - SurfaceGraphics -



Out [69]= - SurfaceGraphics -



Out [70]= - SurfaceGraphics -



Out[71]= - SurfaceGraphics -