Lab Exercises: LAB 6
(Image Filtering)

General guidance:

1. Download the template code to make menus and demonstrate how to read, write and manipulate images.
2. All the images you use can be downloaded from the course website: http://www.eecs.qmul.ac.uk/~phao/IP/Images/
3. For RAW images, the files have no head data, just the image data as matrices stored. For our RAW images, we do not provide the colour components, and all the data are gray-scale values, a one-byte unsigned integer per pixel, value from 0 to 255.
4. The size of image Cameraman is of 128x128. Other images are of 512x512.

Exercise 1.

Image Convolution: Convoluting an image with a mask for smoothing and edge detection (MSc students should do more mask sizes than 3x3)

To convolute an image stored in a matrix with a mask stored in another matrix.

Note that images are formatted as a one-byte unsigned integer per pixel and the masks are formatted as one floating-point number per pixel, so the final result should be shifted or converted to absolute values and re-scaled to 0-255, and rounded to one-byte integers for displaying in a window and saving in a file.

The mask sizes are better to be odd numbers, such as 3x3, 5x5, 7x7 or 5x7.

For the 3x3 masks, the programme should try following templates:

1. Averaging: $\frac{1}{9}\times\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix}$
2. Weighted averaging: $\frac{1}{16}\times\begin{bmatrix}1 & 2 & 1\\ 2 & 4 & 2\\ 1 & 2 & 1\end{bmatrix}$
3. 4-neighbour Laplacian: $\begin{bmatrix}0 & -1 & 0\\ -1 & 4 & -1\\ 0 & -1 & 0\end{bmatrix}$
4. 8- neighbour Laplacian: $\begin{bmatrix}-1 & -1 & -1\\ -1 & 8 & -1\\ -1 & -1 & -1\end{bmatrix}$
5. 4-neighbour Laplacian Enhancement: $\begin{bmatrix}0 & -1 & 0\\ -1 & 5 & -1\\ 0 & -1 & 0\end{bmatrix}$

6. 8-neighbour Laplacian Enhancement: $\begin{bmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{bmatrix}$

7. Roberts : $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -1 \\ 0 & 1 & 0 \end{bmatrix}$ and $\begin{bmatrix} 0 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$ with absolute value conversion.

8. Sobel X: $\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$ with absolute value conversion.

9. Sobel Y: $\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$ with absolute value conversion.

For the 5x5 masks, the programme should try following templates:

1. Gaussian: $\frac{1}{273}\begin{bmatrix} 1 & 4 & 7 & 4 & 1 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 1 \end{bmatrix}$

2. Laplacian of Gaussian (LoG): $\begin{bmatrix} 0 & 0 & -1 & 0 & 0 \\ 0 & -1 & -2 & -1 & 0 \\ -1 & -2 & 16 & -2 & -1 \\ 0 & -1 & -2 & -1 & 0 \\ 0 & 0 & -1 & 0 & 0 \end{bmatrix}$ with absolute value conversion.

Anyway, for better image enhancement or edge detection, a sequential combination of multiple masks can be applied.

Questions: What’s the difference between shifting and absolute value conversion? In what cases, the absolute value conversion is needed after convolution?