Work Sheet ONE

The aim of this computer based exercise is to reinforce the material that you have covered during the lectures. Your have 2 hours to complete this worksheet, after which you will be required to complete a 30 minute test.
You may refer to your lecture notes, other reference sources, such as text book and websites and confer which your colleges to complete the exercises, however the test is a closed note assessment and must be done individually.

The image required for this worksheet can be found at the following URL: http://newton.ex.ac.uk/teaching/resources/jjm/pam3012/Labs/index.html

To open ImageJ: Finder/Applications/ImageJ/ImageJ

Exercise 1: Spatial and Grey Scale Resolution

1(a) Image Size

- Images 1-1 to 1-4 are SMPTE (Society of Motion Picture and Television Engineers) test patterns
- All four images have the same bit-depth (8-bits) with, (1-1) 1024x1024 pixels, (1-2) 512x512 pixels, (1-3) 256x256 pixels and (1-4) 128x128 pixels.
- Calculate the size of each image in megabytes.
- Compare the calculated values to the physical values quoted by the computer.

1(b) Number of Pixels vs Spatial Resolution

- Images 1-1 and 1-5 to 1-7 are SMPTE (Society of Motion Picture and Television Engineers) test patterns.
- All four images have the same bit-depth (8-bits), however the number of pixels varies as follows (1-1) 1024x1024, (1-5) 512x512, (1-6) 256x256 and (1-7) 128x128.
- **This time the images are all presented at the same size**. I.e. as the number of pixels is reduced the size of the individual pixels is increased to maintain the original image size.
- Observe how the number of pixels effect the spatial resolution of the image. I.e. the number of line-pair per mm that can be resolved.

1(c) Bit-depth vs Contrast Resolution

- Images 1-1 and 1-8 to 1-14 are SMPTE (Society of Motion Picture and Television Engineers) test patterns
- All eight images have the same number of pixels (1024 x 1024), however, the bit depth varies as follows: 1-1, 8-bit, 1-8, 7-bit, 1-9, 6-bit, 1-10, 5-bit, 1-11, 4-bit, 1-12, 3-bit, 1-13, 2-bit and 1-14, 1-bit.
- The bit-depth varies from 8-bits (1-1.bmp) to 1-bit (1-14.bmp)
- Observe how the bit-depth affects the contrast and contrast resolution of the image. I.e. the number of greys in the image and the minimum resolvable difference in grey level.

Exercise 2: Point Processing and Image Histograms

Images 2-1.jpg to 2-5.jpg are incorrectly exposed radiographs.

2(a) Image Histograms (Probability Density Function)

- Use ImageJ to plot the probability density function (PDF) of each image.
- Make note how the PDF relates to the contrast characteristics of each image.

Hints:

- To open the images: File, Open
- To generate an image PDF: Analyse, Histogram

2(b) Contrast Enhancement by Windowing (Contrast and Brightness)

- Incorrect exposures can, to some extent, be corrected using 'windowing'
- Use ImageJ to window each image to achieve optimal contrast
- Plot the probability density function (PDF) of each image.
- Make note how the PDFs of the enhanced images compare with those post-enhancement.
- Save the enhanced image in your network folder. (For example, as 2-1-windowed.jpg)

Hint:

- To adjust image windowing: Image, Adjust, Window/Level
- Remember, image enhancement is a subjective process!

2(c) Contrast enhancement by Gamma Processing

- Gamma correction can also be used to adjust the contrast of poorly exposed images.
- Use ImageJ to perform gamma correction on images 2-1.jpg to 2-5.jpg to achieve optimal radiographic contrast.
- Plot the probability density function (PDF) of each image.
- Make note how the PDFs of the enhanced images compare with those post-enhancement.
- Save the enhanced image in your network folder. (For example, as 2-1-gamma.jpg)

Hint:

- Process, Maths, Gamma
- Set the gamma correction factor to a value between 0.1 and 5.0
- Remember: gamma < 1 brightens the image, gamma > darkens the image

Gamma Correction

- Open any of the five images from 2-1 to 2.5.
- Process the image using any gamma value between 0.1 and 5.0.
- Note the change in appearance.
- Repeat the gamma processing with a value of gamma that will 'undo' the previous process. How are the two gamma values related?

2(d) Contrast Enhancement by Histogram Equalisation

- Enhance the contrast automatically using the ImageJ histogram equalisation function

- By adjusting the percentage of saturated pixels, compare the shapes of the histograms before and after enhancement as a function of saturation percentage.
- Save the image, which in your opinion, has the optimal saturation value in your network folder. (For example, save as 2-1-equalised.jpg)

Hint:

- Process, Enhance Contrast; check 'histogram equalization'

2(e) Comparing the Results.

- Using your own personnel preference, decide which enhancement method provides the 'best' image.
- Compare the PDFs of the enhanced images. Do the PDFs of the images with the 'best' appearance have anything in common?