Sample Question Paper 2 -

(based on MM61513 Autumn 2012-13)

Question 1:

Microfluoros Inc., a new player in the field of medical imaging has recently developed a very efficient fluorescence microscopy techniques for investigating nucleus in carcinogenic cells. Their innovation potential is the development of a quantum electronic sensor that responds to specific wavelengths of excitation. This results in high SNR sensing. With lab-scale production in place and calibration of the sensor finished, they have approached us while exploring opportunities of integrating this sensor module on out telemicroscopy equipment. We have completed the first phase of design integration and the sensor now provides us with fluorescence images of cells with a conventional optical microscopy without requirement of any specialized monochromatic lighting arrangement. [data.bmp] is the acquisition of that sensor in our pilot run. The acquisition is a bit noisy when compared to that obtained with our state-of-the-art microscope [ideal.bmp]. However, currently we are facing another grave situation. While transmitting these images over our remote transmission framework, we end up receiving much more noisy images, where the pattern of noise is irritating for visual inspection and evaluation by Pathologists. The received data for the same acquisition at three different instances are [received1.bmp], [received2.bmp] and [received3.bmp]. The vertical grid like pattern relatively shifts during different acquisitions as can also be observed in these three images.

T Can you suggest a way of denoising these dynamically shifting vertical grid like noisy patterns? [10 Marks]

P Can you write down a modular implementation of this noise filtering scheme? [5 Marks]

P Suggest a cost function comparing the result of your denoising scheme with [data.bmp] and suggest the optimal configuration so that your results match closest to [data.bmp] with proper illustrations justifying your choice. [8 Marks]

Wizard Can you identify the family of noise causing these grid like pattern in [received1.bmp], [received2.bmp] and [received3.bmp]? [2 Marks]

Question 2:

Now that this problem is solved, the managers from Microfluoros Inc. would like you to assist them in visualizing these images on their custom designed high resolution eye-friendly displays. Since these displays are high resolution ones of size 2048×1536, and their display drivers do not have dynamic rescaling capability, they would like you to scale the processed output appropriately to properly match the display resolution without loss of any information.

T Compute the best fit scaling factor as a fraction. Briefly state the process. [10 Marks]

P Write down the modular implementation of your suggested algorithm. [5 Marks]

P Plot the cost associated with information loss due to rescaling. [5 Marks]

Wizard These managers would also like to employ a recently developed cost function modelled as $J_1(F,G)=(2\mu_F\mu_G+c_1)(2\sigma_{F,G}+c_2)/(\mu_F^2+\mu_G^2+c_1)(\sigma_F^2+\sigma_G^2+c_2)$ to measure to degree of information loss associated with scaling of the image. Here $c_1=\zeta_1L^2, c_2=\zeta_2L^2$ and $\zeta_1=0.01$, $\zeta_2=0.03$. F and G are the test and reference images. μ_F is the mean intensity of F, and σ_F is the variance of its intensity. $\sigma_{F,G}$ is the covariance of intensity change in F and G. Here L is the dynamic range of the measured data. Can you provide a modular implementation of using this new cost function ? Provide illustrations comparing this cost function with the one you have used earlier. [5 Marks]

Question 3:

The bright blob located in [data.bmp] denotes a nucleus in a pathologically active state. Can you suggest a method to display this bright blob against a complete black background so as to assist easy visualization without and trace of the surrounding cytoplasm.

T How would you proceed to accomplish this objective. Since the sensor is a photon sensor, so using appropriate physics models would provide you with the extra edge over others. [10 Marks]

P Write down a modular implementation with artefact correction available. [15 Marks]

Question 4:

Now we would like to have some measurements of the pathologically active nucleus available as the bright blob in the centre of the image.

T Can you compute the area, perimeter, compactness of the lesion and suggest a method of identifying if this is a circle or ellipse. Also suggest if the blob is perfect convex? [10 Marks]

P Write a modular implementation of the above. [10 Marks]

Wizard Can you plot the lesion boundary in Red colour on [data.bmp]? If so, create with lesion boundary marked on it [bound.bmp]. [5 Marks]