UNIVERSITY OF PERADENIYA
DEPARTMENT OF STATISTICS AND COMPUTER SCIENCE
END SEMESTER EXAMINATION - SEMESTER I (2022/2023)
CSC3141 - IMAGE PROCESSING LABORATORY (1 Credit)

Answer **ALL** Questions — Time Allowed: **3** hours

Open Book Examination

Create three separate Python files to answer the three questions. Name the python files as S19XXXQ1.py, S19XXXQ2.py, and S19XXXQ3.py, in which S19XXX stands for your registration number.

1. [40 Marks]

Selective blurring is a useful technique that blurs undesired regions of an image to improve focus on specific objects of interest. One approach to implement selective blurring is to blur the background while keeping the objects of interest unchanged.

An image of a galaxy captured with surrounding space is provided in the file "**galaxy.jpg**". Using the galaxy as the object of interest, implement a selective blurring process to blur the background of the image (background is the portion of the image that is **NOT** the galaxy).Then, outline the boundary of the galaxy in green. Visualise the results in a grid (as displayed in Figure 1) and save the visualisation grid with the file name "**galaxy_processed.png**".

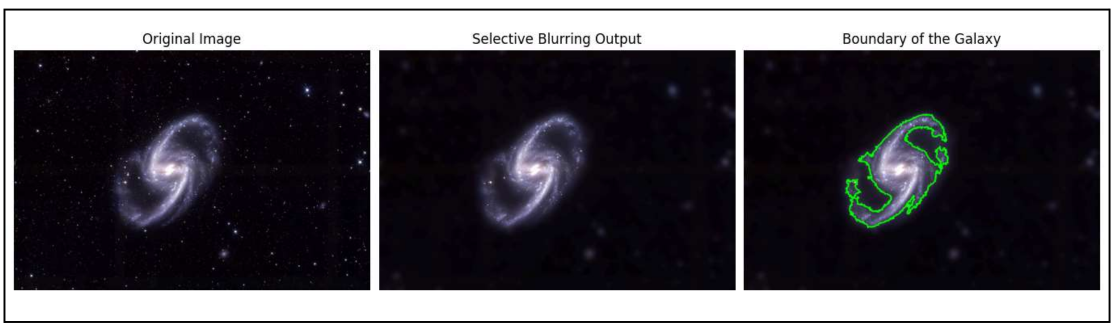

Figure 1 : Expected output of Question 1

2. [30 Marks]

Provided image "**planet_surface.png**" is corrupted by noise.

a. Using frequency domain image enhancement techniques, implement a process to reduce pattern noise in the image while retaining as much of the image's detail as possible.

b. Visualise the steps of the denoising process in a grid with the corresponding titles as illustrated in Figure 2.

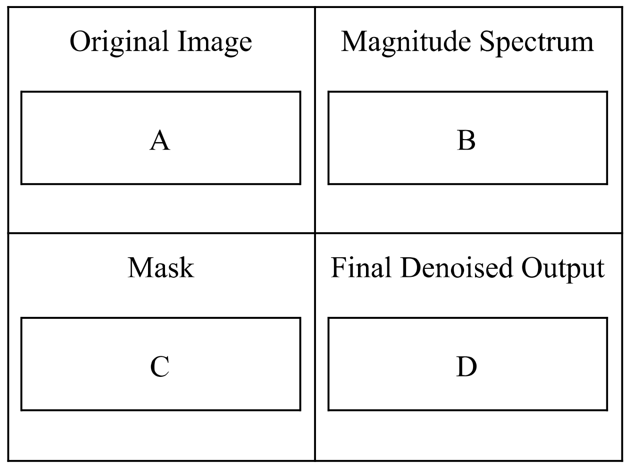

Figure 2 : Visualisation grid description for Question 2

A. Original image
B. Magnitude spectrum after placing the zero frequency at the centre
C. Mask
D. Final output after removing the pattern noise

c. Save the visualisation grid with the name “**planet_surface_denoising_steps.png**” and the final output image with the name “**planet_surface_denoised.png**”.

3. [30 Marks]

The Visible Atmospherically Resistant Index (VARI) is a vegetation index used to highlight vegetation in remote sensing and image analysis applications. Follow the steps below to calculate the VARI for an RGB image and to generate a colour map based on the values of VARI.

a. Implement a function named **calculate_vari** which takes an RGB image as the input and compute the VARI according to the following formula.

$$\mathbf{VARI} = \frac{\mathbf{G - R}}{\mathbf{G + R - B + 0.1}}$$

Where:
G = green channel intensity of the image
R = red channel intensity of the image
B = blue channel intensity of the image
0.1 is a small constant added to the denominator to avoid division by zero

The output is a 2-dimensional array (matrix) where each element corresponds to the VARI value computed for the corresponding pixel in the input RGB image.

b. VARI value is typically between -1 and +1. Implement a function named **normalise_vari** to scale the VARI values to the range [0, 255] using the following formula and convert the scaled values to 8-bit unsigned integers.

$$\textbf{Normalised VARI} = \left(\left(\textbf{VARI}+1 \right) \times 127.5 \right)$$

c. Implement a function named **apply_threshold_colormap** which takes normalised VARI values and an integer threshold for colouring as inputs and returns a colour map according to the following rules.

$$\textbf{colour\_map[i, j]} = \begin{cases} \textbf{[255,0,0] if VARI\_normalised[i, j]} < \textbf{threshold} \\ \textbf{[0,255,0] if VARI\_normalised[i, j]} \geq \textbf{threshold} \end{cases}$$

Where:
VARI_normalised[i,j] = Normalised VARI value at pixel (i, j)
threshold = Threshold value used for colouring
colour_map[i,j] = Corresponding colour map value at pixel (i, j)

d. Generate the colour map of the given image **land.jpg** using the above implemented functions with **100** as the threshold value for colouring and save the resulting colour map image (as shown in Figure 3) with the name **colour_map.jpg**.

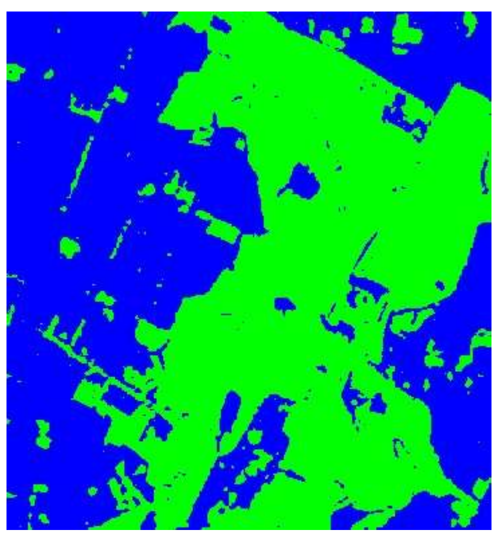

Figure 3: Expected colour map for Question 3 part d.

—End of Paper—