RO4101 – DIAGNOSTIC TECHNOLOGIES

Lab Session #4

Learning Outcomes:
This lab exercise aims to introduce and familiarize you with different image-processing techniques including image thresholding, edge detection, image enhancement, and noise removal that are crucial for extracting meaningful features from CT images.

By the end of this exercise, you will have the knowledge and tools to perform the following tasks in PYTHON:

- Learn techniques to eliminate or minimize background noise with the help of thresholding and edge detection.
- Apply image enhancement techniques including scaling and histogram equalization on CT images to enhance the imaging features.

Marks Allocated: 3.0% (30 points)

Computing Tools Required:

- **Python 3.x**
- **Libraries:** pydicom, numpy, nibabel, matplotlib, scipy, opencv-python (for image processing)

You can install the necessary libraries using pip by running the following command in the terminal:

```
D:\>pip install pydicom numpy nibabel matplotlib scipy
```

Instructions:

Download the data:

https://drive.google.com/file/d/14ViDHq6KrKetcrBzmifu-0z_Iirr4qwv/view?usp=sharing

You are expected to submit your work as a ***Python script file*** with the following filename after you have been marked in the lab ***(marking in-lab components for these DT labs will be in the last 30mins of any lab session):***

DT-4104-Yourname-lab4.ipynb

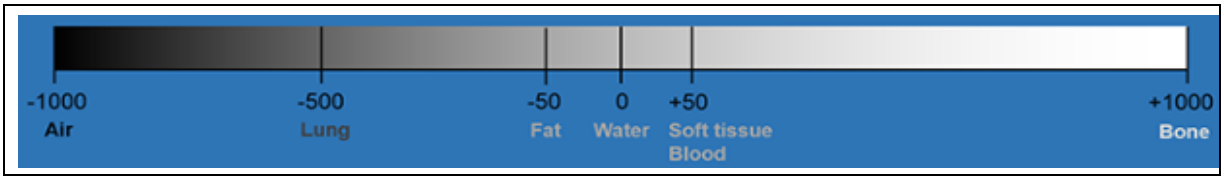
TASK-1: Load the CT image and adjust the HU levels *(5 points)*

Complete the following tasks:

-1.1: Load a DICOM image (1-055.dcm) from the CT folder and plot the image. **(1)**

-1.2: Print the DICOM metadata and extract the following tags: Window Center, Window Width, Rescale Intercept, and Rescale Slope. Store these extracted values accordingly. **(1)**

-1.3: Adjust the CT numbers or HU levels according to the requirement or as directed in metadata by applying Windowing. **(2)**

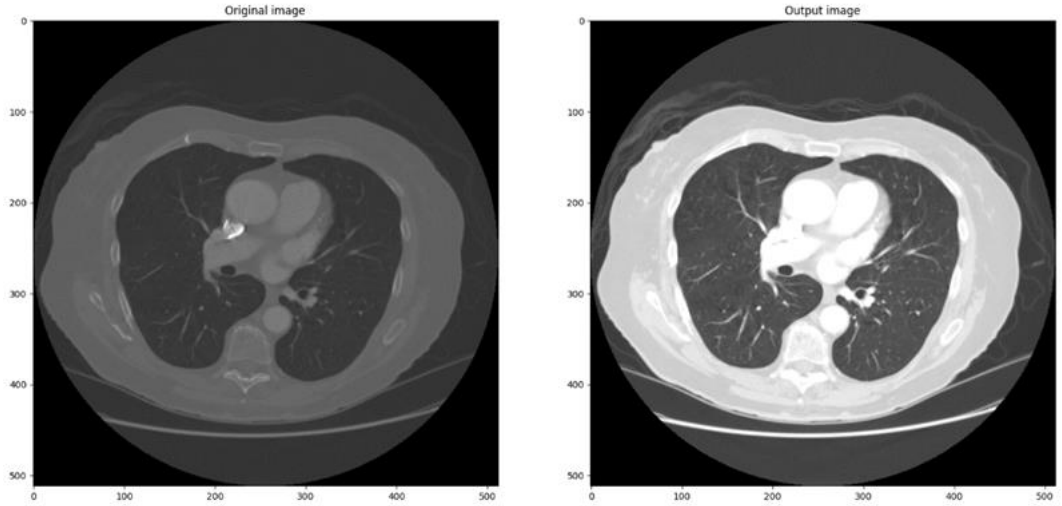


(Windowing, also known as grey-level mapping, contrast stretching, histogram modification, or contrast enhancement is the process in which the CT image greyscale component of an image is manipulated via the CT numbers; doing this will change the appearance of the picture to highlight particular structures. The brightness of the image is adjusted via the window level. The contrast is adjusted via the window width.)

```
def window_image(img, window_center,window_width, intercept, slope, rescale=True):
    img = (img*slope +intercept) #for translation adjustments given in the dicom file.
    print(np.unique(img))
    img_min = window_center - window_width//2 #minimum HU level
    img_max = window_center + window_width//2 #maximum HU level
    img[img<img_min] = img_min #set img_min for all HU levels less than minimum HU level
    img[img>img_max] = img_max #set img_max for all HU levels higher than maximum HU level
    return img
```

```
output = window_image(dicom_image, window_center, window_width, intercept, slope, rescale = False)
```

-1.4: Plot the input image and output image **(1)**



TASK-2: Image normalizing and background removal *(5 points)*

Complete the following tasks:

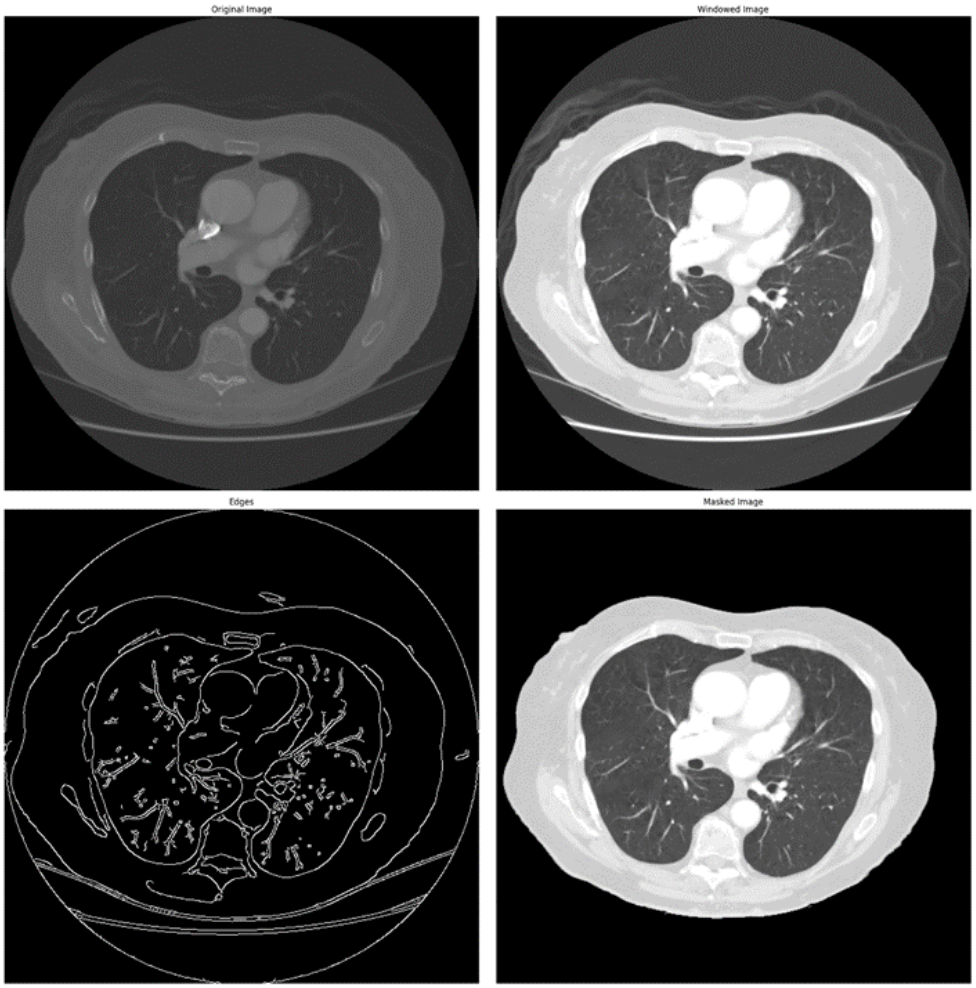
-2.1: Normalize the output image in the range 0-255. **(1)**

-2.2: Apply canny edge detection on the normalized image from cv2. **(1)**

-2.3: Find the largest contour from the edge-enhanced image. **(1)**

-2.4: Apply masking according to the largest contour detected to eliminate the background. **(1)**

-2.5: Plot a 2*2 grid to visualize the results (Original image, Windowed Image, Edges, Masked Image) **(1)**



Home Assignment: Apply image enhancement techniques on CT images and visualize the results with required histograms (20 points).

Complete the following tasks:

-1: Load another CT image from the CT folder and preprocess the image from the above-mentioned pipeline **(5)**

-2: Apply the histogram image enhancement and CLAHE technique to the processed image. **(5)**

-3: Compare the visualize the results (Original Image, Histogram Enhanced Image, CLAHE image) **(5)**

-4: Compare the respective histograms and CDFs and plot them **(5)**