ACSE-5 ASSIGNMENT 2 REPORT BY IMAGEFILTER-INC

1.0 **Sole creator:** Yusuf Falola

2.0 **Overview**

This study is to create filters for enhancing and modifying medical images in different ways. Five filters were created in this study, namely; Threshold filter, Four-point averaging filter, Laplacian filter, Median filter and Gaussian filter. Grayscale medical images were considered in this work. An external C++ library named OpenCV was employed to load, open and save images. This library also helped to generate the image matrix, which is needed for the filtering algorithms to process the images. All filter algorithm created work well to their specifications. However, they could be improved upon to advance their usage. For instance, the averaging technique could be advanced to an 8-point averaging filter and Gaussian Blur filter could be made robust enough to use matrices higher than 5x5 as its kernel.

2.0 **Brief filters' description**

- **Threshold filter**: Thresholding is the simplest method of image segmentation[1]. Here, the filter sets the value of all pixel values less than 128 to 0 (black) and pixel values otherwise to 255 (white). Threshold value of 128 was used since it represents the average of pixel values. But, for a specific image, the most correct method is to find the average of all the pixel values and use it as the threshold value.
- **4-point averaging filter**: This is a four-point neighbouring average technique. The contribution of the four neighbours of a reference pixel are used to redefine the value of the pixel. A 3x3 widow is used here. which contains the neighbouring pixels surrounding a given pixel. For a reference pixel $f(i,j)$, its new value is;

$$g(i,j) = 1/4[f(i-1,j) + f(i+1,j) + f(i,j-1) + f(i,j+1)]$$

- **Laplacian Filter**: This method of filtering is arrived at by taking the second partial derivative (Laplacian) of the pixel value at location $f(i,j)$, then discretizing the Laplacian. One therefore arrives at the convolution kernel for the Laplacian operator. For a reference pixel $f(i,j)$, its new value is;

$$g(i,j) = f(i-1,j) + f(i+1,j) + f(i,j-1) + f(i,j+1) - 4f(i,j)$$

- **Median Filter**: Median filtering is a nonlinear smoothing method. It sorts the pixel values in the neighbourhood window of the reference pixel and selects the median value of the sorted data. The original value at the reference pixel is then replaced by the median value[2].
- **Gaussian Blur Filter**: This is also is another linear filtering method used in the spatial domain. It is mainly used to blur images and remove noise. A 2-D Gaussian kernel was used. The 5x5 matrix derived from this kernel is used to transform a corresponding 5x5 matrix of a referenced pixel and its neighbours. A new value for the referenced pixel is therefore gotten.

3.0 **Code structure and execution**

The code has 3 files. An "image.h" file containing the classes. An "Image.cpp" file containing the definition of classes' member functions and an "Image_main.cpp" file containing the main and filters' functions for execution. The OpenCV-3.1.0 library used can be downloaded here https://opencv.org/releases.html. The installation guide for this library is well explained in this video https://www.youtube.com/watch?v=l4372qtZ4dc.

To use this code, the GitHub page should be cloned and Then folder directory should be included after opening the project, by right clicking on project >> properties >> C/C++ >> General >> Additional Include Directories. This code is executed by first creating an object of class BMPImage, PngImage or JpegImage to be processed. User should type the < imagename.imagetype> in the imread() function, then run. The code should be run in x64 mode which is compatible with the library used. Then the user interface will pop up, requiring the user to choose the type of filter desired, by entering numbers 1-5. Then two images will be shown; original and filtered. Also, a jpeg format of the filtered image will be saved in the project folder. Also, the format of the original image will be displayed on the console. If a wrong number is typed, an error message will be shown telling the user to type a correct number. Typing an image name not saved in the project folder will lead to display of an error notification on the interface. Three images of .jpg, .png and .bmp format have been provided for testing.

4.0 **References**

1. https://en.wikipedia.org/wiki/Thresholding_(image_processing), Accessed 10th, February 2019.
2. Choi-hong, L & Meiqing, W (2009). A Concise Introduction to Image Processing using C++. (1st ed.). London, UK: CRC press.