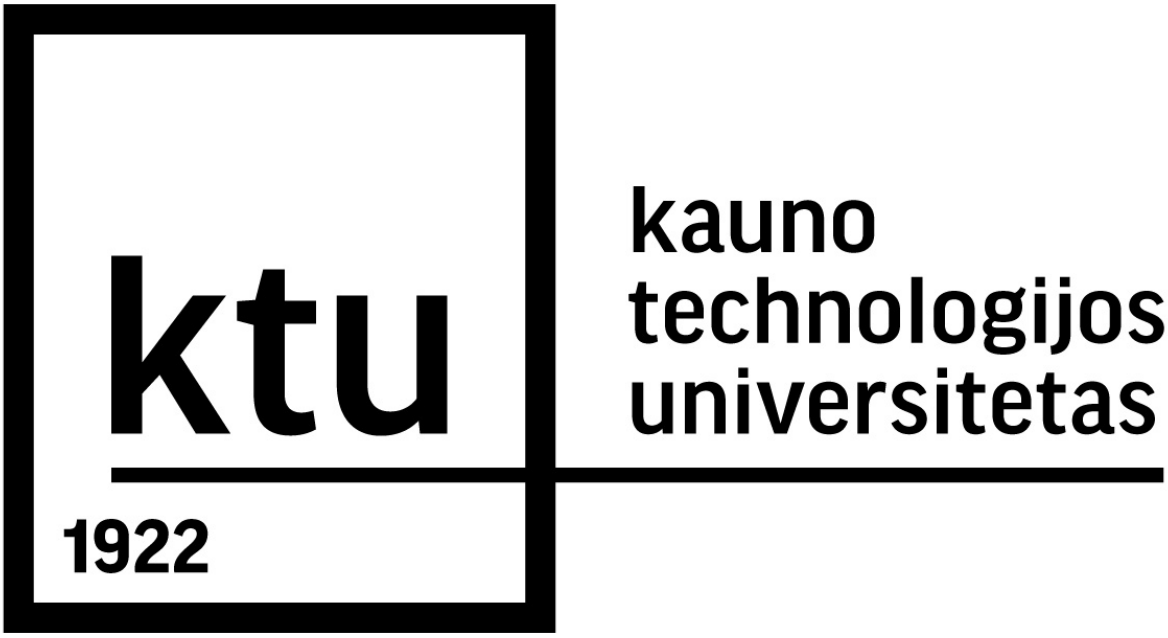

KAUNAS UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRONICS ENGINEERING

BIOMEDICAL IMAGE PROCESSING

ASSIGNMENT 2

Kaunas, 2024

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1. In accordance with the given instructions, the dataset is examined, and the two images with the best quality are selected. Subsequently, histograms of these images are analyzed, and a reference histogram is generated by averaging them. Following this, the *histeq* function is utilized to adjust the remaining images in the dataset.

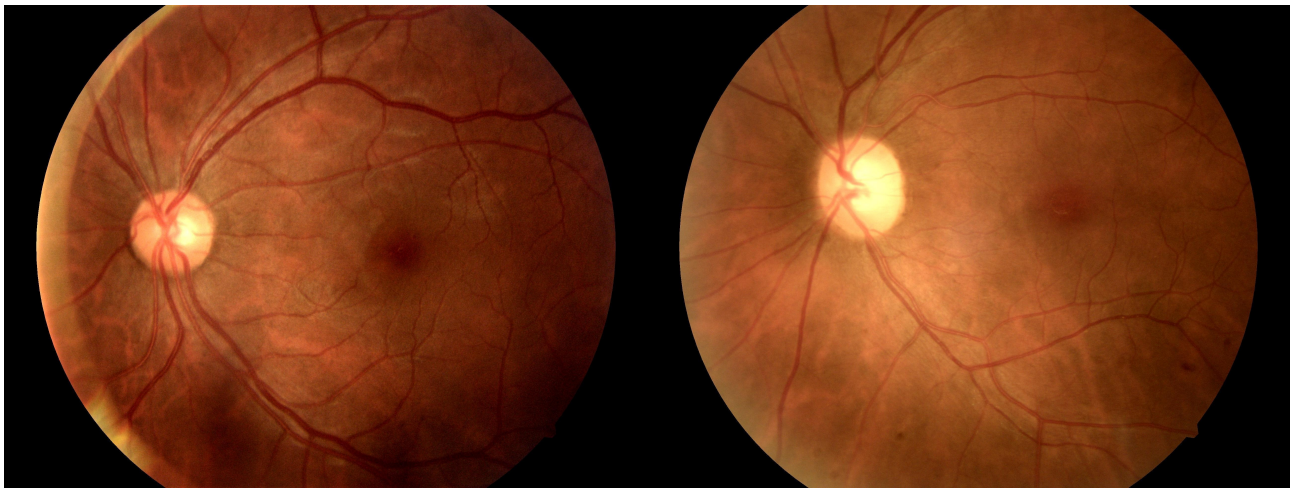

Fig.1: Reference image 1 on the left and reference image 2 on the right.

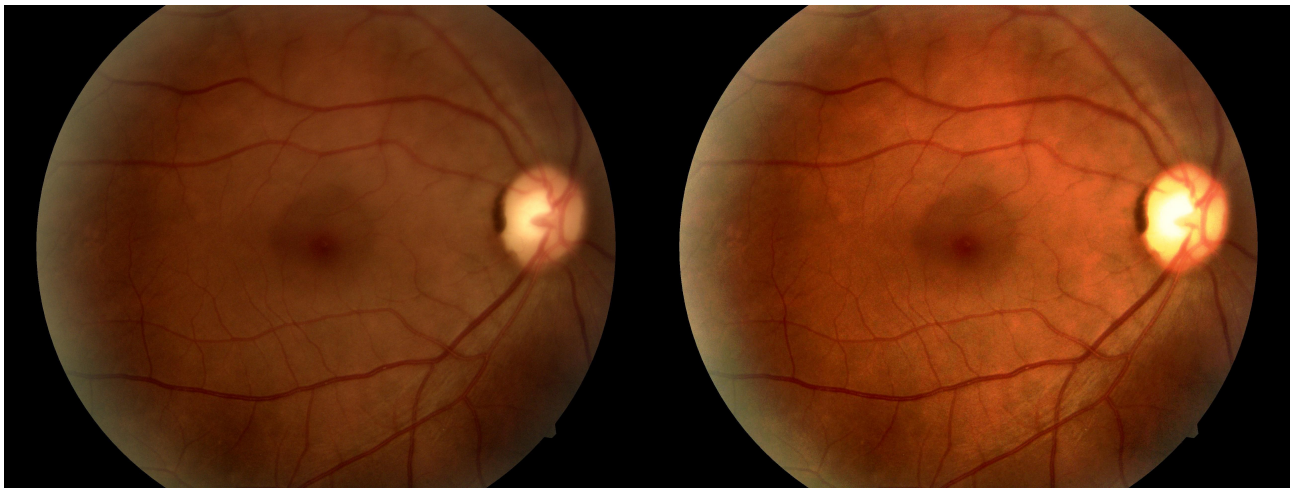

Fig.2: Adjustable image on the left and image after histogram adjustment on the right.

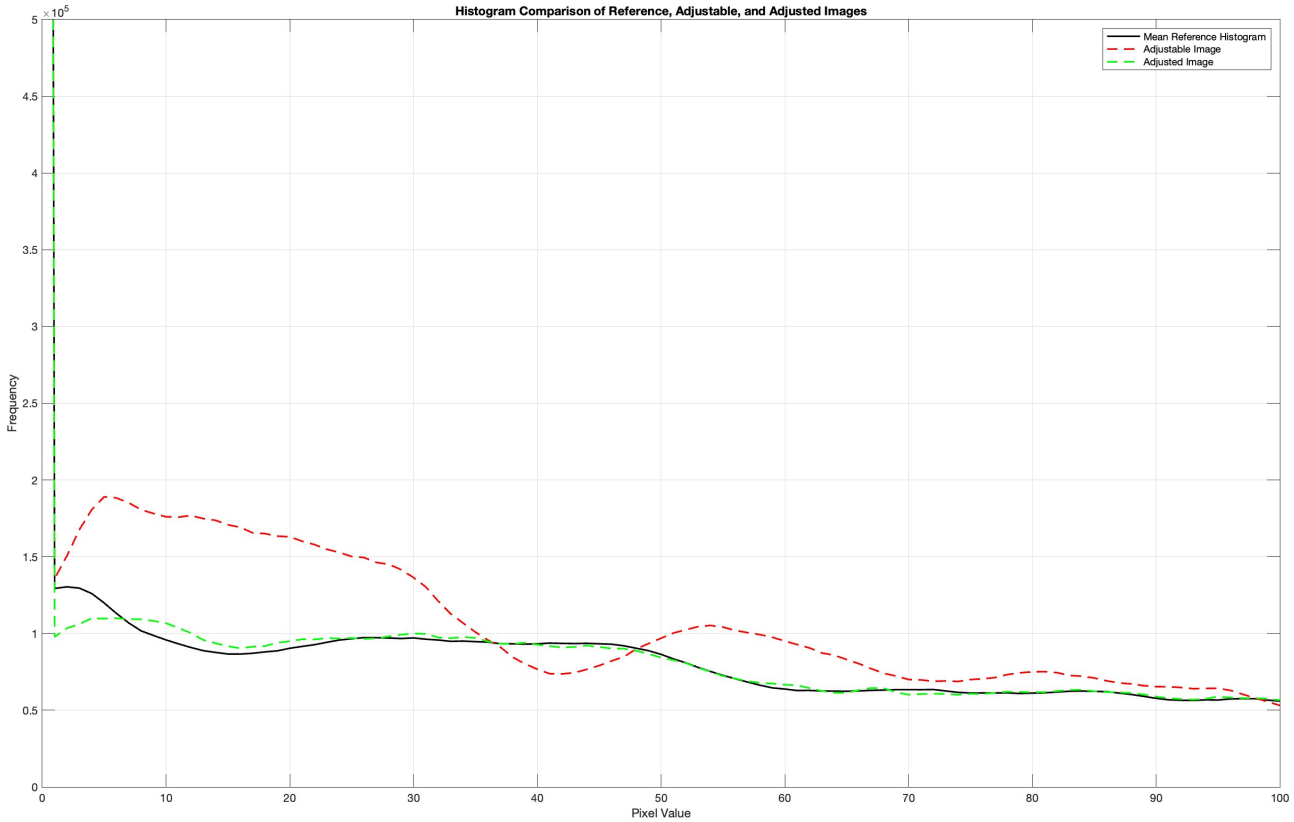

Fig.3: Histogram Comparison of Reference (black), Adjustable (red) and Adjusted (green) Images.

2. The images whose histograms are adjusted are converted to grayscale images using the im2gray function.

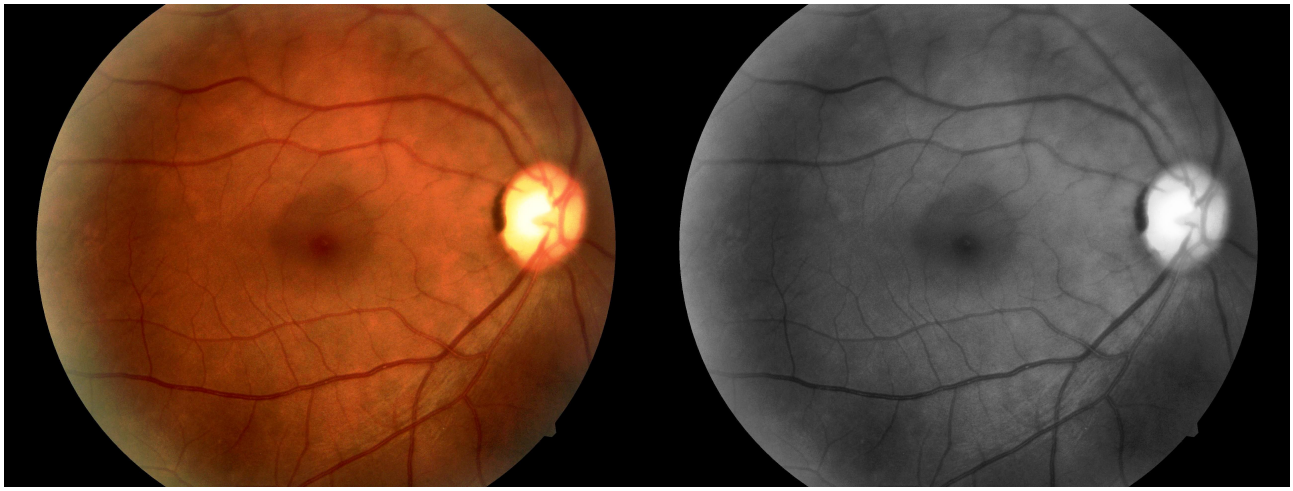

Fig.4: Image before (left) and after (right) conversion into grayscale image

3. A Spatial Gaussian filter is designed with appropriate parameters to filter out the vessels in the images. Subsequently, the selected images are filtered using this filter. Afterward, the FFT2 of the kernel, original image, and the image after Gaussian filtering is calculated.

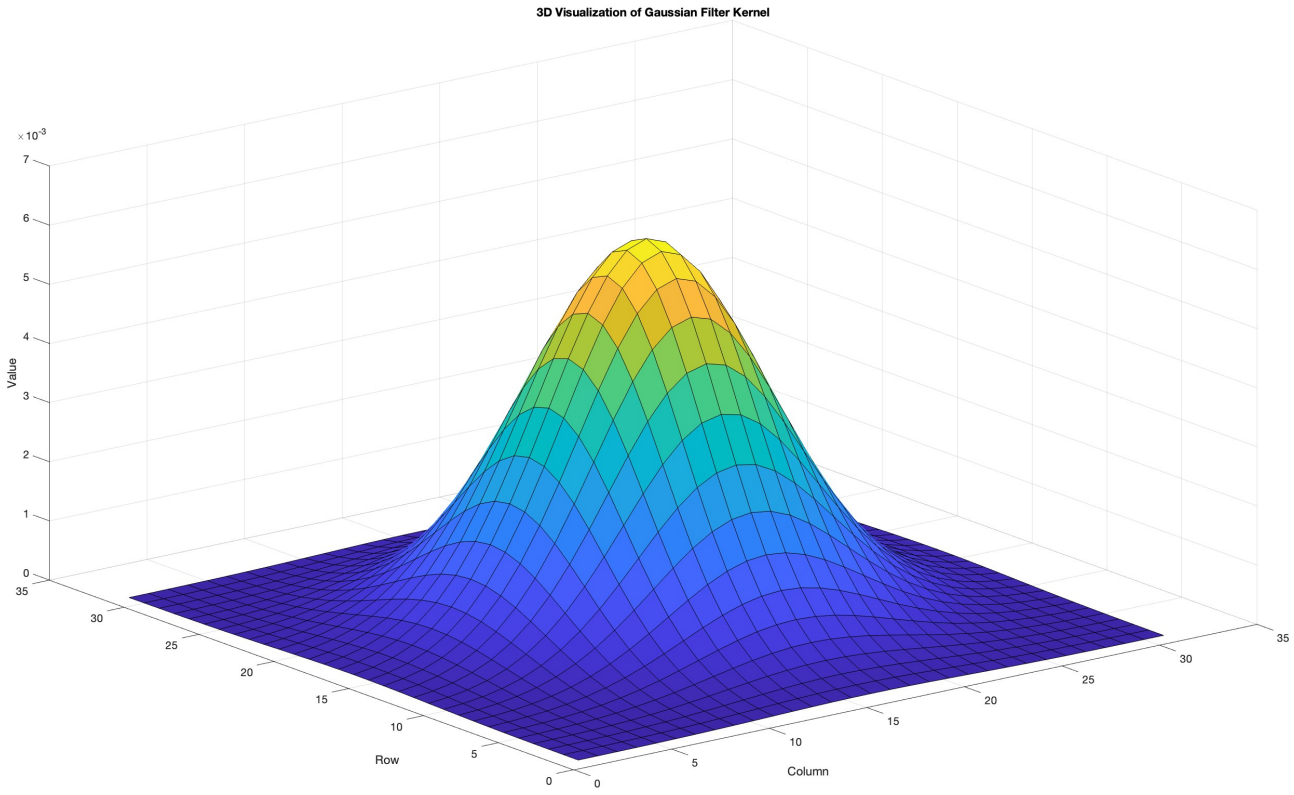

Fig.5: 3D Visualization of Gaussian Filter Kernel.

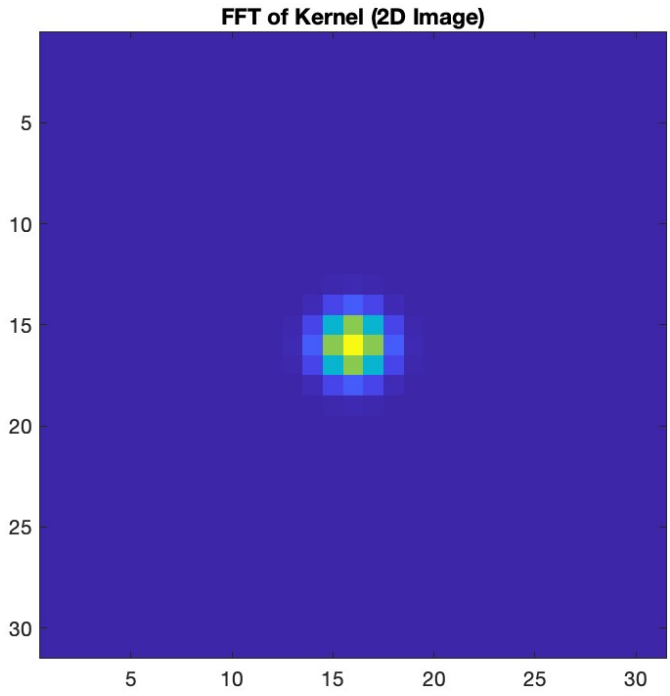

Fig.6: FFT of Kernel (2D Image).

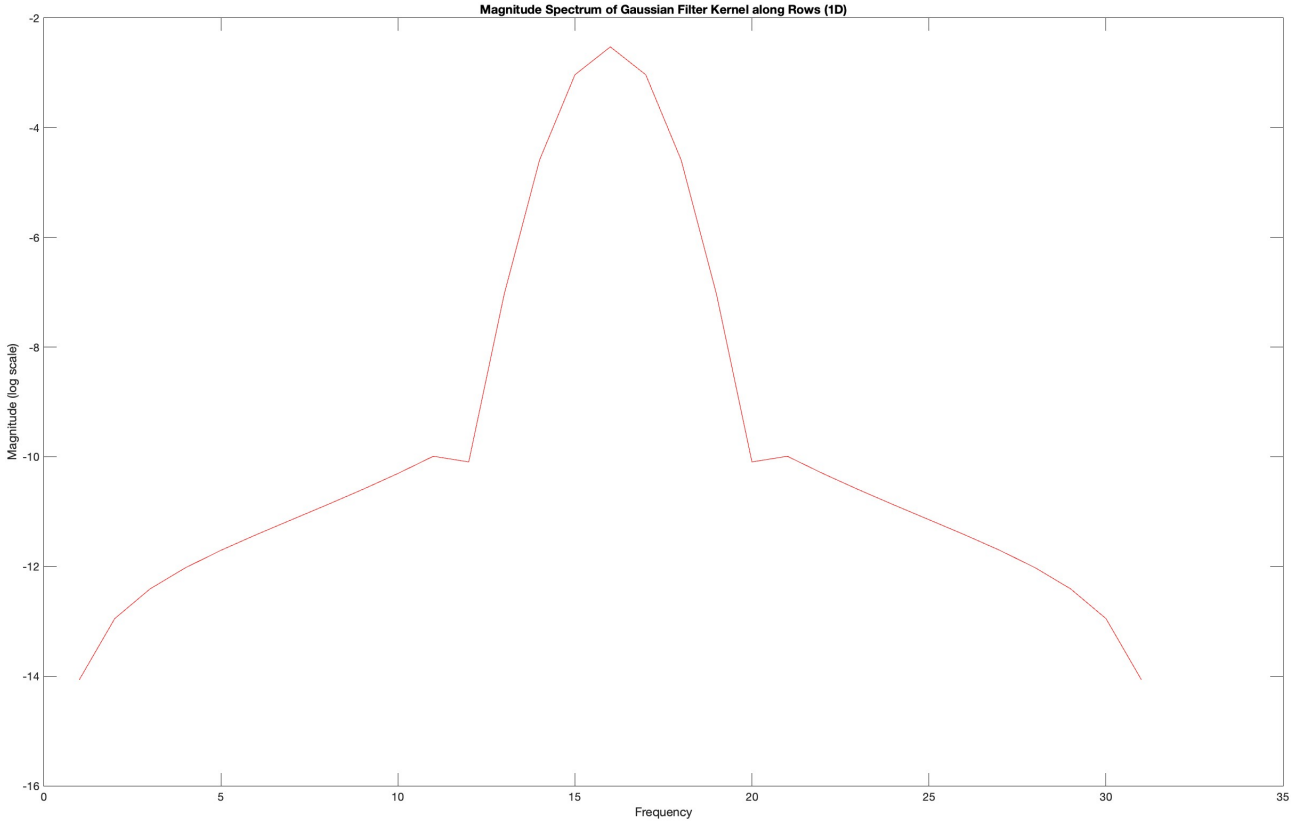

Fig.7: FFT of Kernel (1D).

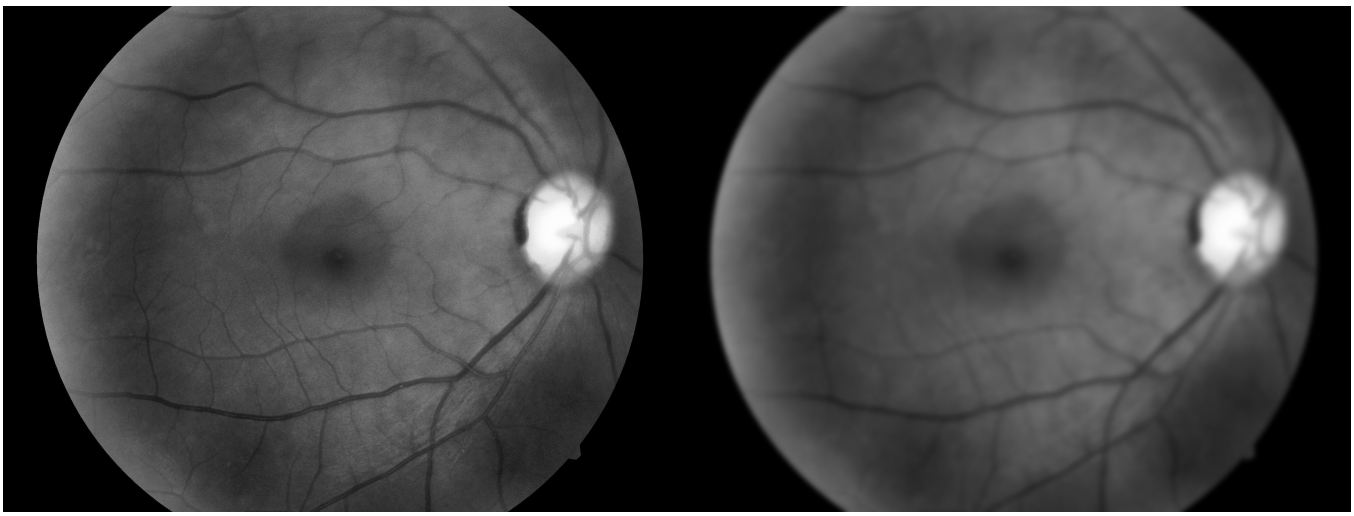

Fig.8: Image before (on the left) and after (on the right) of the filtering with Gaussian kernel.

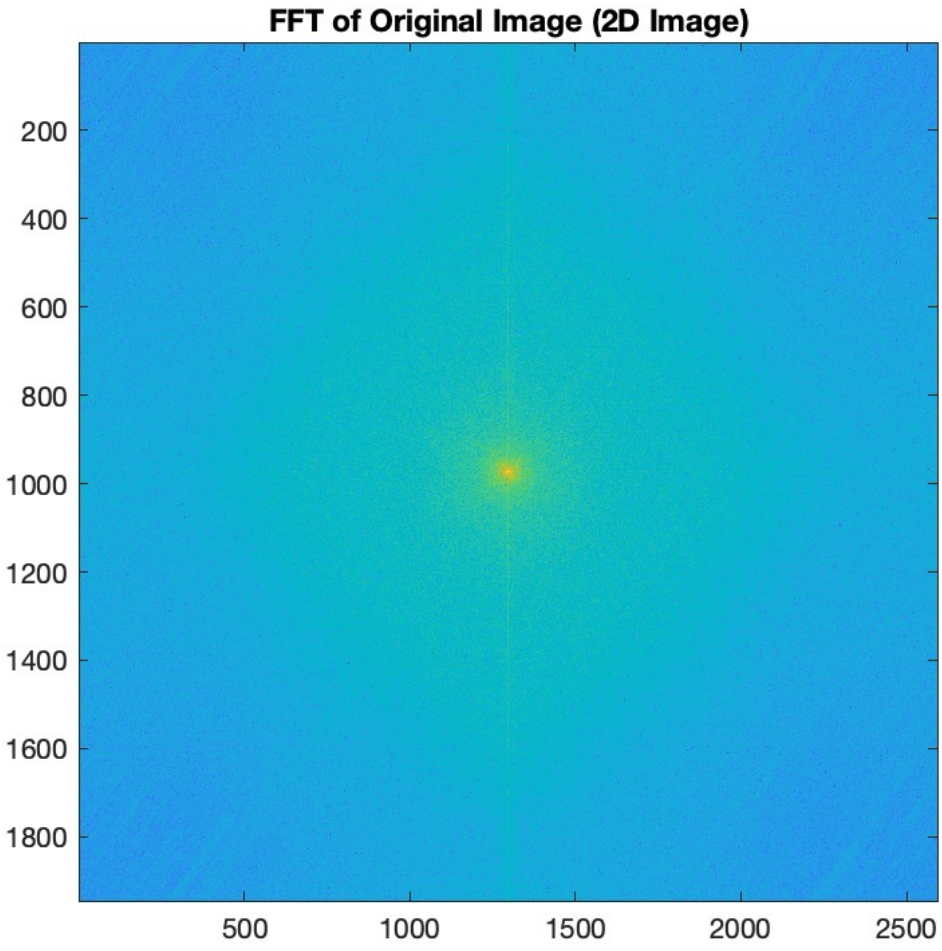

Fig.9: FFT of Original Image (2D).

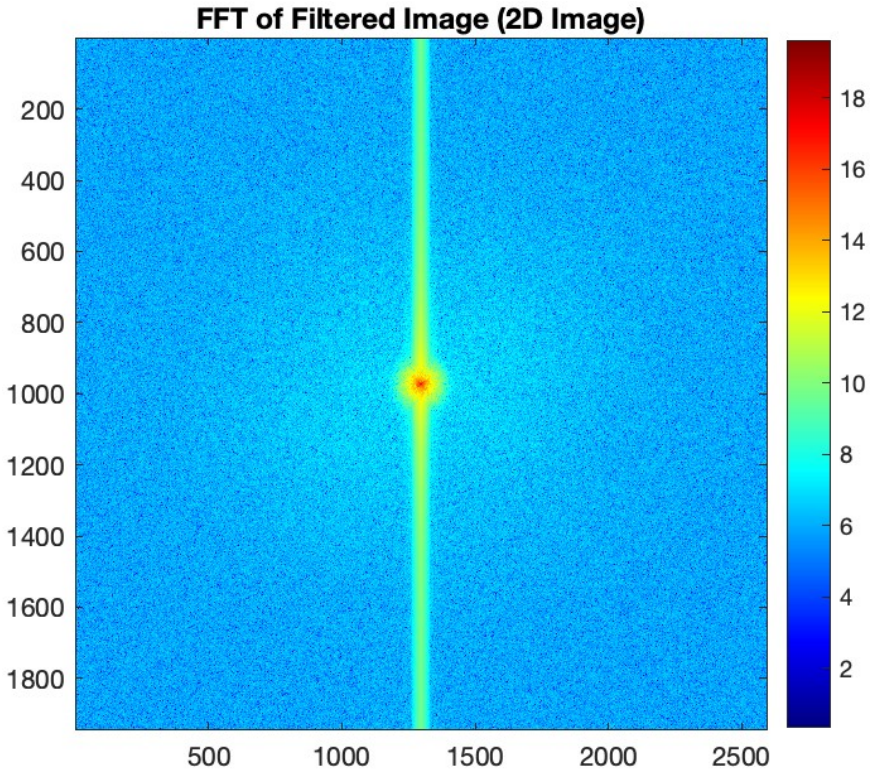

Fig.10: FFT of Filtered Image

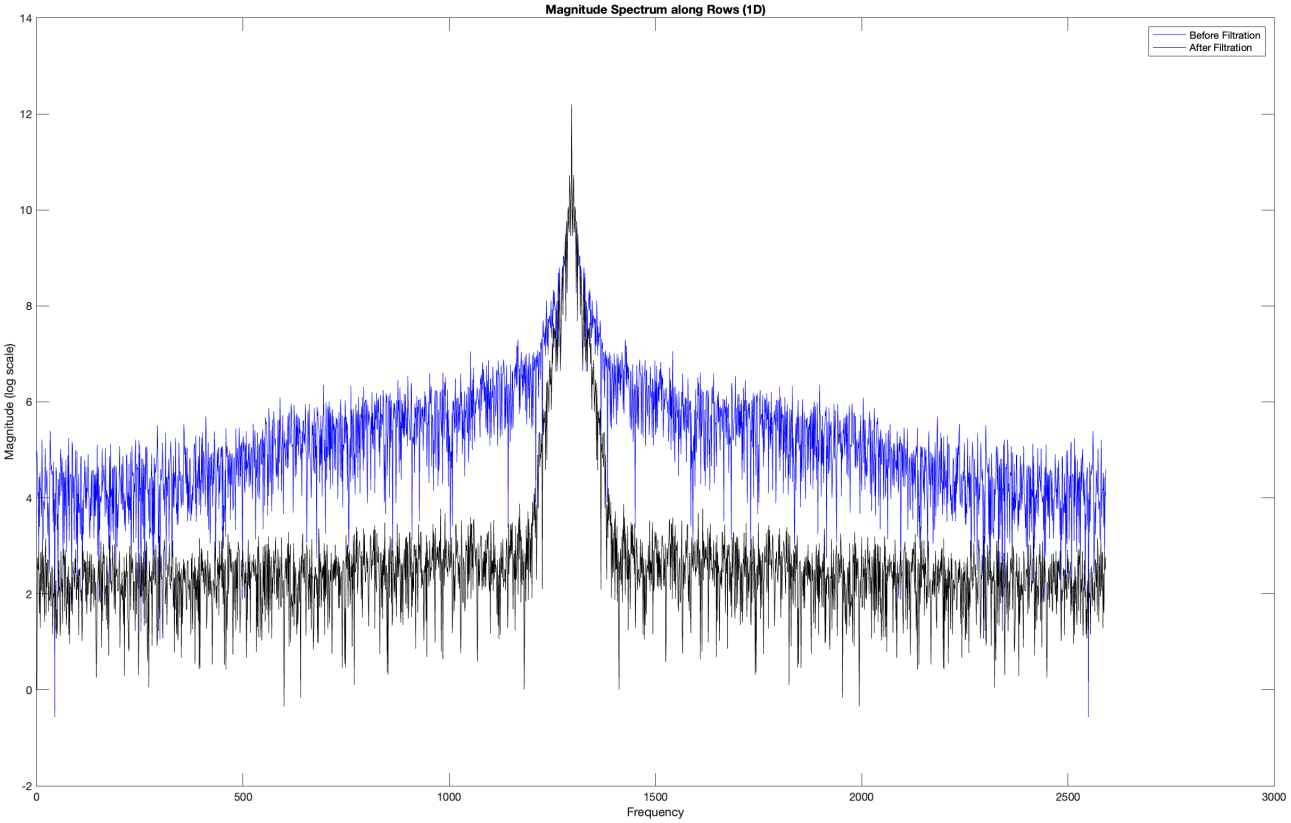

Fig.11: Magnitude spectrum of images (in logarithmic scale): before (blue) and after (black) filtration in 1D.

4. A Spatial Log filter is designed with appropriate parameters to filter the vessels in the images. Subsequently, the selected images are filtered using this filter. Afterward, the FFT2 of the kernel, original image, and the image after Gaussian filtering is calculated.

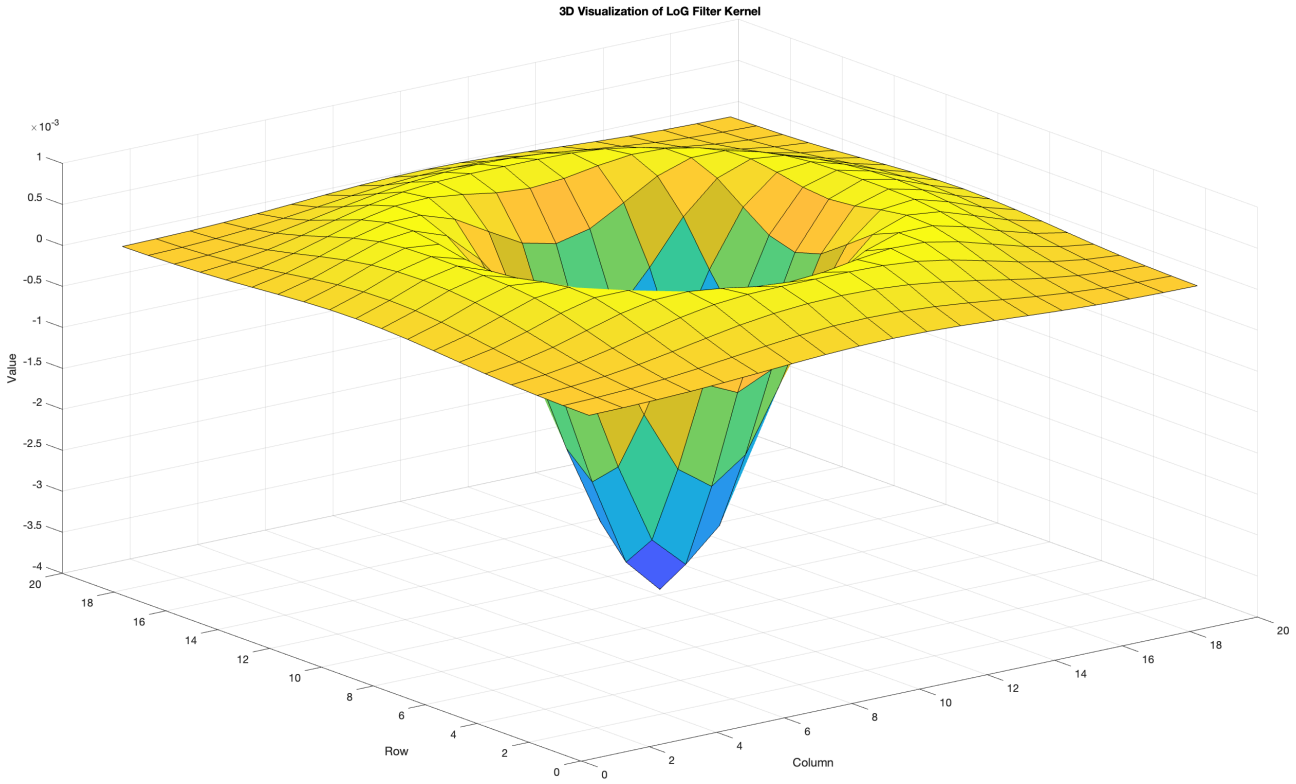

Fig.12: 3D Visualization of Log Filter Kernel.

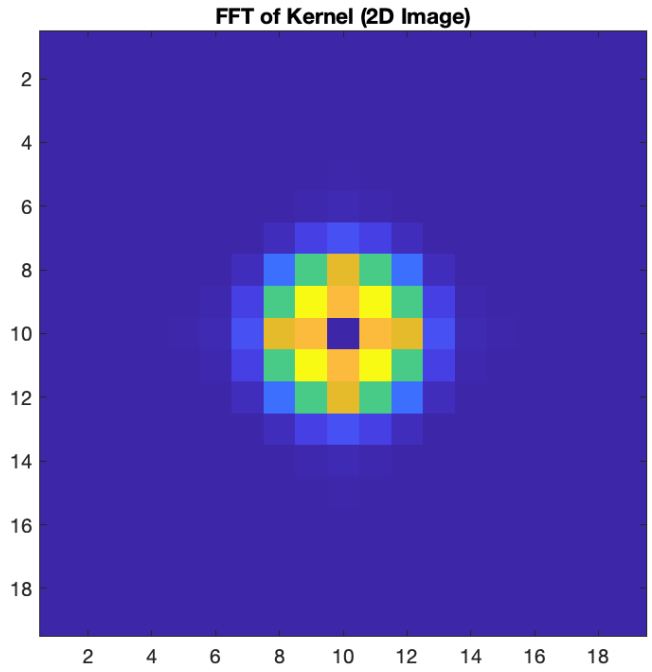

Fig.13: FFT of Kernel (2D).

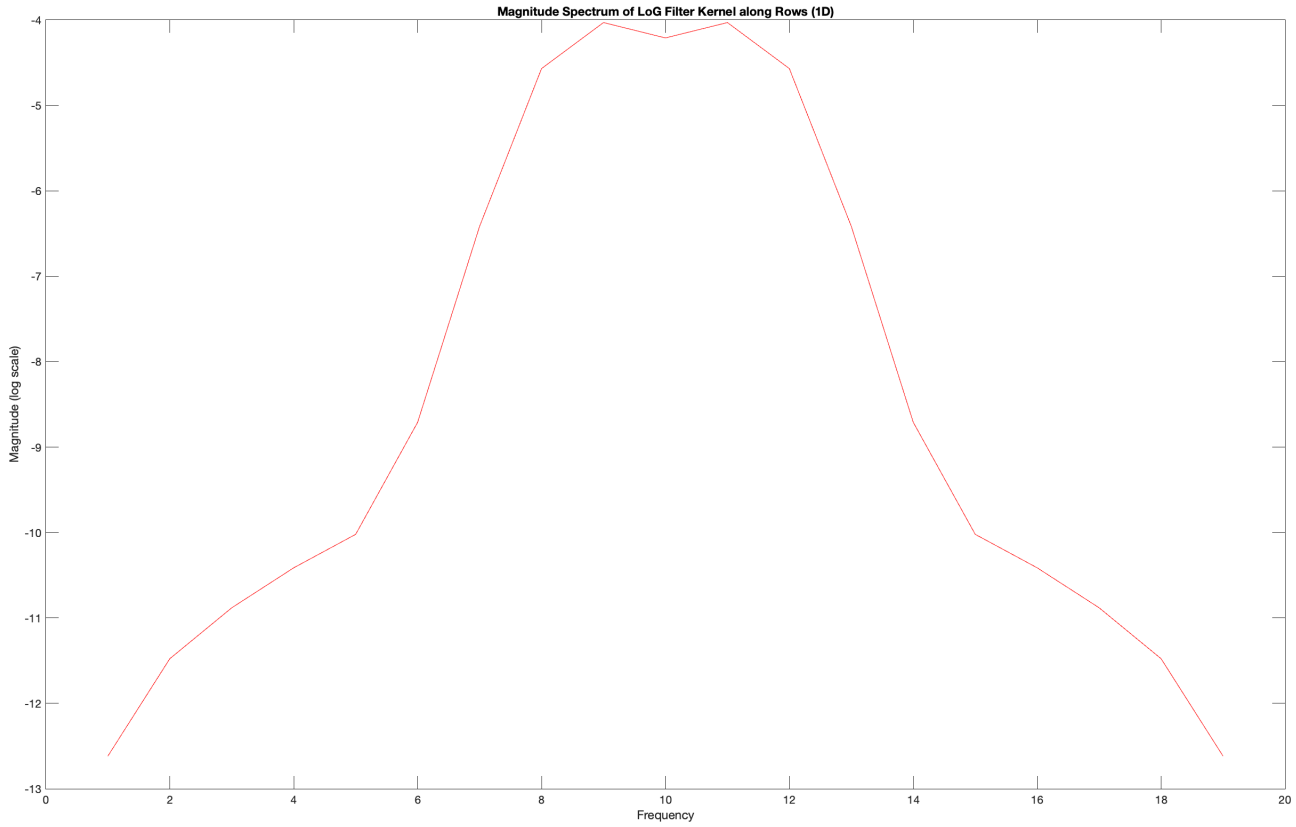

Fig.14: FFT of Kernel (1D).

Fig.15: Image before (on the left) and after (on the right) of the filtering with Log kernel.

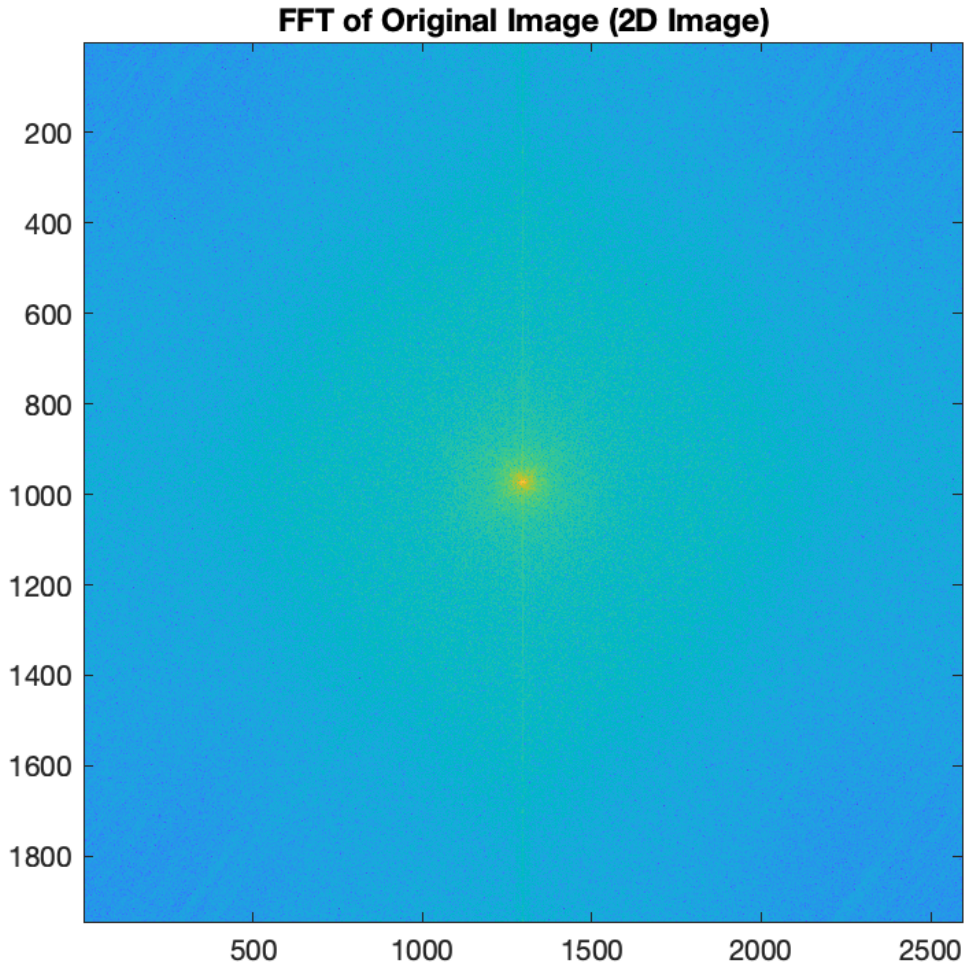

Fig.16: FFT of Original Image (2D).

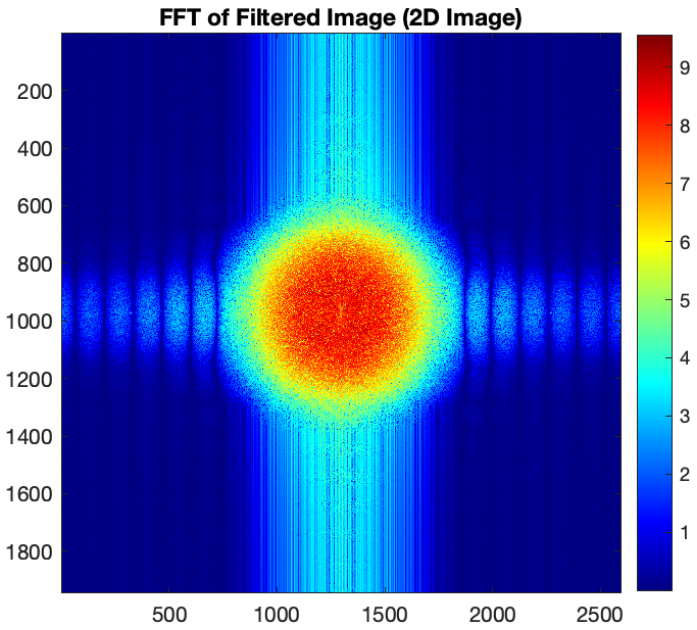

Fig.17: FFT of Filtered Image (2D).

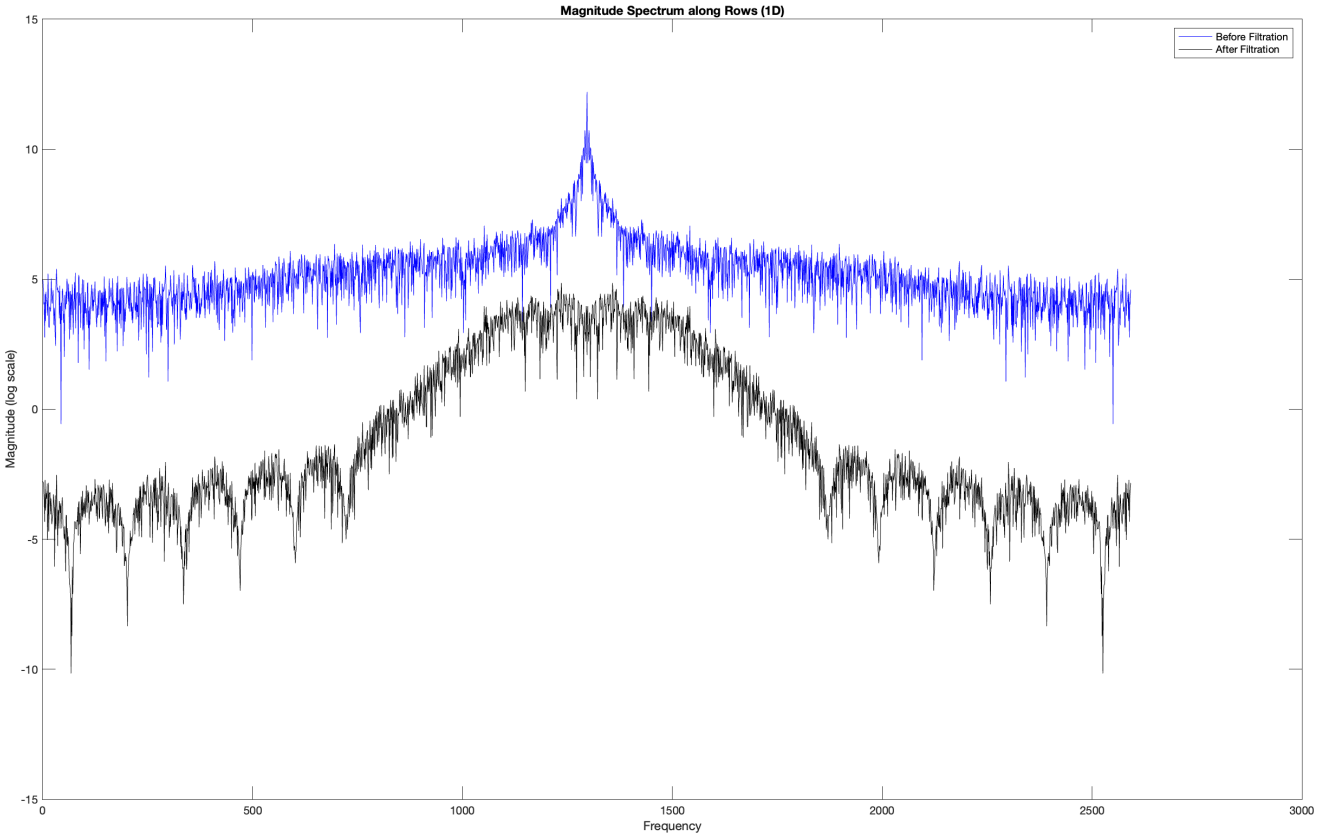

Fig.18: Magnitude spectrum of images (in logarithmic scale): before (blue) and after (black) filtration in 1D.

5. The Log filtered image is binarized, and the region of interest (ROI) edge of the image is removed. Following this, morphological operations are applied to filter the binarized image. Finally, the filtering of the binarized image is performed using region properties, with specific areas selected.

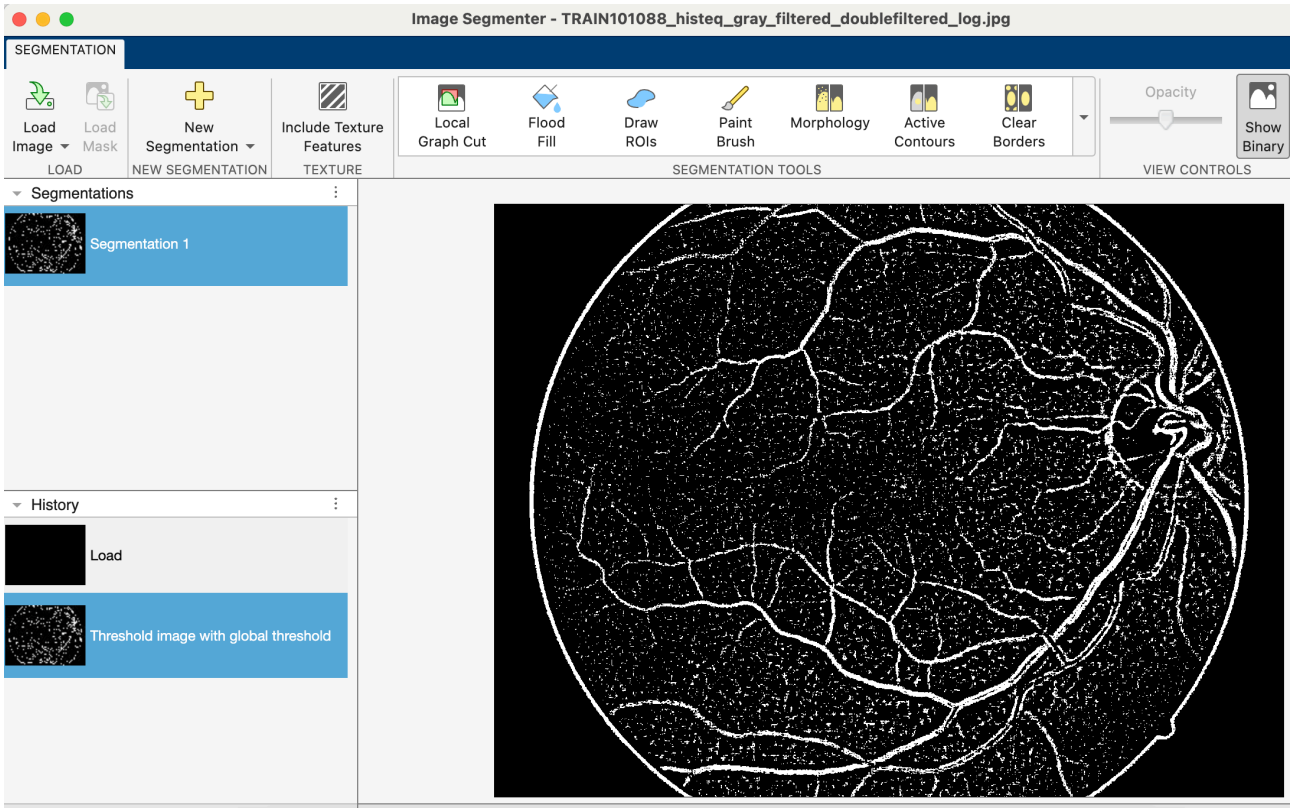

Fig.19: Binarized Image.

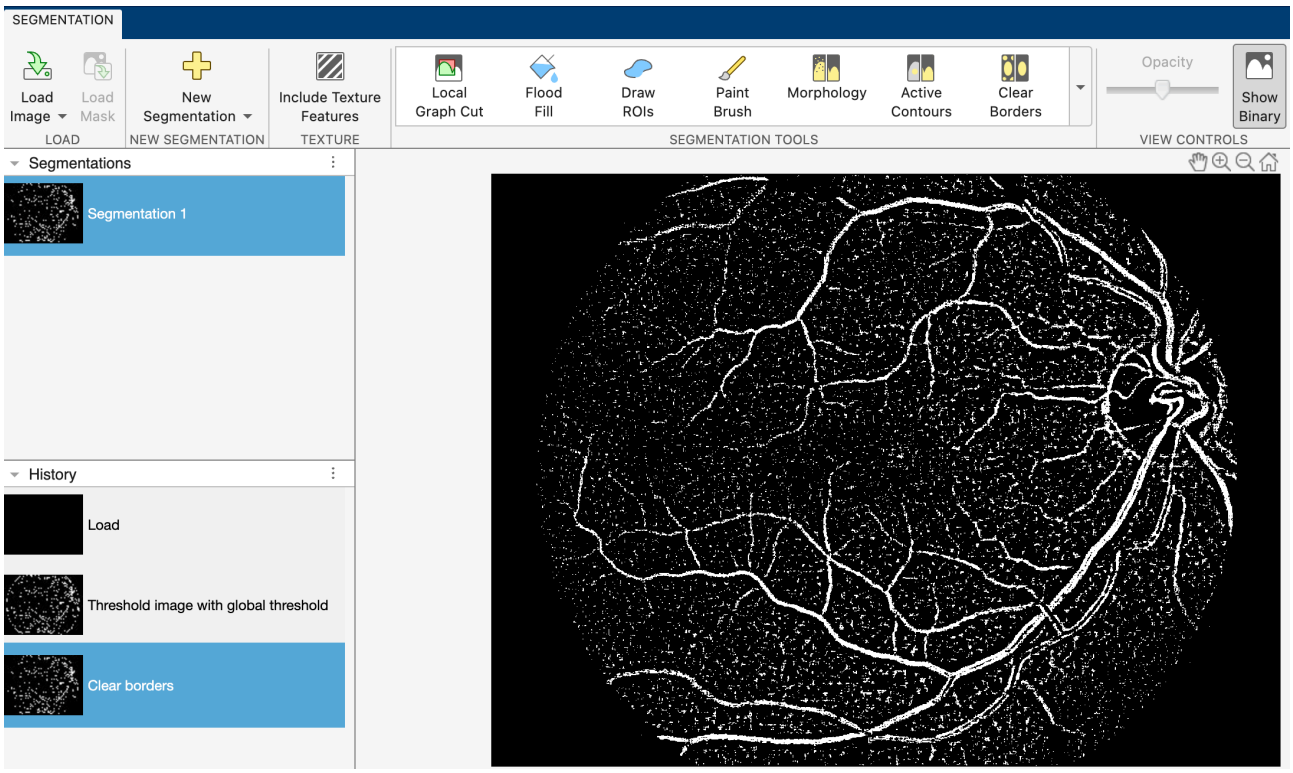

Fig.20: Binarized Image with removing ROI edge.

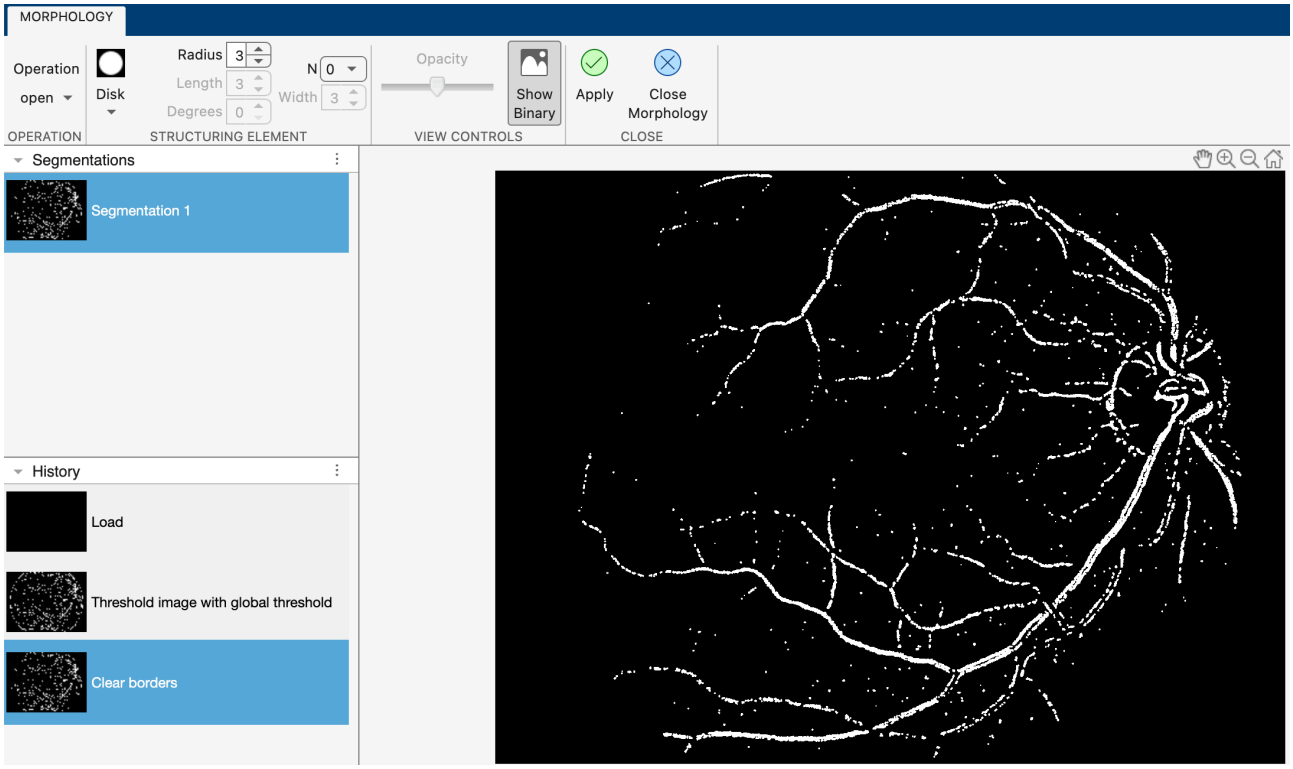

Fig.21:Filtering of the binarized image using morphological operations.

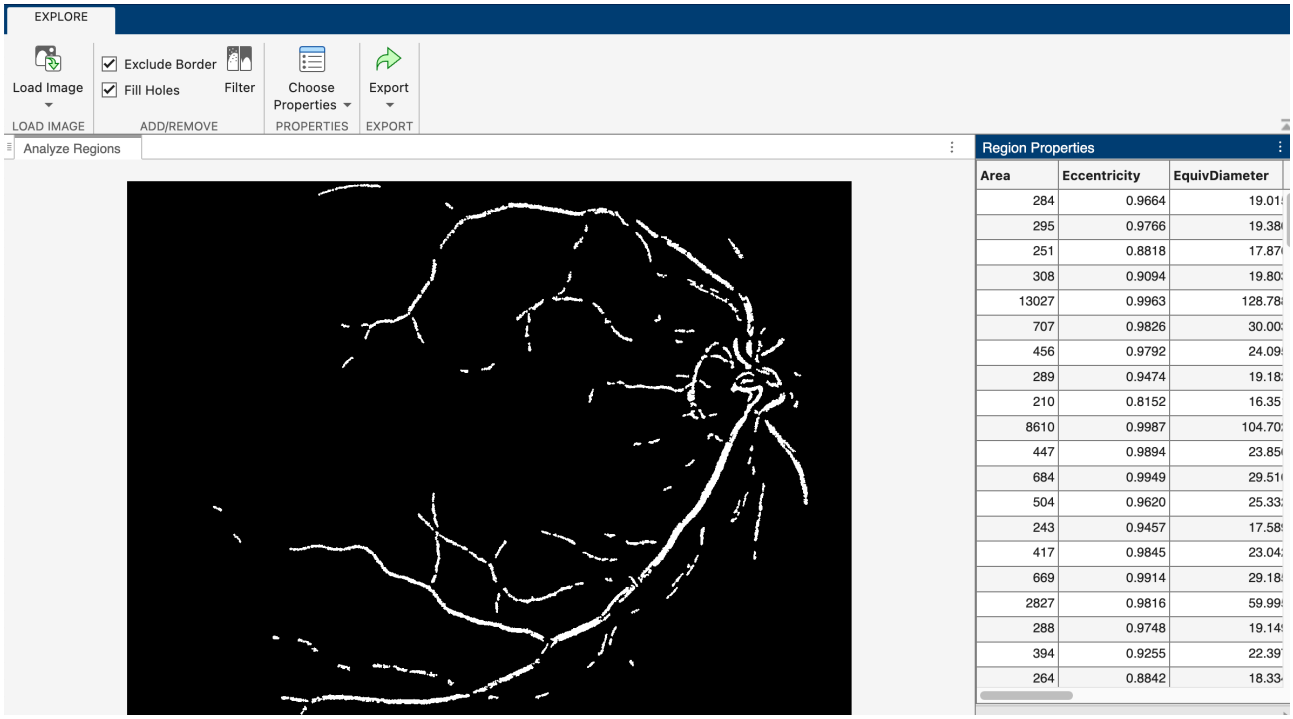

Fig.22:Filtering of the binarized image using regions properties (selected area).

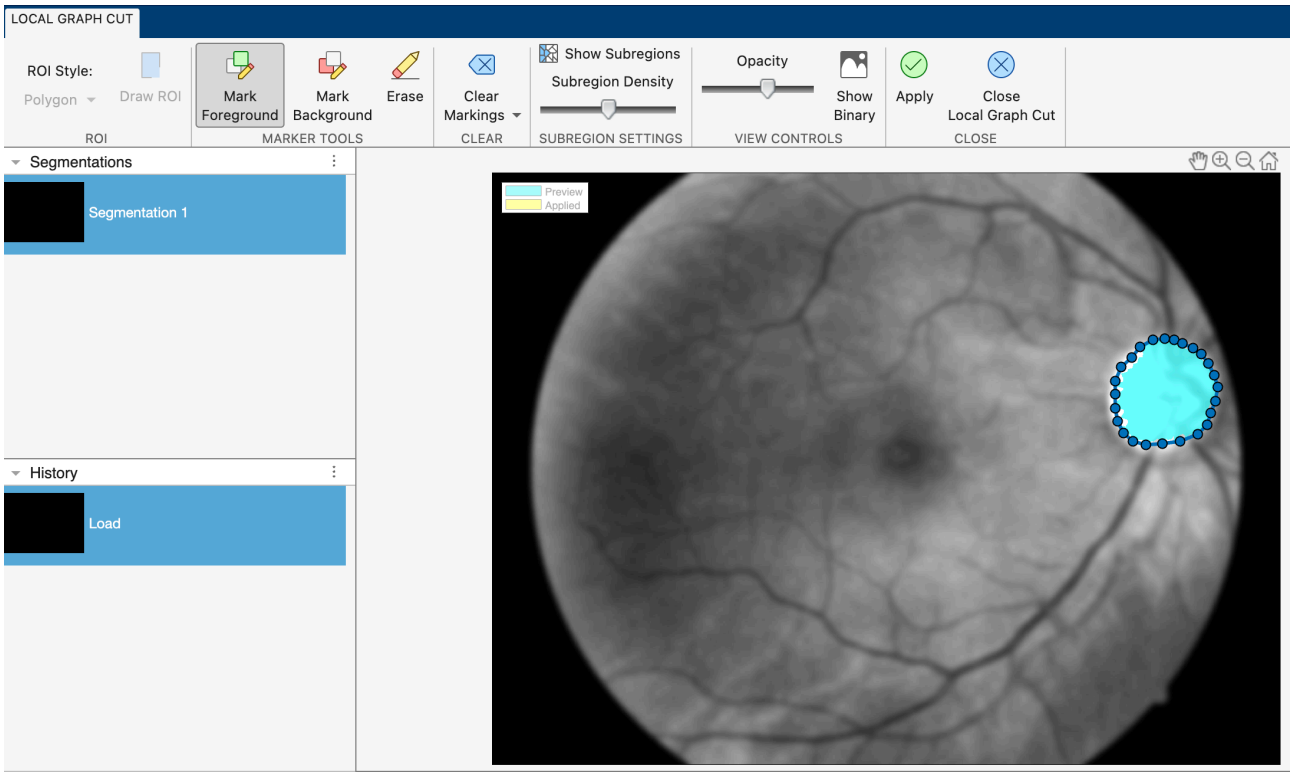

Fig.23:Thresholded ROI mask.

6. Conclusion:

In this study, a series of processes were conducted to extract vascular structures using various image processing techniques. Initially, a dataset consisting of images with heterogeneous ethnic backgrounds was analyzed. Considering the differences in color and quality among the images, the histogram of the highest quality image was used as a reference to equalize the histograms of other images. Subsequently, the images were converted to grayscale, and Gauss and Log filters were applied to extract vascular structures. For the Gauss filter, a filter was designed to emphasize vessels, and its parameters were estimated. This filter successfully enhanced vascular structures in the images. However, in some cases, the level of noise in the filtered images might increase, necessitating the application of a low-pass filter. For the Log filter, a filter was designed to further enhance vascular structures, and its parameters were adjusted. In some instances, applying a low-pass filter before the filter operation might be necessary to obtain cleaner results. Nevertheless, when applied with appropriate parameters, the Log filter effectively highlighted vascular structures. To reduce noise in the processed images and further enhance vascular structures, morphological operations were employed. These operations successfully identified vessel crossings and segments between crossings. Overall, the combination of image processing techniques allowed for the successful extraction of vascular structures. The results obtained could serve as a basis for the analysis and diagnosis of vascular structures in medical imaging. However, further refinement may be needed to reduce noise in certain cases. Future research involving testing these techniques on a wider dataset and integrating them into clinical applications will be crucial for obtaining more accurate and reliable results.