University of Burgundy

MsCV

MEDICAL IMAGE ANALYSIS

Lab 1 Pre-Processing

by

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1. Introduction

Pre-processing in a significant step to enhance the images before any further processing of images. It includes spatial and temporal filtering, where spatial filtering is achieved using anisotropic diffusion, bias correction (mainly in MRI due to non-homogenous magnetic field) and normalization of images of different patients with varying intensity levels.

2.1 Bias Field Correction

This type of correction is required because in the same image, same type of tissue has different grey levels. This occurs mainly in MRI images because of non-homogenous magnetic field in the system.

This correction is achieved using 'Multiplicative intrinsic component optimization (MICO)' algorithm.

The code for this module can be found in 'biasCorrection' folder. There is a README.txt file which explains how to run this code.

The results of this preprocessing step is as shown below.

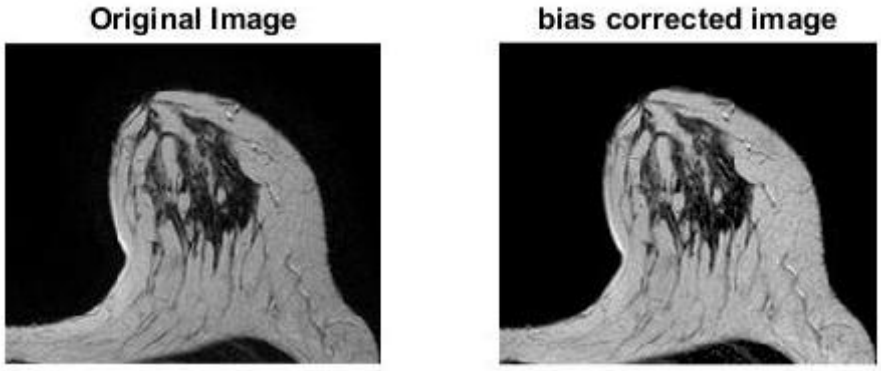

Figure 1 Original and Bias Corrected Image

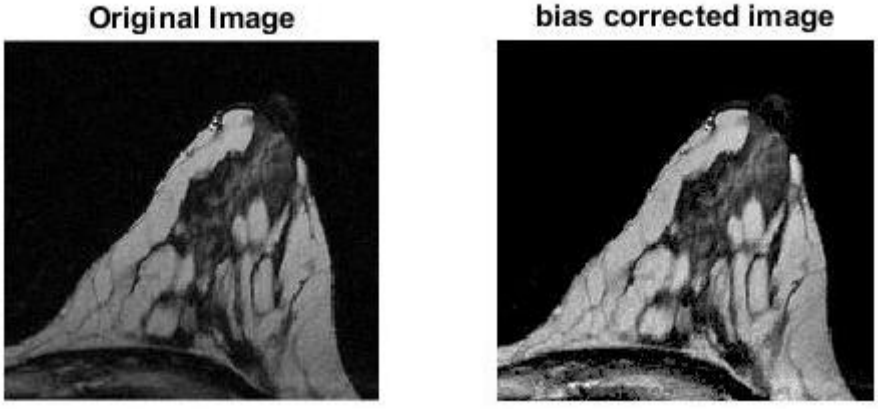

Figure 2 Original and Bias Corrected Image

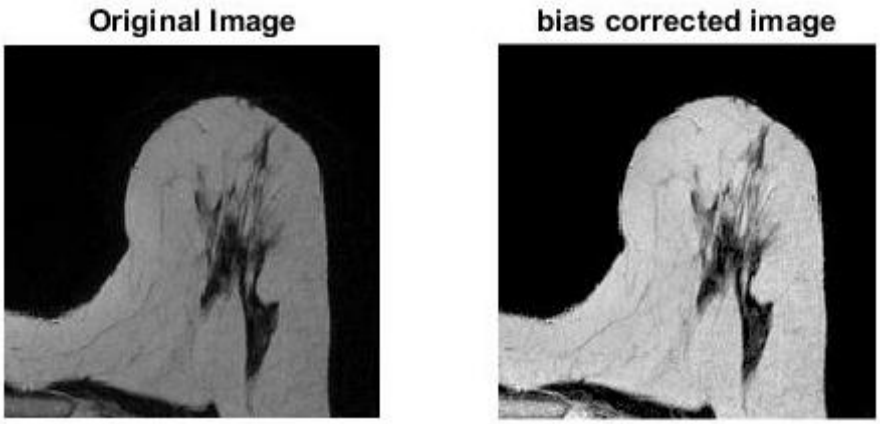

Figure 3 Original and Bias Corrected Image

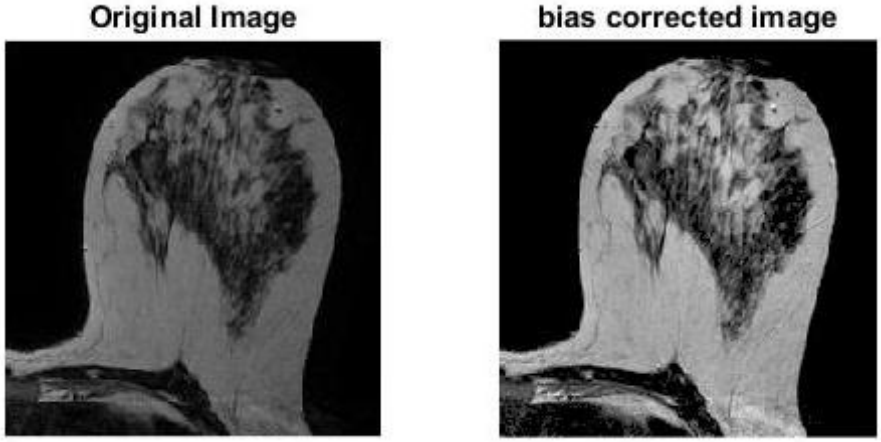

Figure 4 Original and Bias Corrected Image

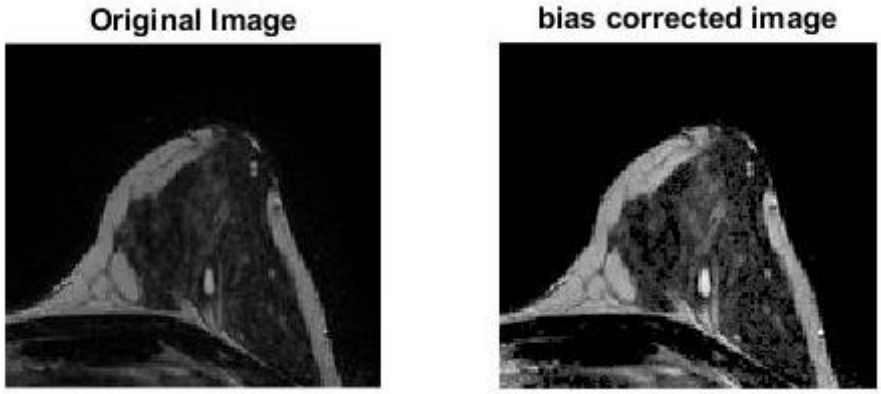

Figure 5 Original and Bias Corrected Image

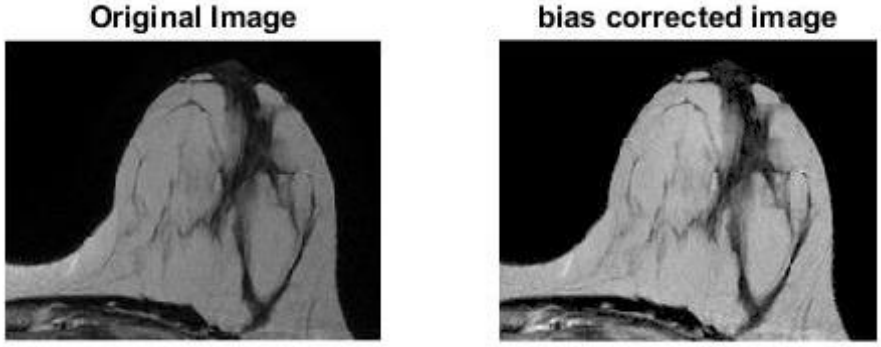

Figure 6 Original and Bias Corrected Image

2.2.1 Normalization after Bias Correction

There are inter patient differences in the imaging modalities. Here, same structure may have different values with different patients. So, we need to normalize the images to a frame of intensities. We perform this step by dividing the images by the mean of top few of intensities and multiplying a bias value to scale them up.

The results of normalization are as given below.

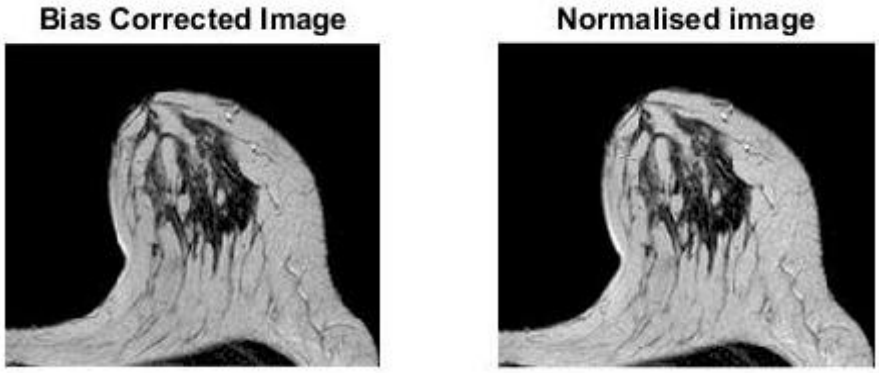

Figure 7 Bias Corrected and Normalised Image

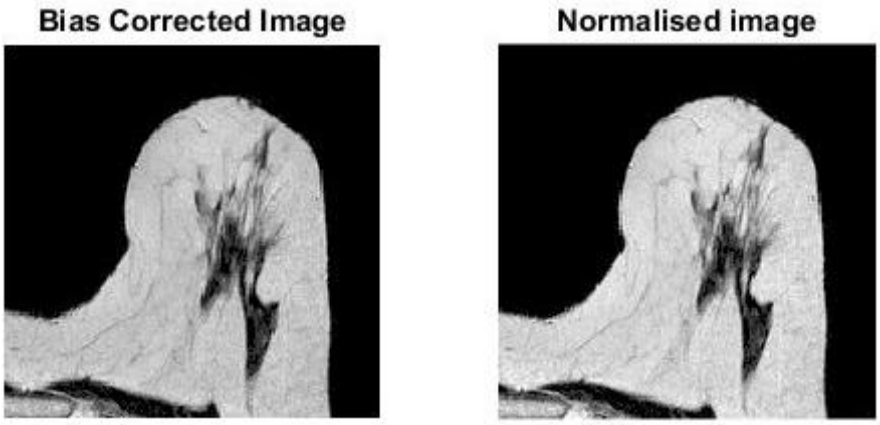

Figure 8 Bias Corrected and Normalised Image

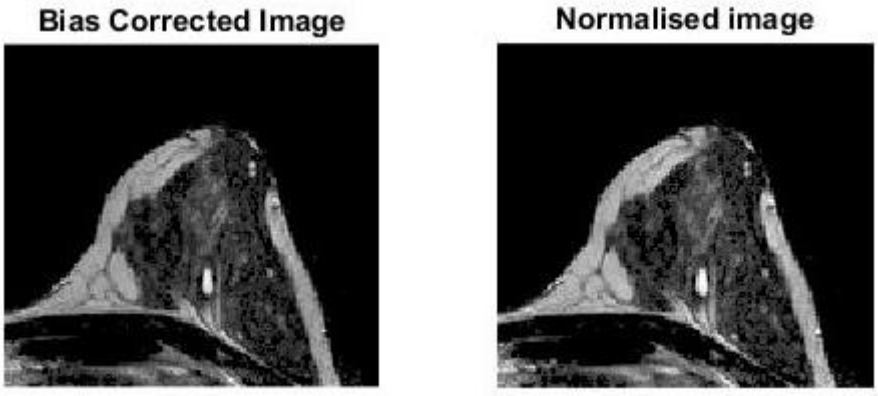

Figure 9 Bias Corrected and Normalised Image

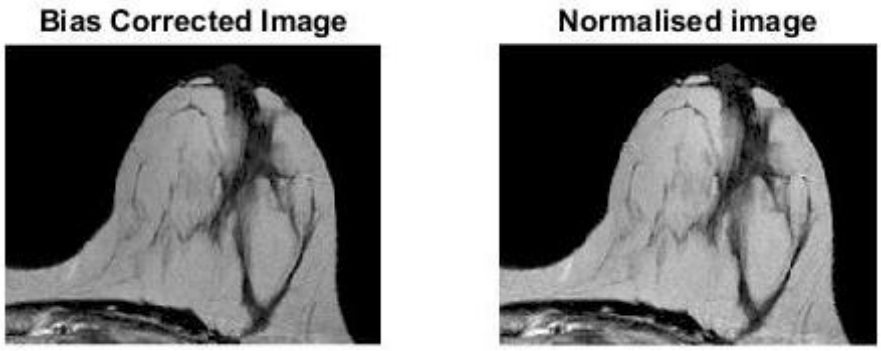

Figure 10 Bias Corrected and Normalised Image

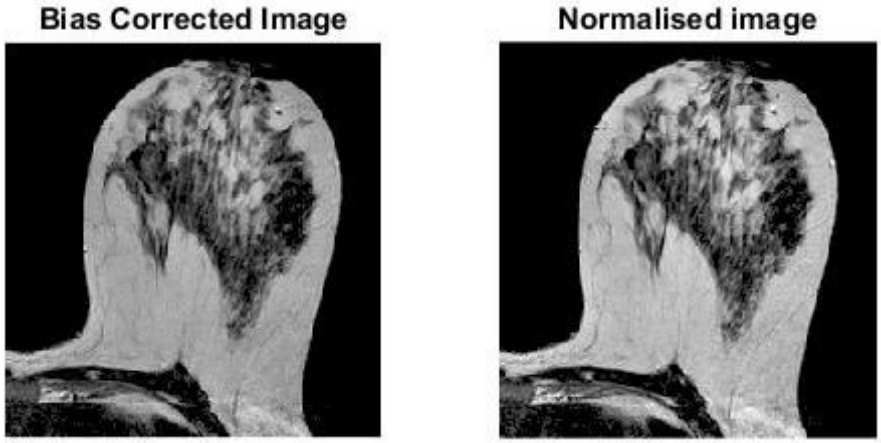

Figure 11 Bias Corrected and Normalised Image

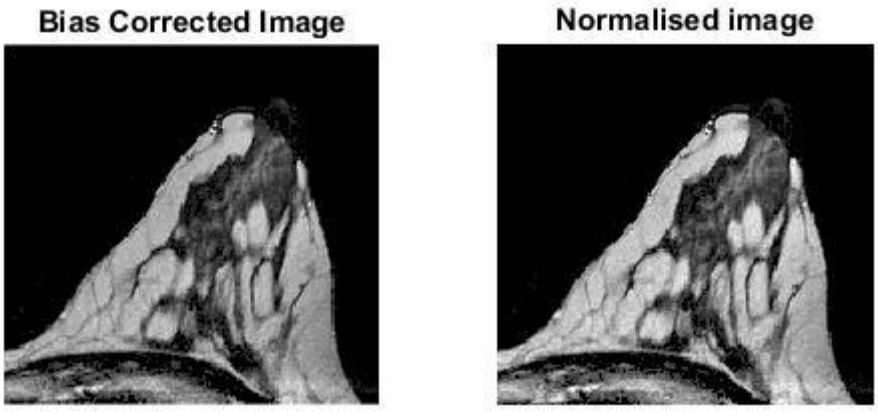

Figure 12 Bias Corrected and Normalised Image

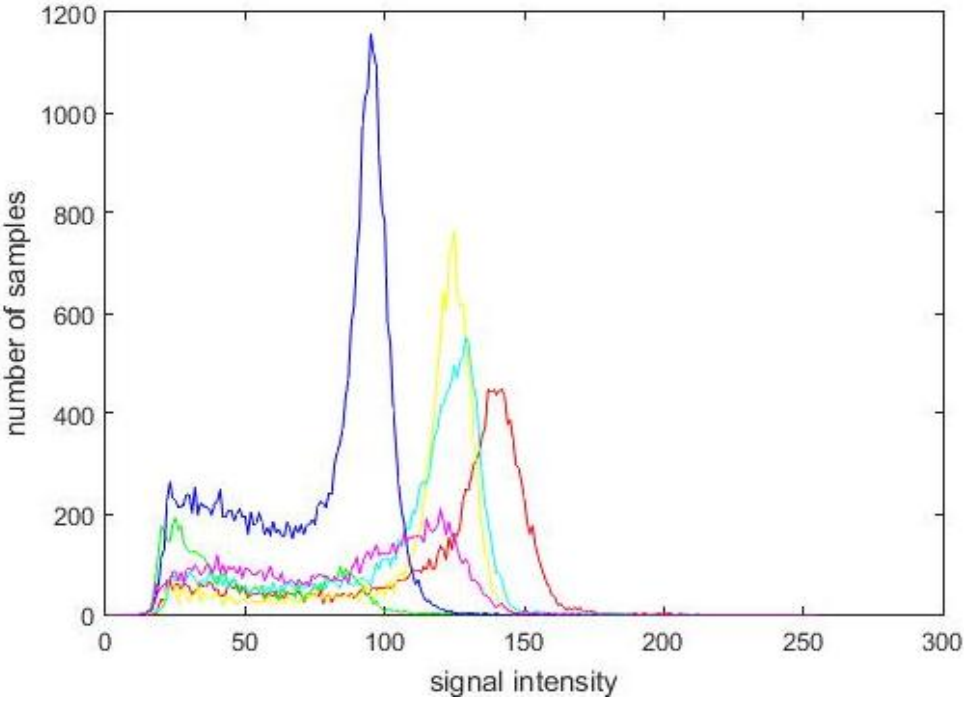

Figure 13 Histograms of bias corrected images (before normalisation)

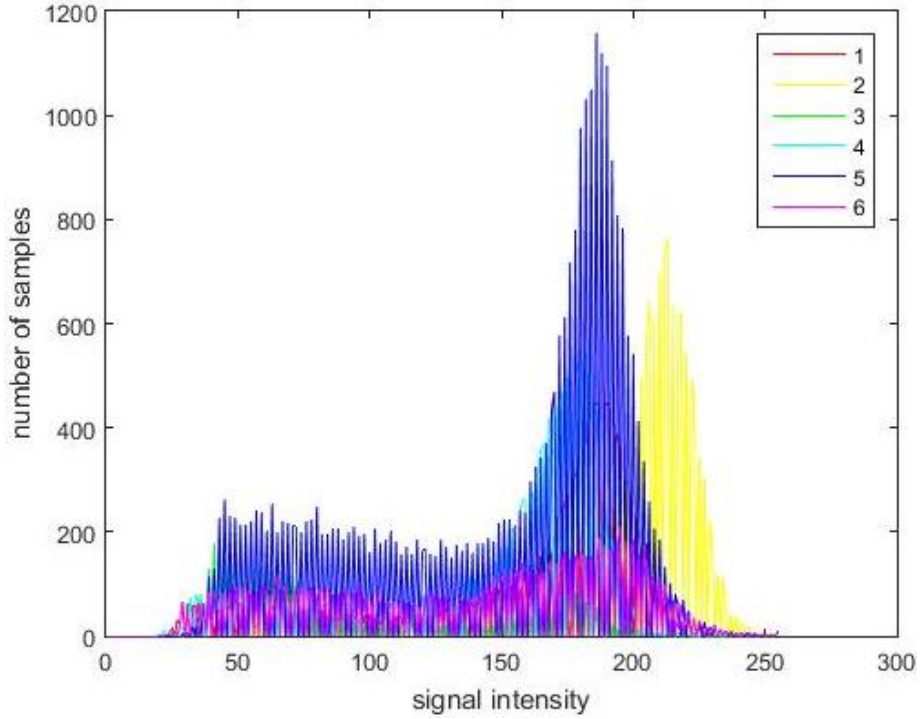

Figure 14 Histograms after Normalised Images

2.2.2. Normalisation Before Bias Correction

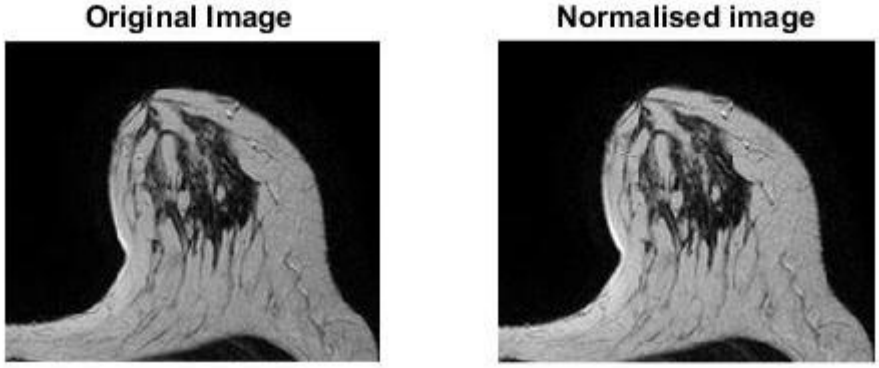

Figure 15 Original and Normalised Image

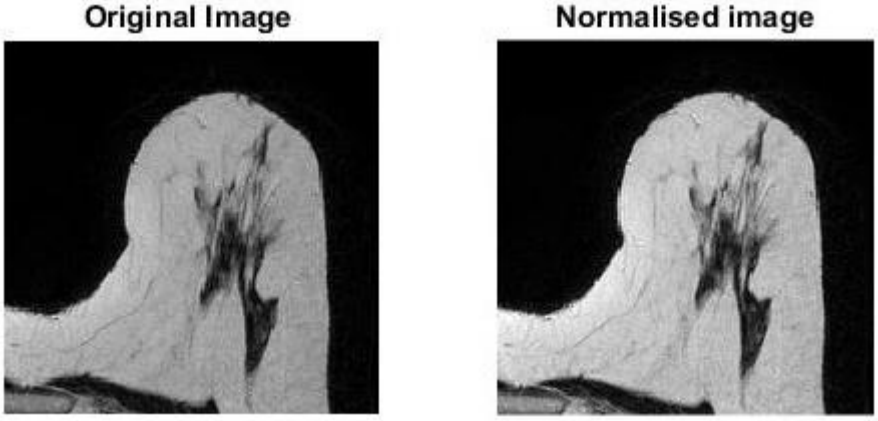

Figure 16 Original and Normalised Image

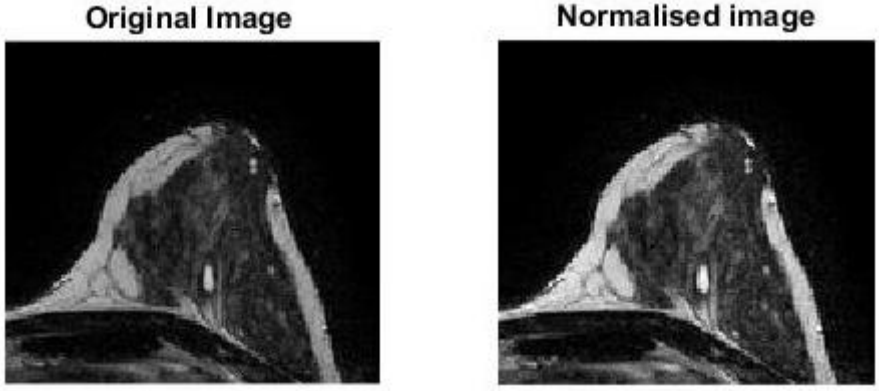

Figure 17 Original and Normalised Image

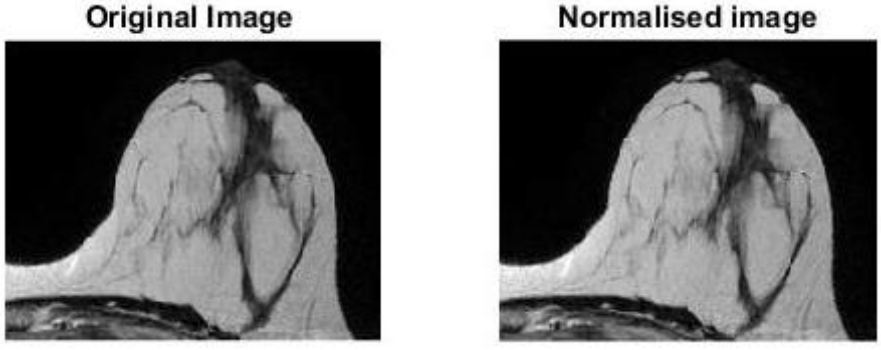

Figure 18 Original and Normalised Image

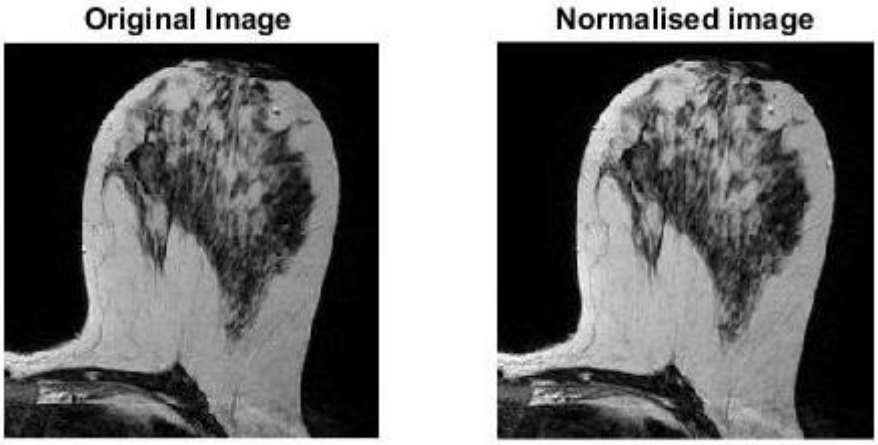

Figure 19 Original and Normalised Image

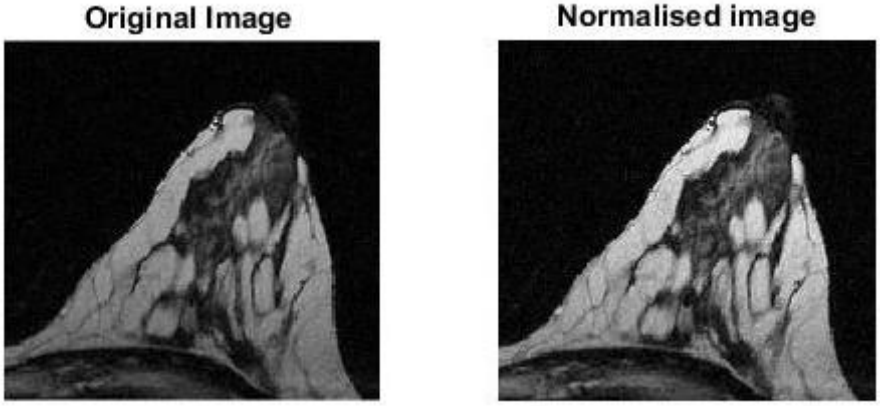

Figure 20 Original and Normalised Image

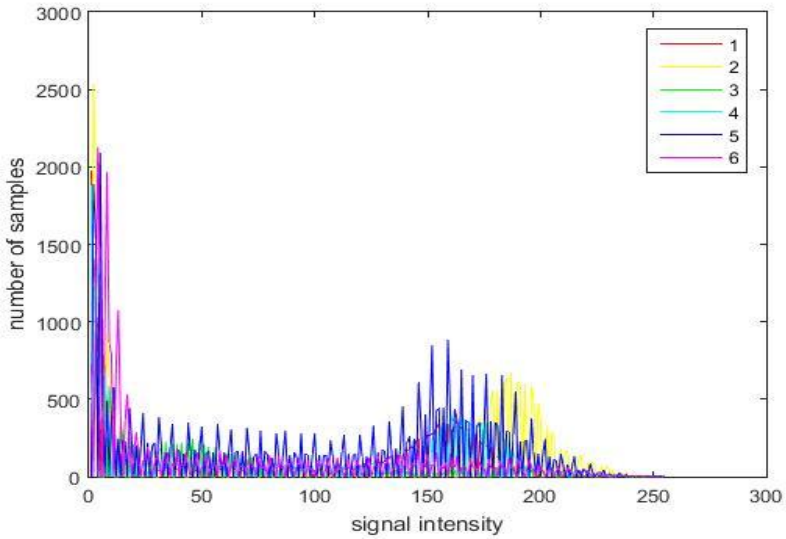

Figure 21 Histograms of Original Images

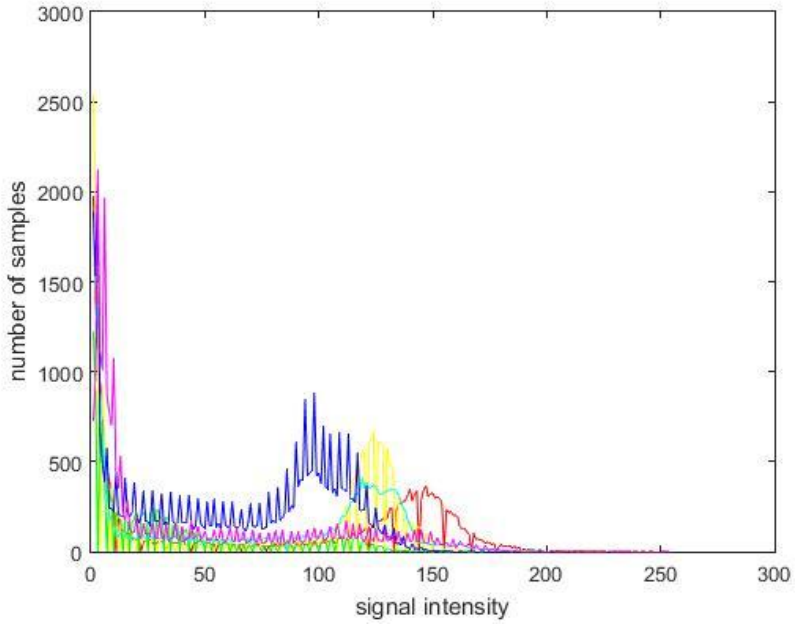

Figure 22 Histograms of Normalised images before bias correction.

A comparison of normalised images without and with biased field images is done as above.

The code for this module can be found in 'normalization' folder. There is a README.txt file which explains how to run this code.

2.3 Anisotropic Diffusion

The main motto of the anisotropic diffusion is to enhance the image without blurring the edges. So, edges are preserved depending on the parameters.

The conduction coefficient 'kappa' is a function of gradient which is used to detect edges. For option 1 of diffusion equation which prefers high contrast edges over low contrast ones, the lower value of kappa, even the small intensity variations are preserved as shown in Fig. 23 and as kappa increases the significance of intensity variations is reduced in the process as shown in Fig. 24. This results are shown below.

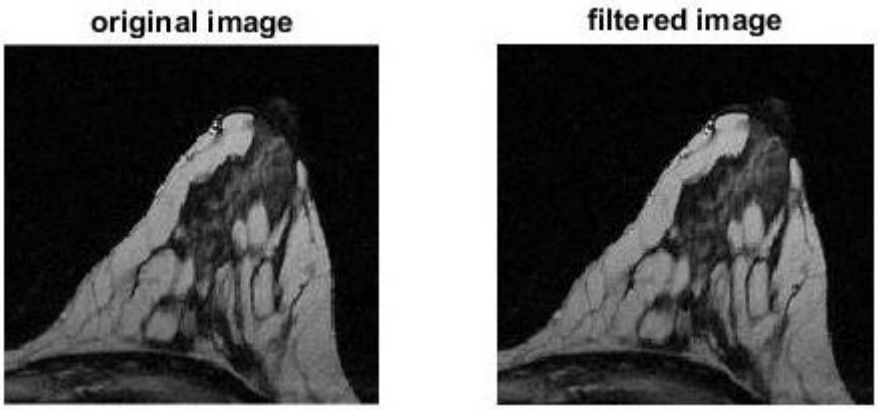

Figure 23 Original and Anisotropic diffused image with option 1 and kappa = 1

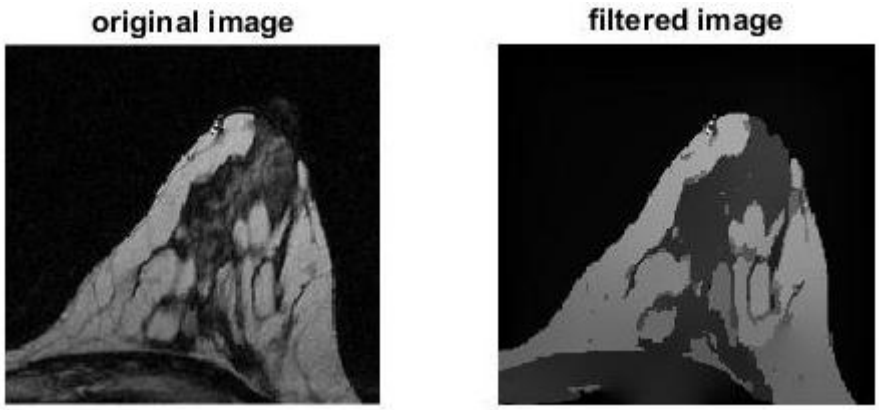

Figure 24 Original and Anisotropic diffused image with option 1 and kappa = 10

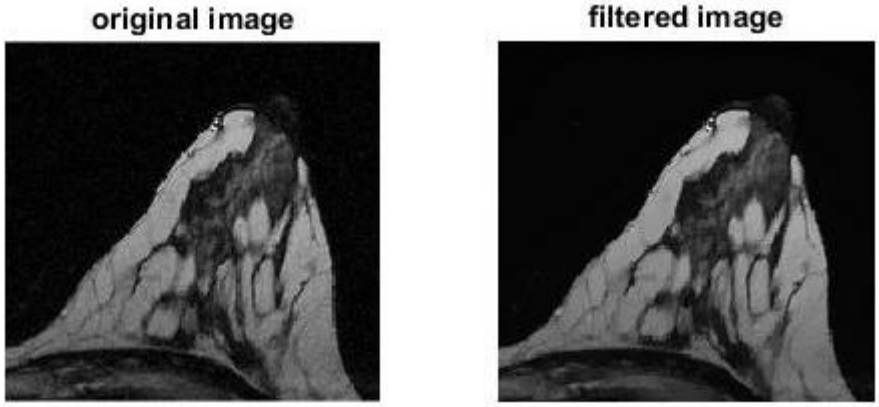

Figure 25 Original and Anisotropic diffused image with option 2 and kappa = 0.4

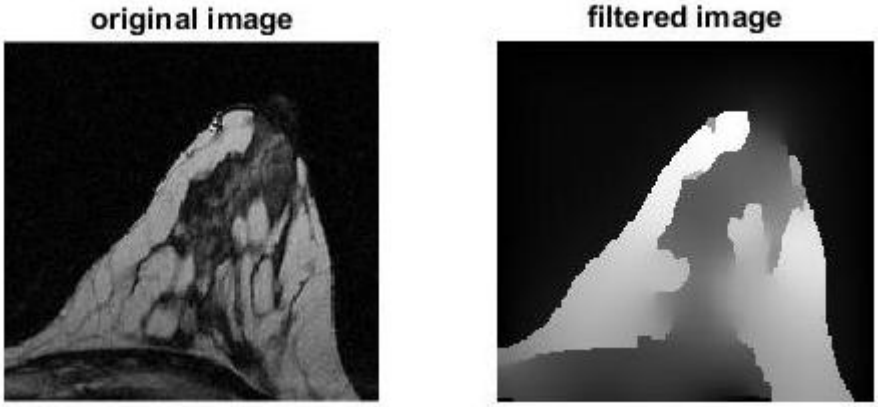

Figure 26 Original and Anisotropic diffused image with option 2 and kappa = 5

For second diffused equation, which prefers wide regions over small ones. High kappa value will lead to blurr the image more than as in option 1.

The anisotropic and isotropic filtering with dicom image is as shown below.

Figure 27 Anisotropic and Isotropic filtering using Dicom image.

The isotropic diffusion is performed in isodiff.m file. The results of it as shown below.

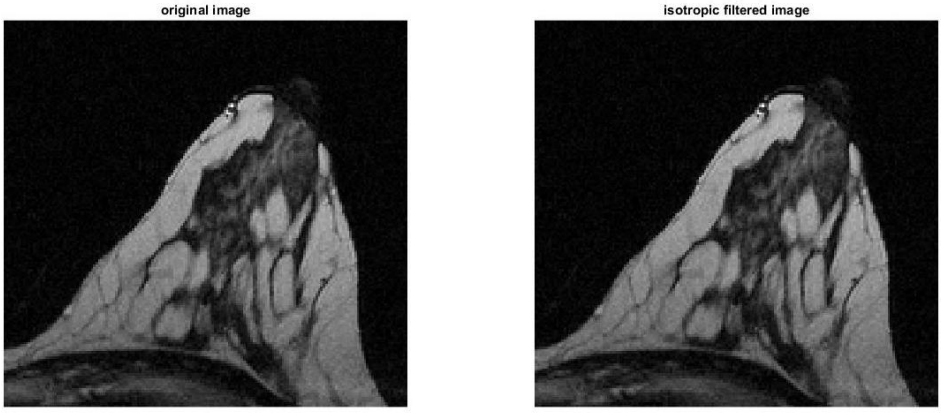

Figure 28 Original and Isotropic filtered image

The code for this module can be found in 'diffusion' folder. There is a README.txt file which explains how to run this code.

3. Conclusion

This lab provides very important insights to the importance of enhancement of images for further steps in image processing.