Ryerson University

Department of Electrical & Computer Engineering
Faculty of Engineering & Architectural Science

Course Title:	Biomedical Image Analysis
Course Number:	BME 872
Semester/Year (e.g.F2016)	W 2021

Instructor:	April Khademi

Assignment/Lab Number:	2
Assignment/Lab Title:	Contrast Enhancement of Medical Images

Submission Date:	March 4th 2020
Due Date:	March 7th 2020

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Reset Form

*By signing above you attest that you have contributed to this written lab report and confirm that all work you have contributed to this lab report is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: http://www.ryerson.ca/senate/current/pol60.pdf

BME 872 Lab 2

Problems

1.

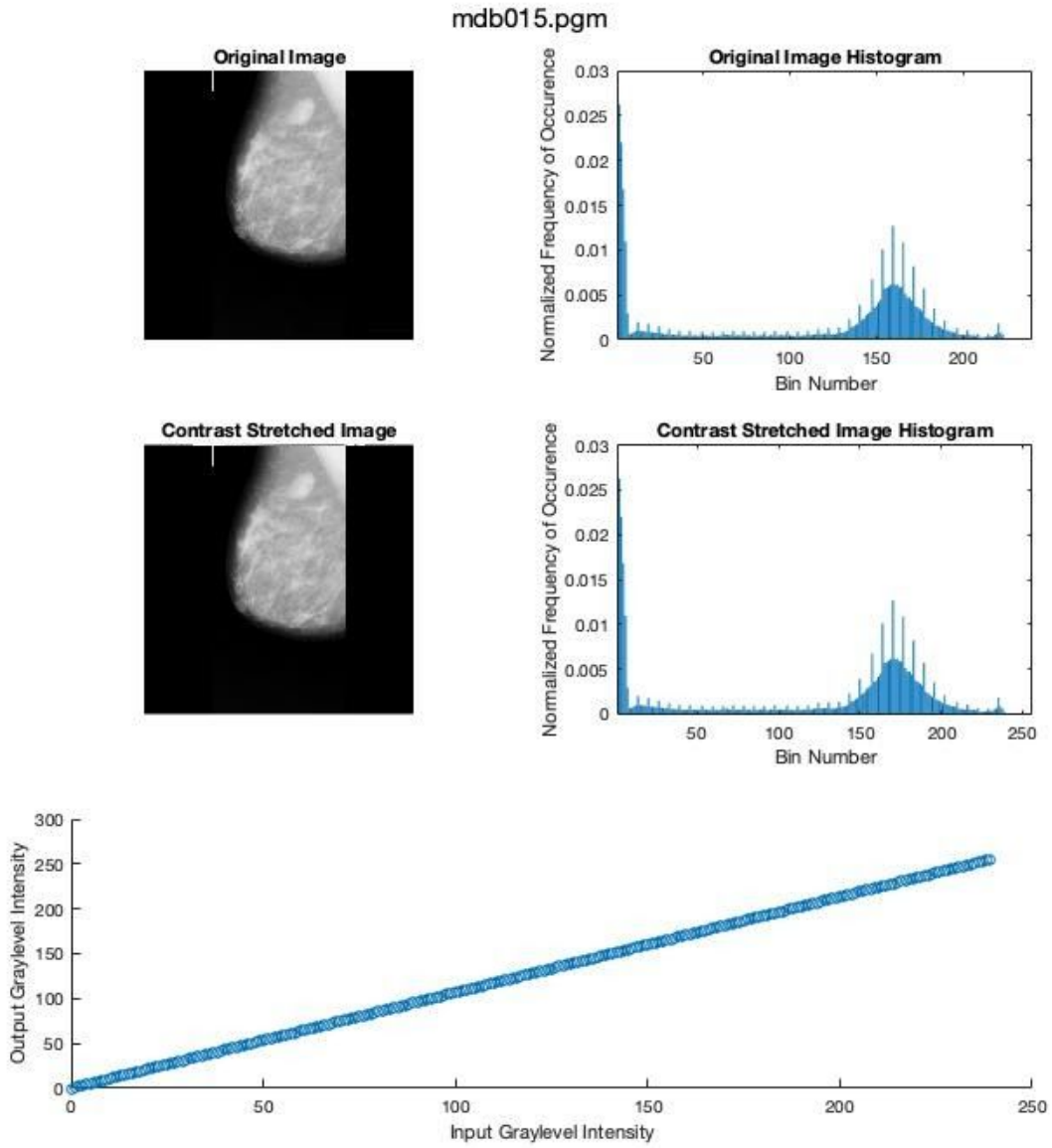

Figure 1: Original, contrast stretched and transfer function

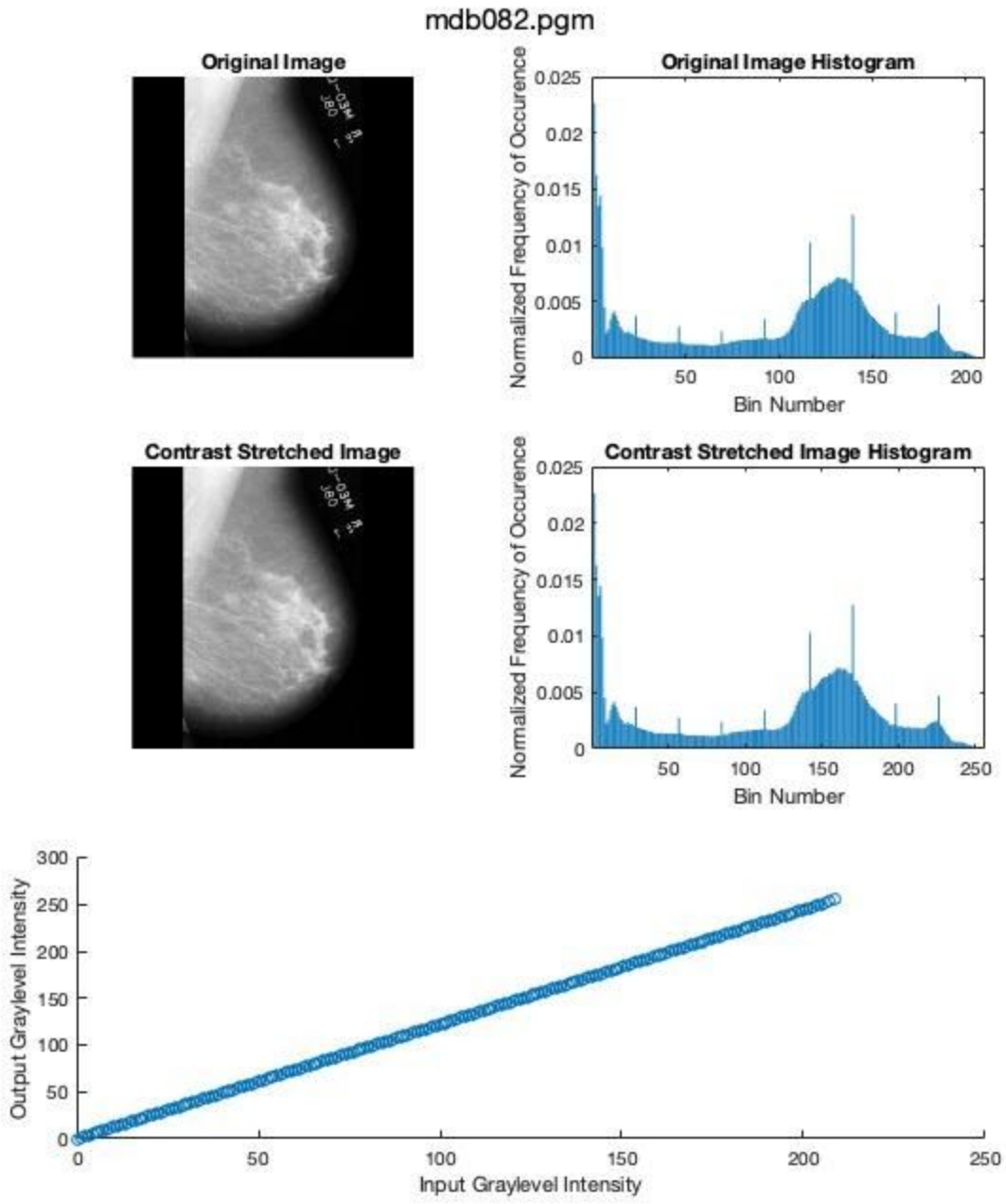

Figure 2: Original, contrast stretched and transfer function

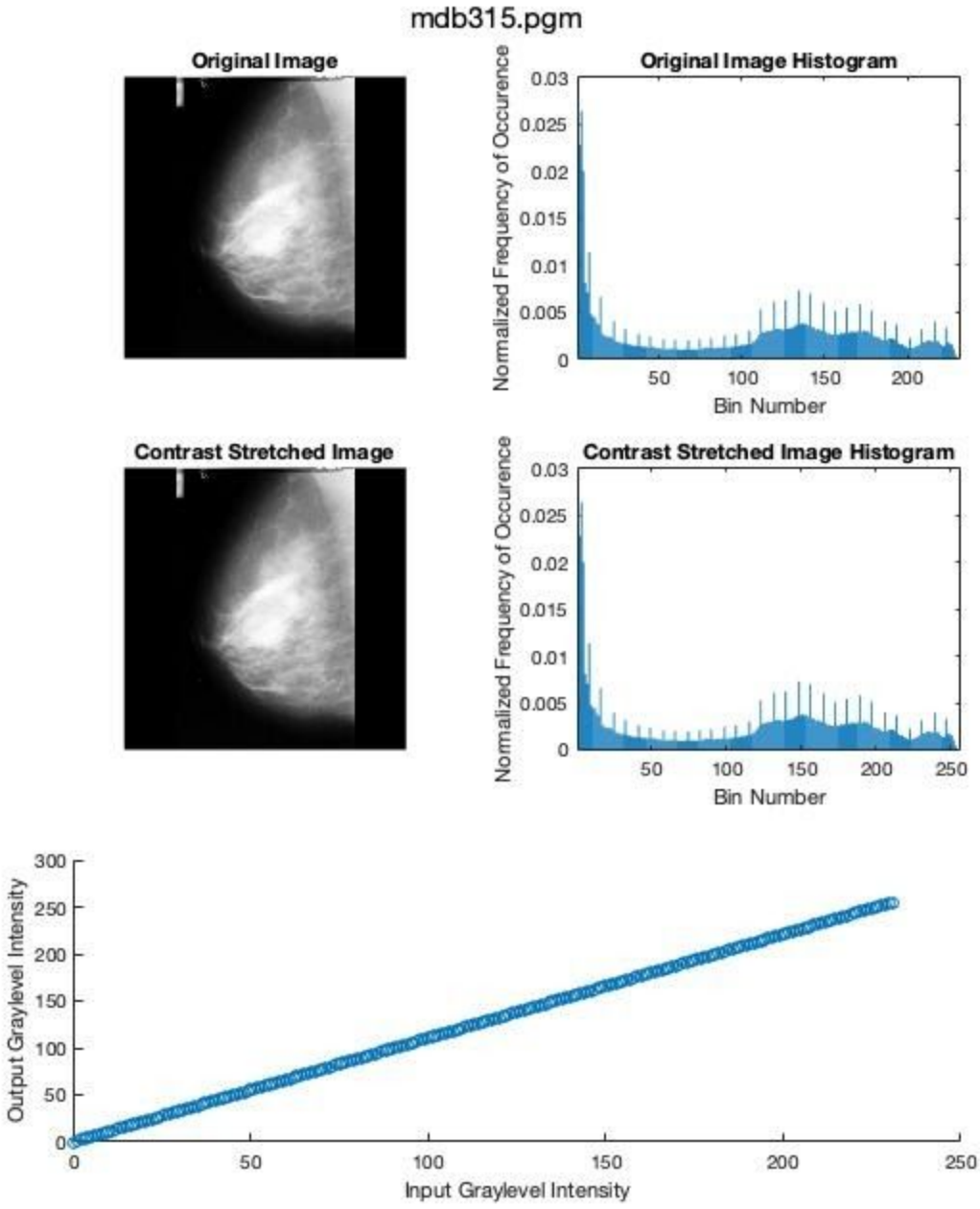

Figure 3: Original, contrast stretched and transfer function

Questions:

- *Comment on what this transformation achieves and how the images have been improved.*

The purpose of the contrast stretching transformation is to better utilize the whole range of output intensities. For example if an image only uses intensity values from 50 to 150, contrast enhancement can be used to stretch those intensities over a wider range of values. In terms of our images, there is a noticeable subjective difference within the images, however to achieve more clear feature enhancement, additional filtering might have to be applied to compensate for the large range of low value intensities.

- *If an image has very poor contrast and is very dim, will contrast stretching be able to produce a high-contrast, high-detail image?*

Yes, that is the goal of contrast enhancement. If the range of the original image is too small then the output can be somewhat poor, but the general idea of contrast enhancement is to help in those low contrast cases.

- *What effect would sensor noise have in this case?*

The effects of sensor noise could create several types of noise. It could potentially create less sharp edges than desired, or create some salt and pepper background noise. Contrast enhancement unfortunately has little influence on the noise within the image. If noise was a significant problem, then some sort of smoothing filter could be applied to minimize the effect of noise.

2.

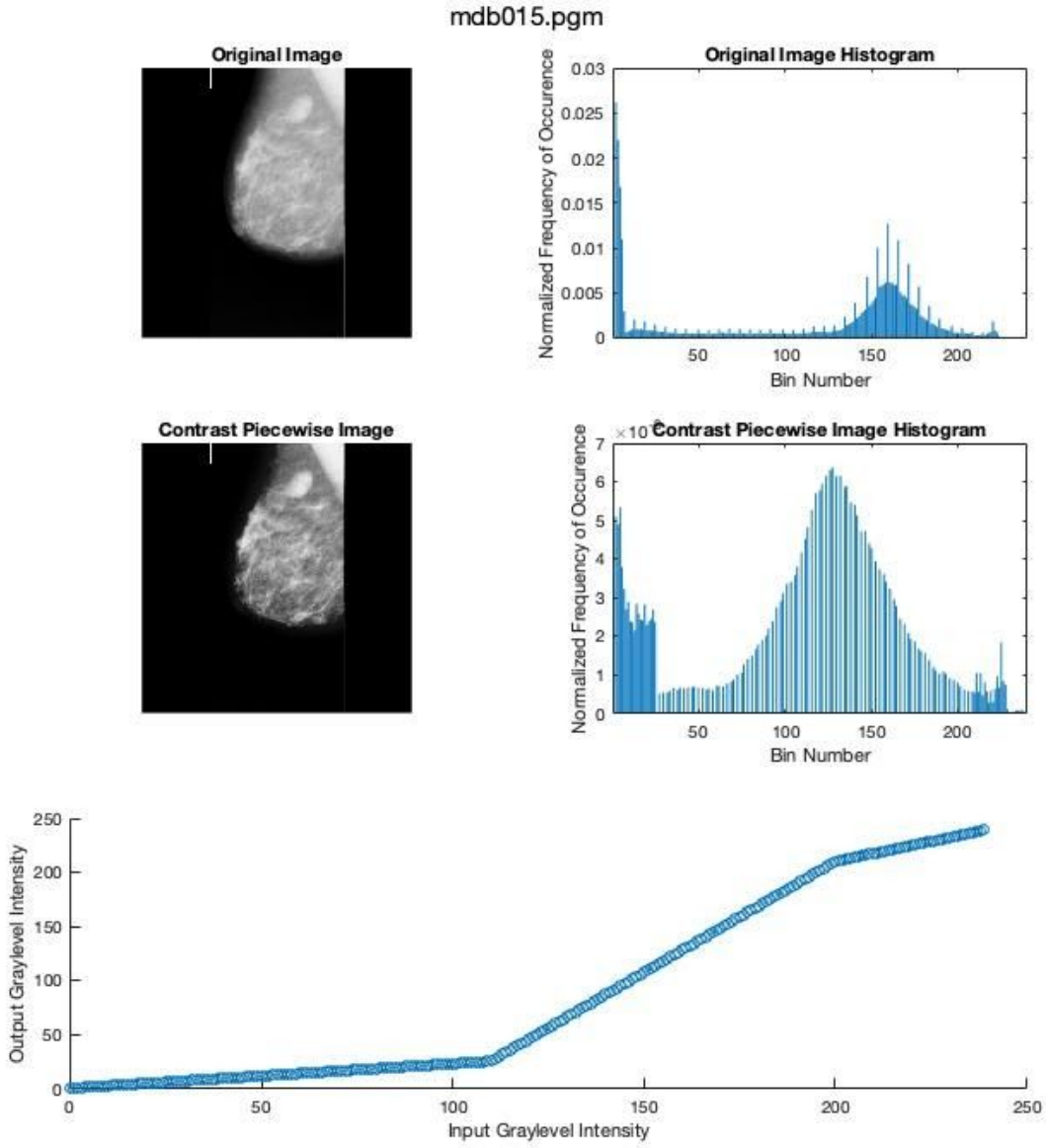

Figure 4: Original, contrast piecewise and transfer function

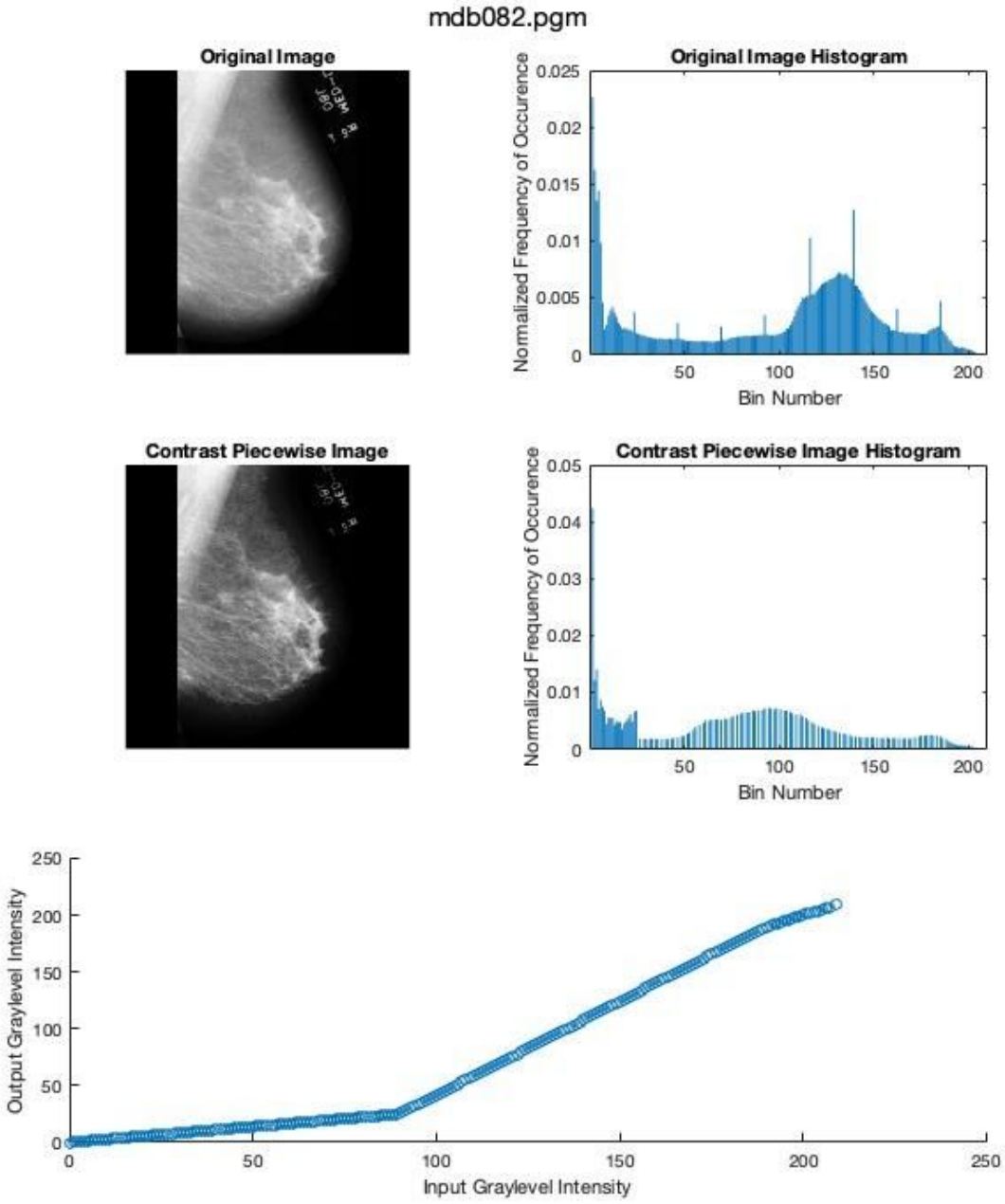

Figure 5: Original, contrast piecewise and transfer function

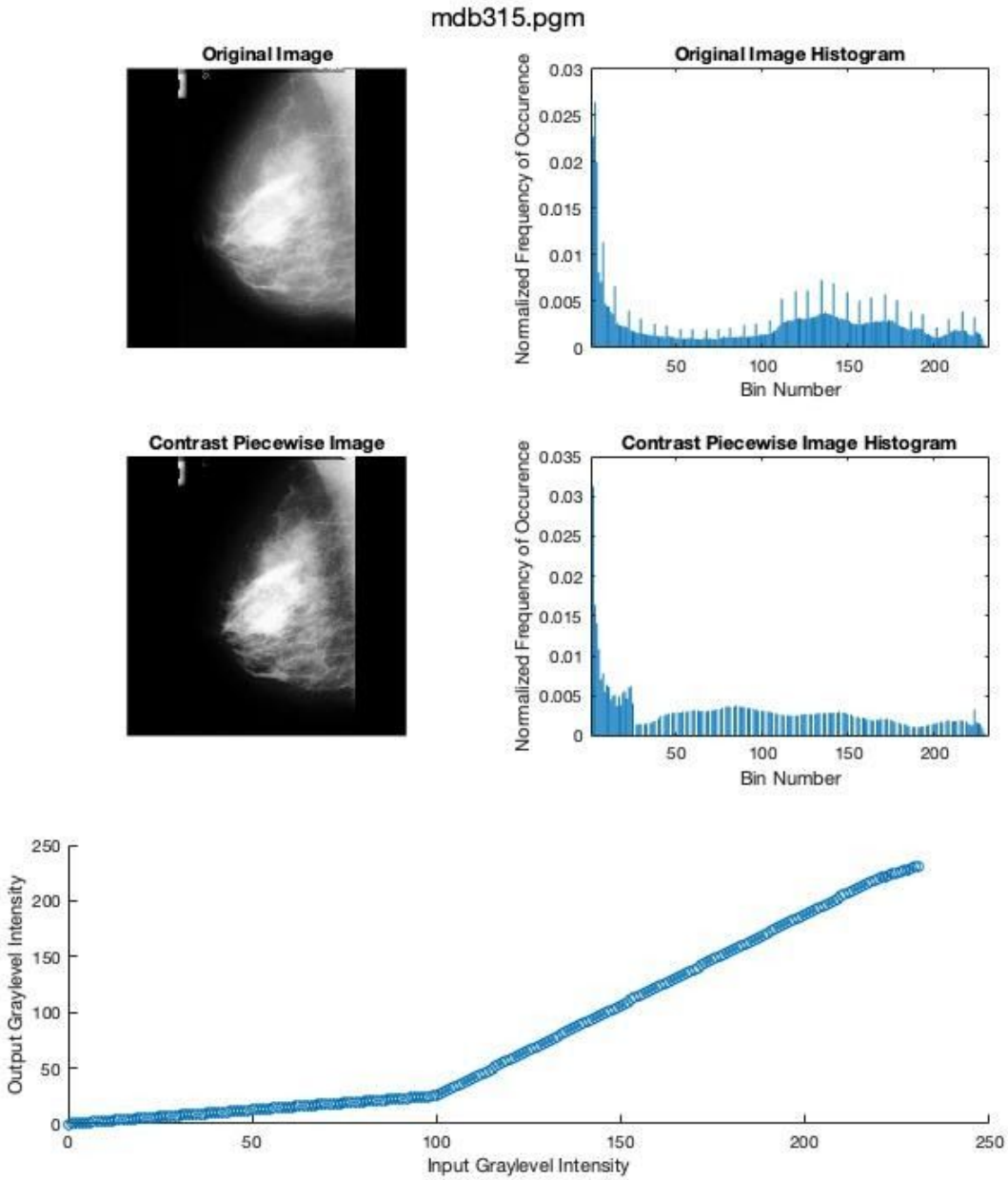

Figure 6: Original, contrast piecewise and transfer function

Questions:

- *Justify values of A and B chosen.*

When creating the piecewise function, it is important to consider what intensity values you want to stretch, and what values you want to keep within the same intensity range. For this application, we want to stretch the contrast within intensity regions that correspond to breast tissue. This was roughly within the range of 100-200 intensity of the original image.

- *Justify whether this improved the contrast.*

The results are improved if you are looking at the actual tissue itself. Unfortunately in many cases that this filter was applied, the edges of the breast were lost, which of course is undesirable.

3.

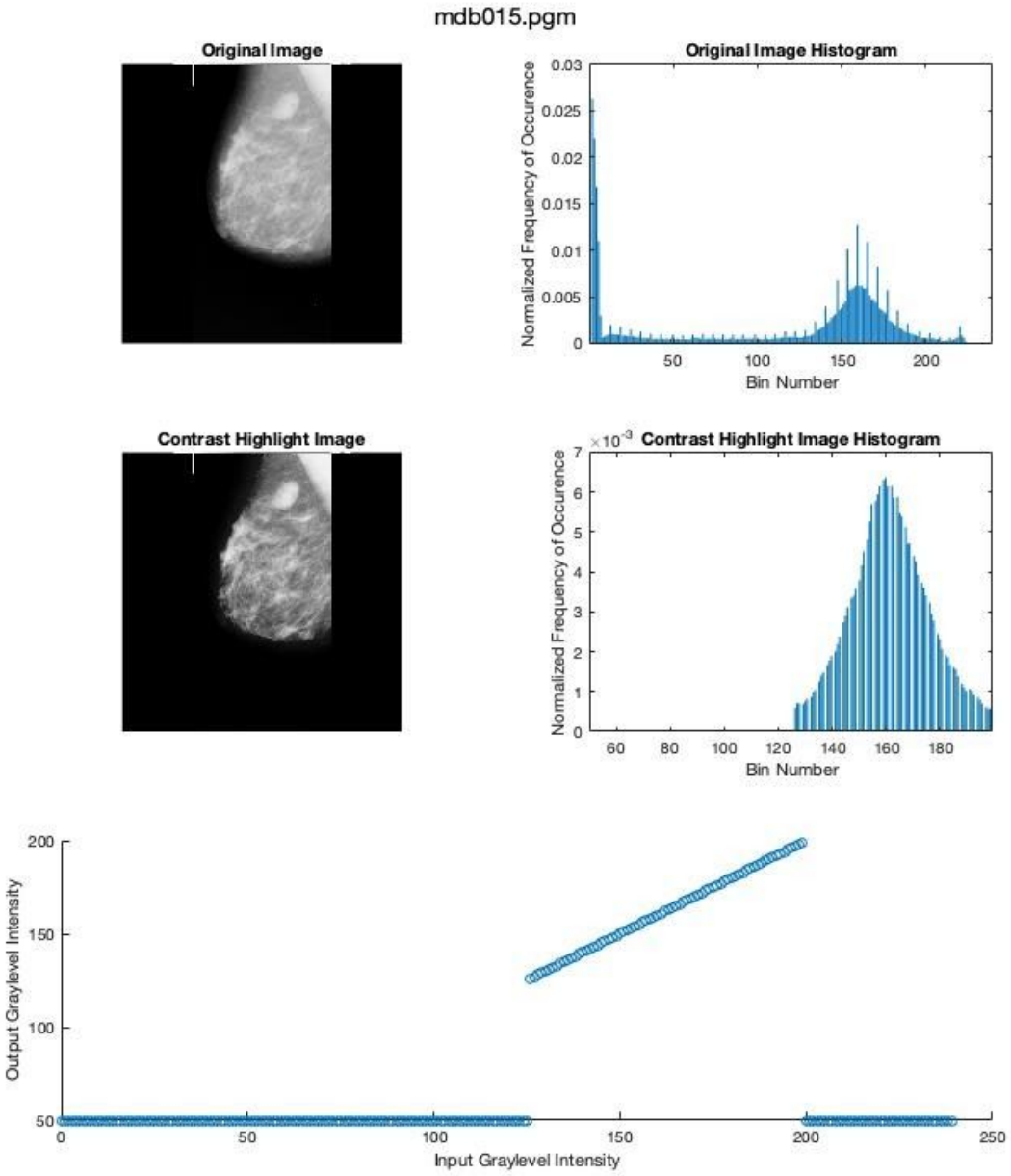

Figure 7: Original, contrast highlight and transfer function

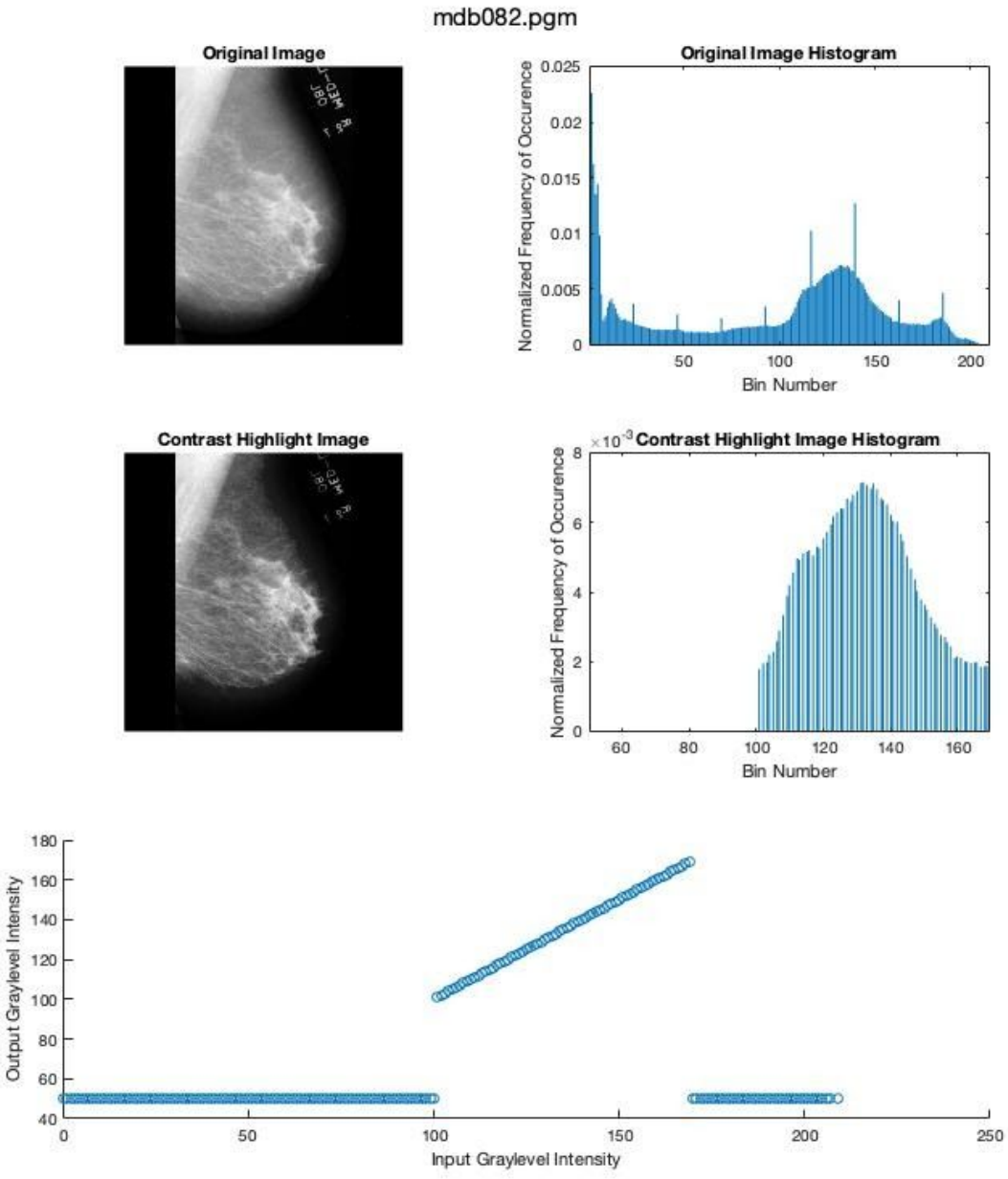

Figure 8: Original, contrast highlight and transfer function

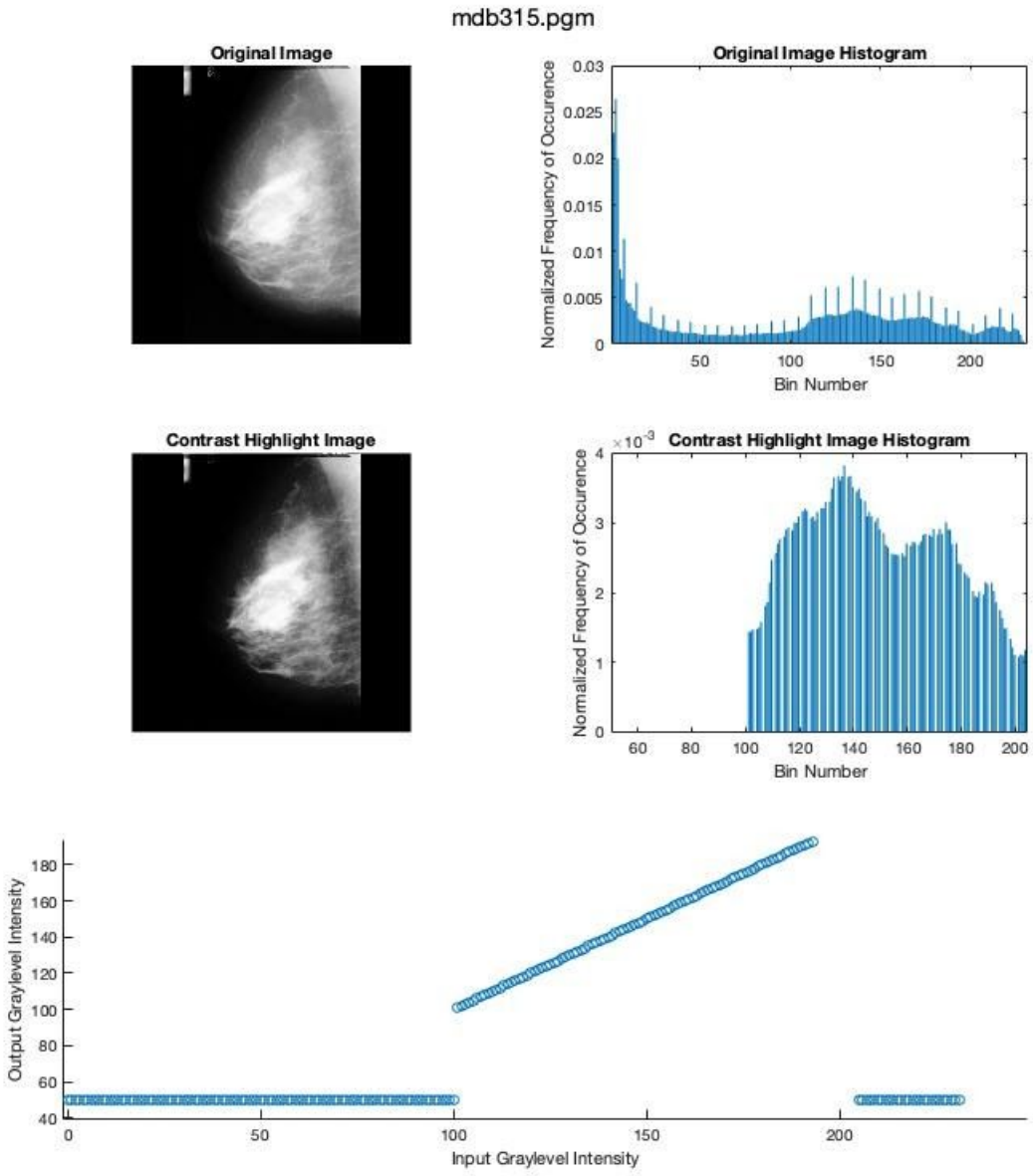

Figure 9: Original, contrast highlight and transfer function

Questions:

- *Discuss what this function achieves and provide justification for your choices of the parameters.*

The goal of this function is to zero out any values that we do not care about, and contrast stretch any intensity regions we do care about. So the parameters chosen depend on which intensity regions are of interest. In other words the range of A to B must cover the range where breast tissue intensities exist.

4.

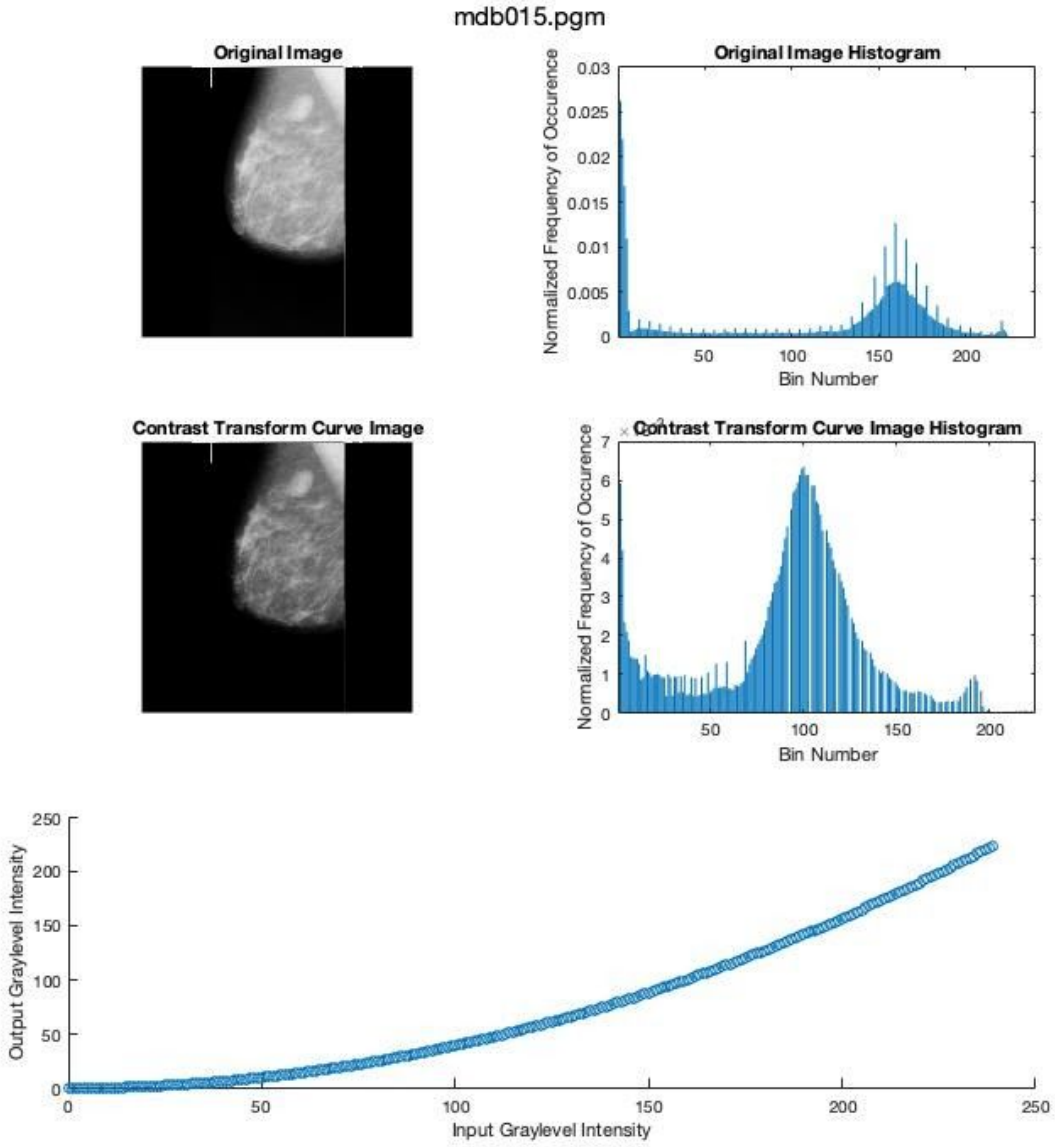

Figure : Original, squared transfer function and transfer function

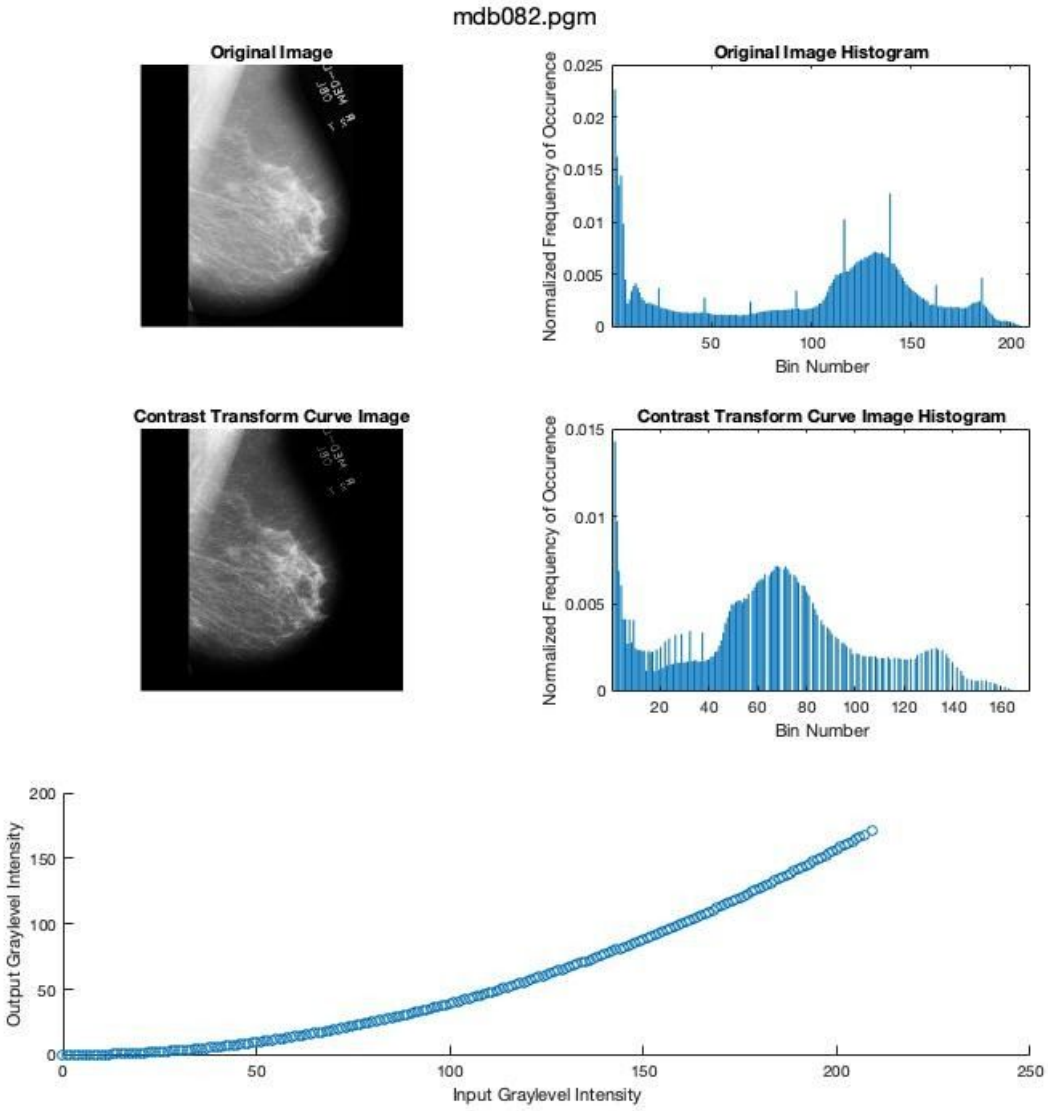

Figure : Original, squared transfer function and transfer function

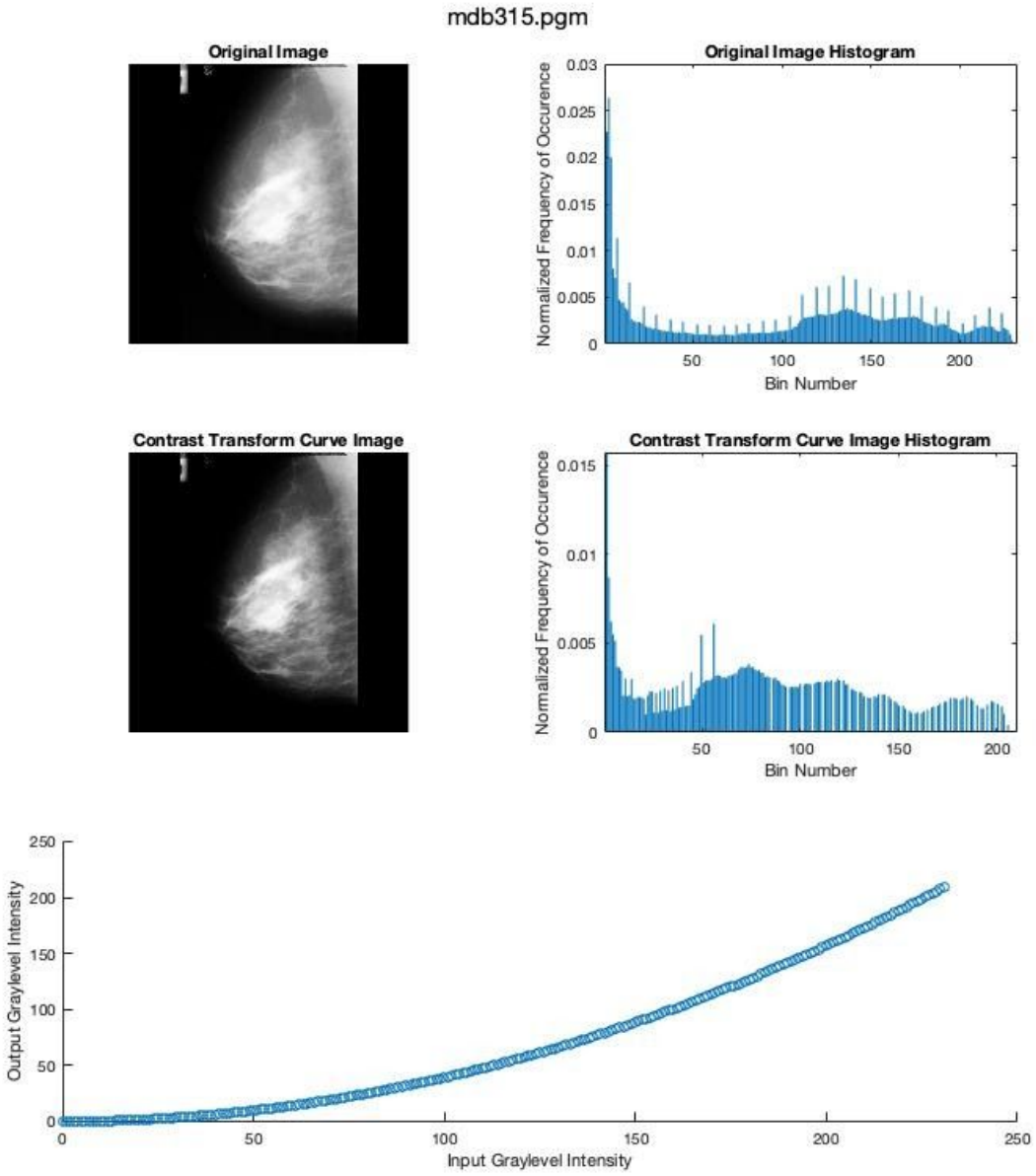

Figure : Original, squared transfer function and transfer function

These filters worked very well at amplifying important intensity ranges. Looking objectively at these images, they show the clearest tissue regions. The transfer function chosen was a squaring function which meant that the higher the intensity value the more it would get amplified. The idea behind this was that since the breast tissue was evident in the higher intensity values that this would stretch these values and compress the darker, lower intensity regions providing more contrast to the region of interest.

5.

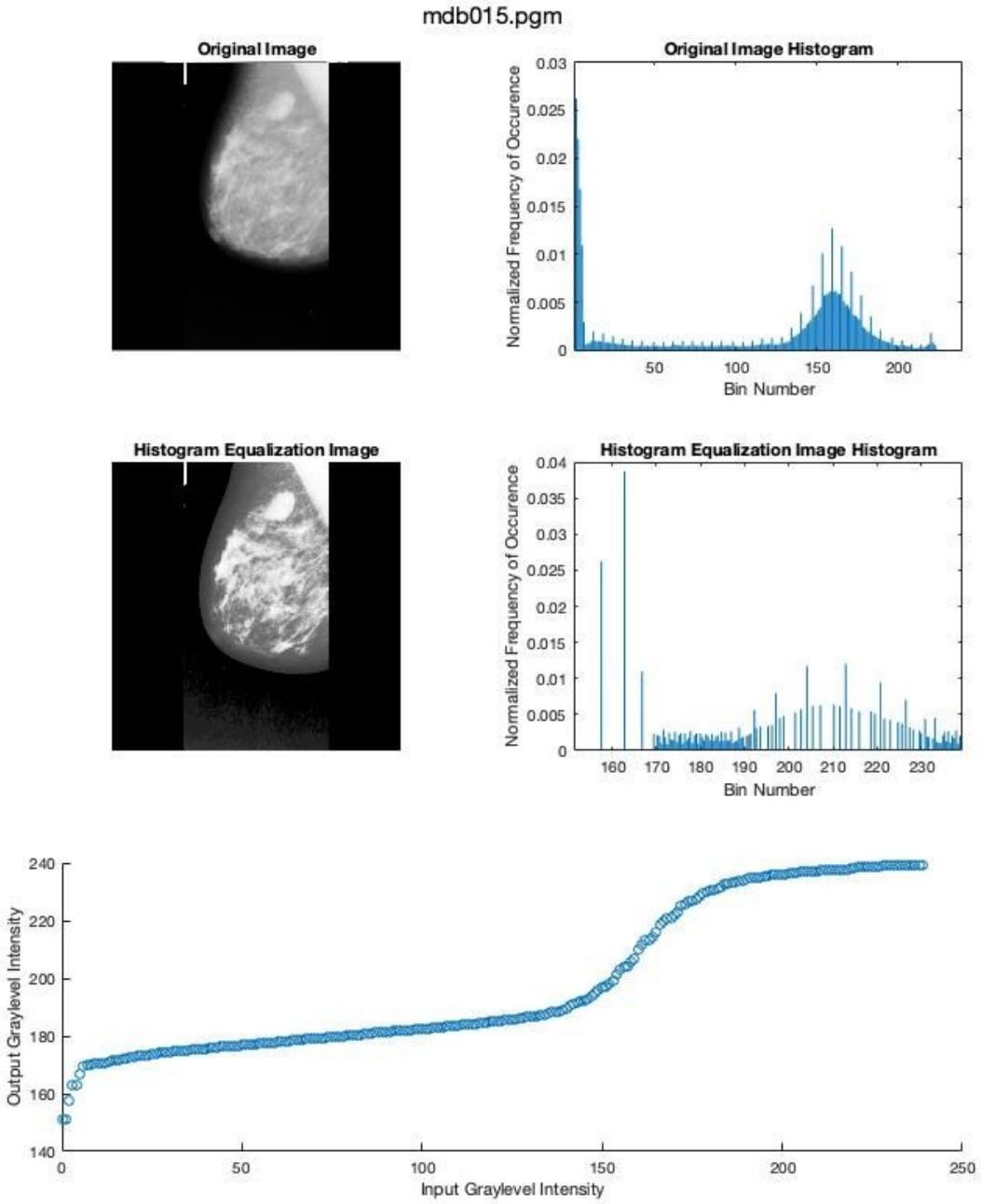

Figure : Original, histogram equalized and transfer function

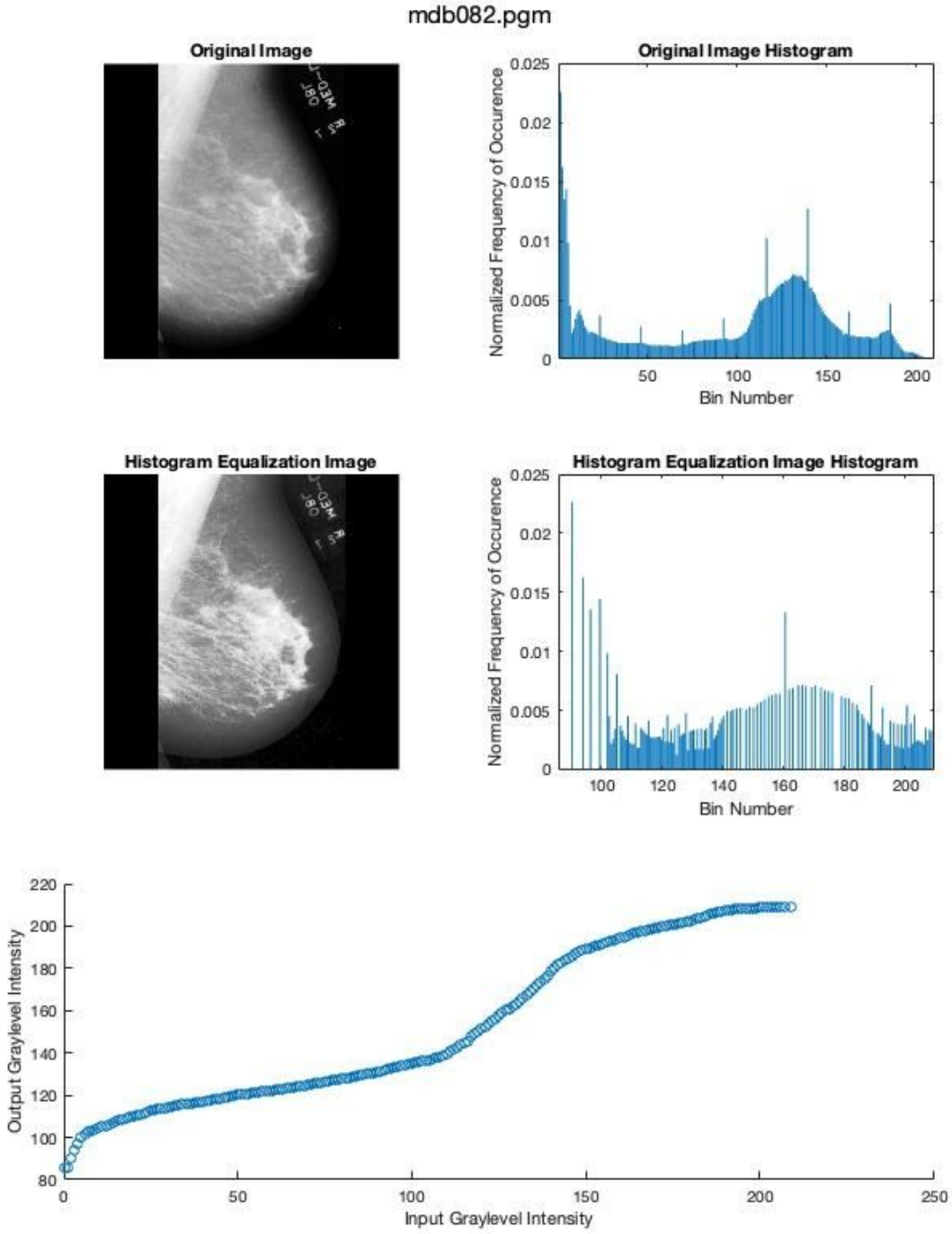

Figure : Original, histogram equalized and transfer function

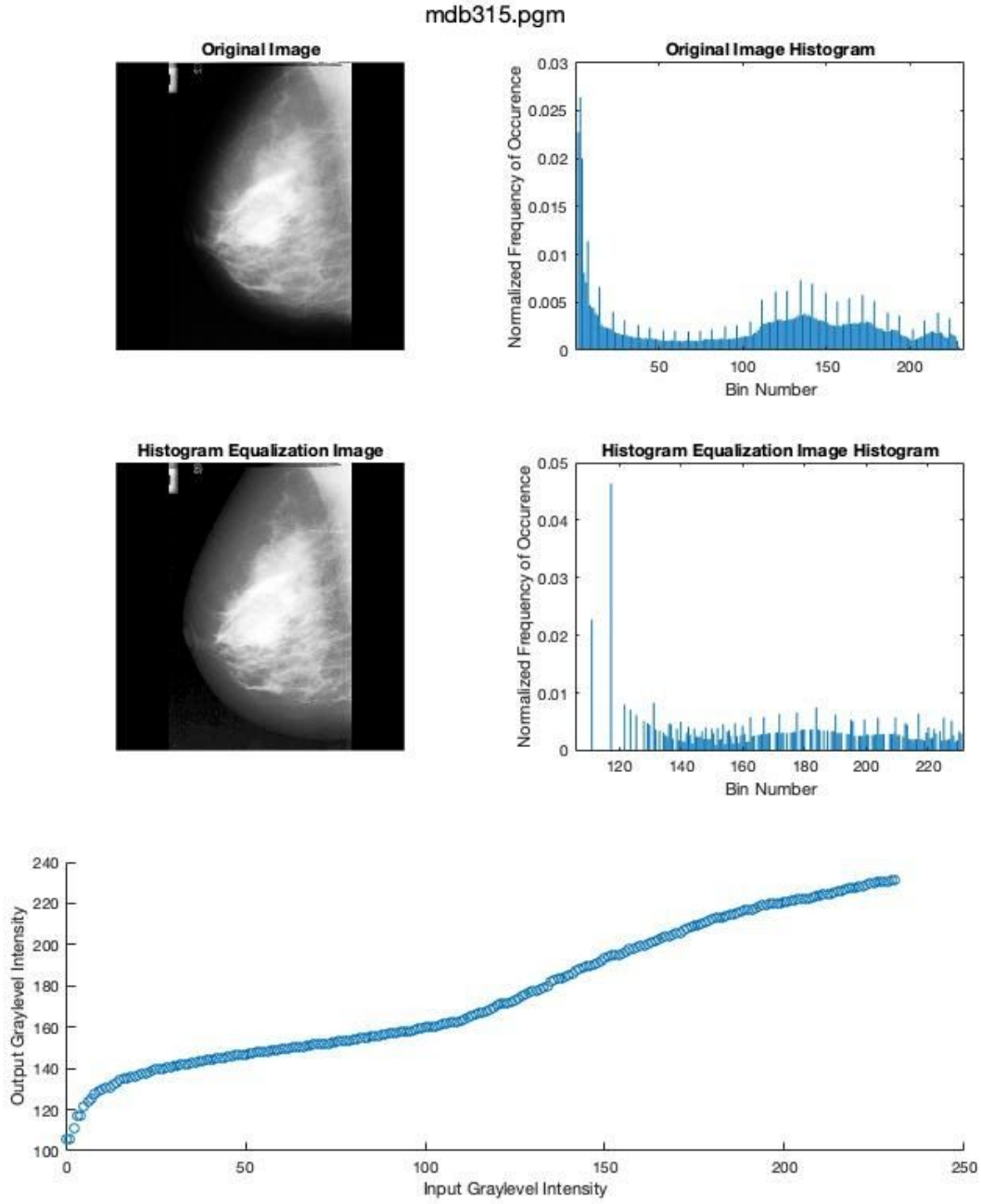

Figure : Original, histogram equalized and transfer function

Questions:

- Describe what this operation does (and why it does or does not work).

The goal of histogram equalization is to create a non-linear transformation that brings an images histogram closer to uniform distribution. To accomplish this the original image histogram is normalized to become a probability distribution function. This was then converted to a cumulative distribution function and the intensity values were implemented into a look up table and applied to the image. This is advantageous because it represents all intensity ranges equally so that very high contrast is achieved. As you can see by the images above, the results of histogram equalized images are very desirable and show strong feature clarity.