

# Digital Image Processing

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## 1 Introduction

All of the programs are written in python 3. The shebangs are included and thus they should work if called using the `"/program.py"` notation. In case this causes a problem, please try to call them using `"python3 program.py"` notation.

I will provide further help on how to call each program.

### 1.1 libraries

I used numpy in all of the programs and scipy in some of them. I will detail when scipy is used.

## 2 Exercise 1

The program called `ex1.py` computes the histogram of a greyscale image, and enhances the image using histogram equalization. it displays the enhanced image, the histograms of the default and enhanced images, and the transformation function.

In this exercise, the matplotlib library is used to plot hitograms and functions.

### 2.1 Examples

#### 2.1.1 Fig1.jpg

All of the results are obtained using the program with the call `"/ex1.py Fig1.jpg"`



Figure 1: Original image

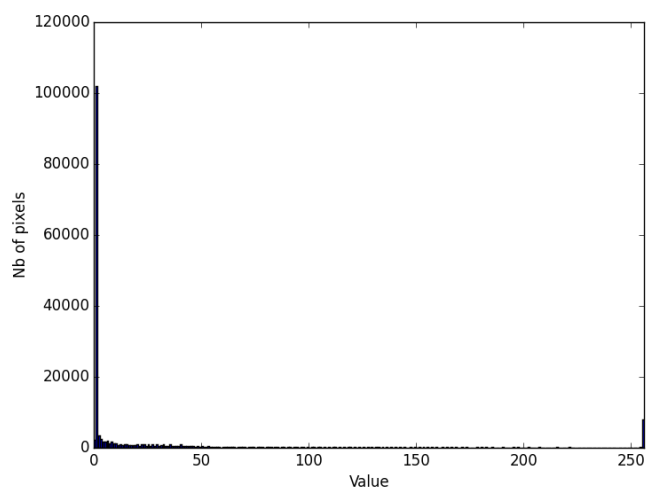


Figure 2: Original image's histogram

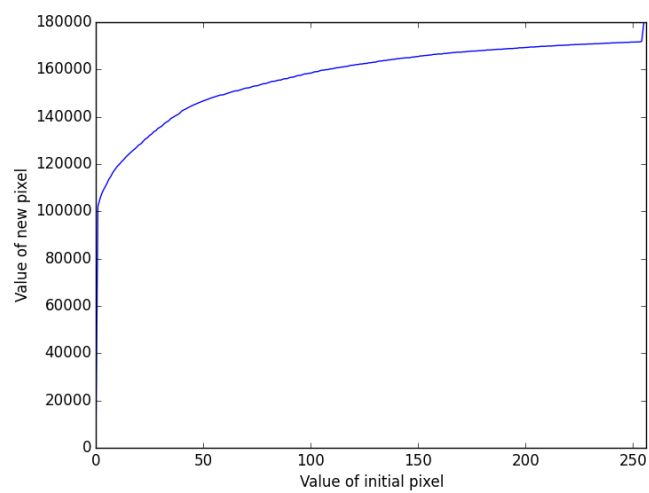


Figure 3: Enhancement function

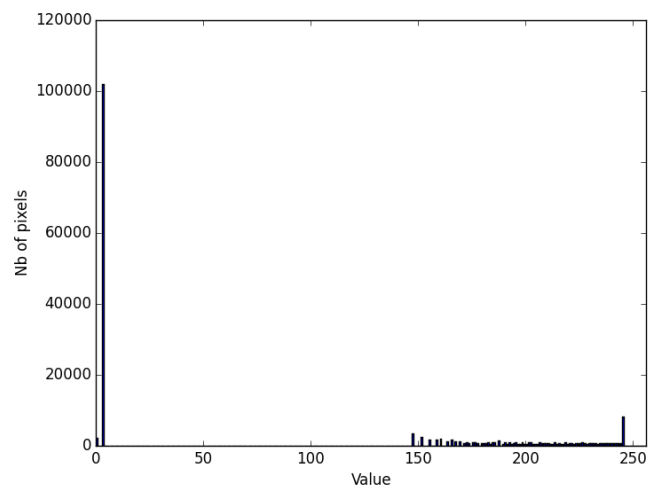


Figure 4: Enhanced image histogram



Figure 5: Enhanced image

### 2.1.2 Fig2.jpg

All of the results are obtained using the program with the call `./ex1.py Fig2.jpg`



Figure 6: Original image

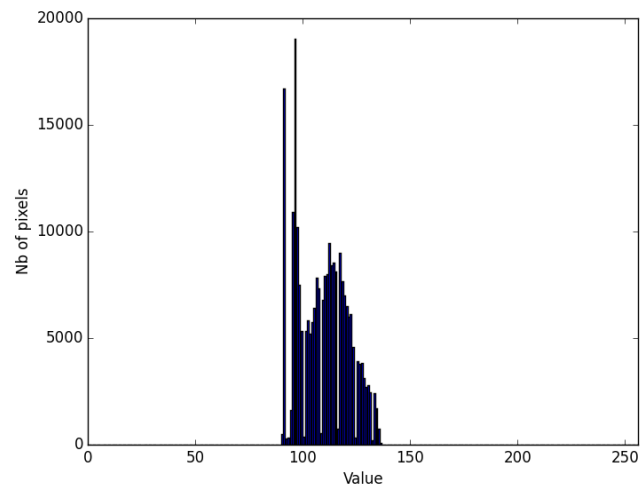


Figure 7: Original image's histogram

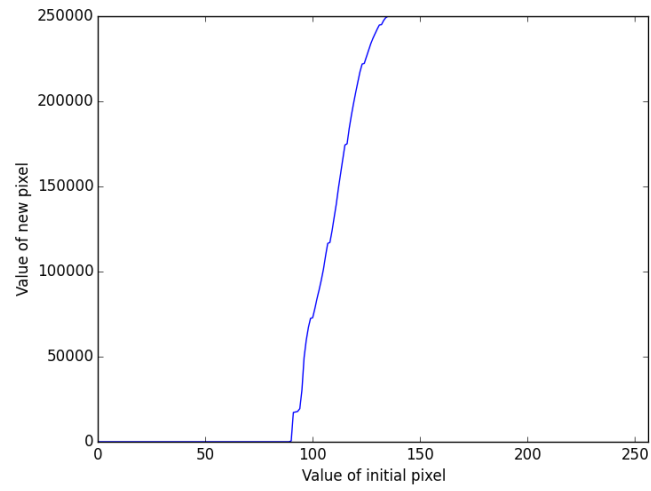


Figure 8: Enhancement function

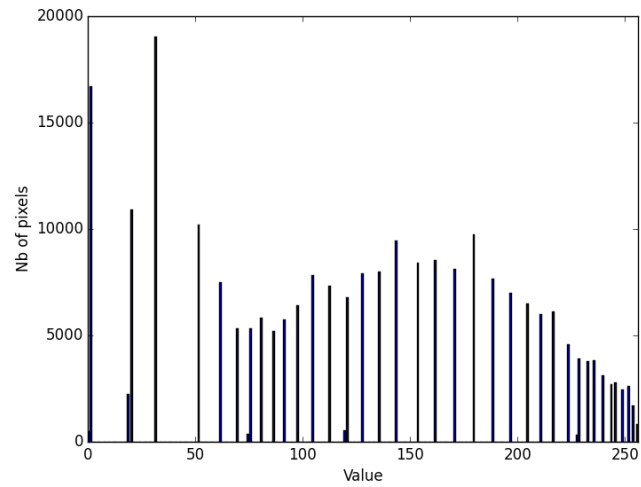


Figure 9: Enhanced image histogram

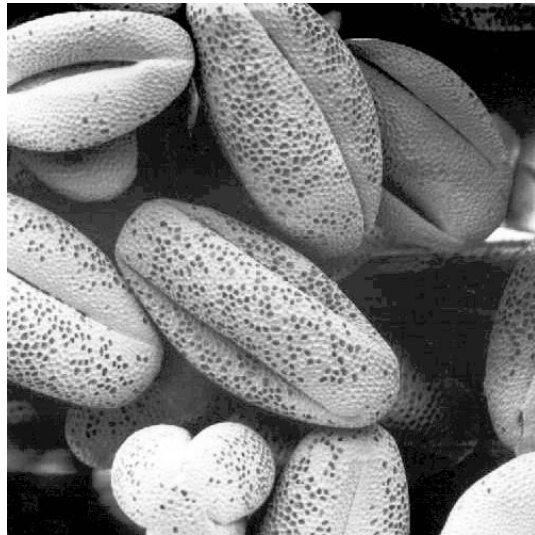


Figure 10: Enhanced image

## 3 Exercise 2

The program called `ex2.py` performs several spatial enhancement techniques on a given greyscale image.

### 3.1 Example on `skeleton_orig.tif`

All of the results are obtained using the program with the call `./ex2.py skeleton_orig.tif`

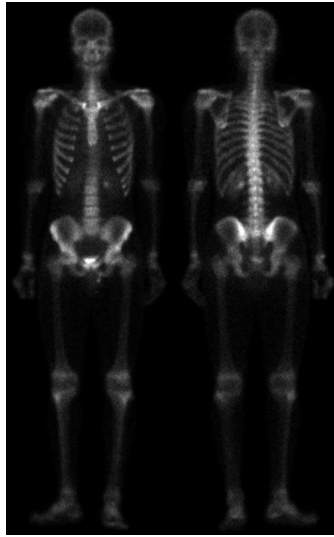


Figure 11: Original image



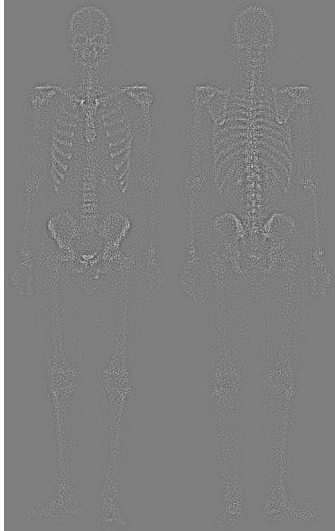


Figure 12: Rescaled laplacian of image

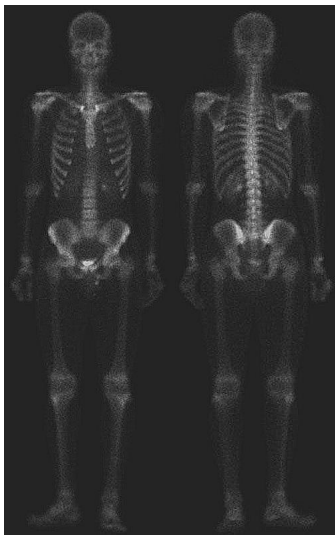


Figure 13: Sum of laplacian and original image

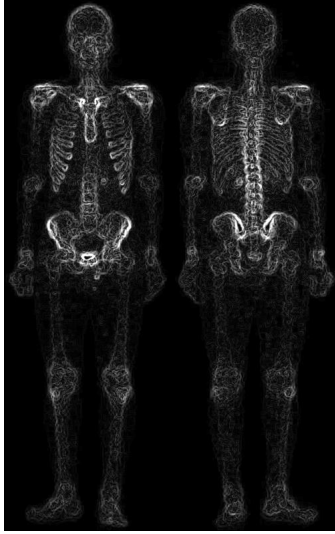


Figure 14: Sobel gradient of original image

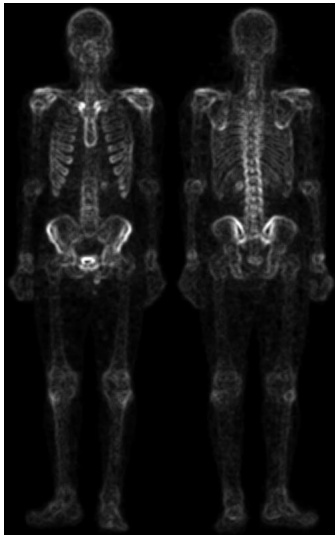


Figure 15: Smoothed Sobel gradient of original image

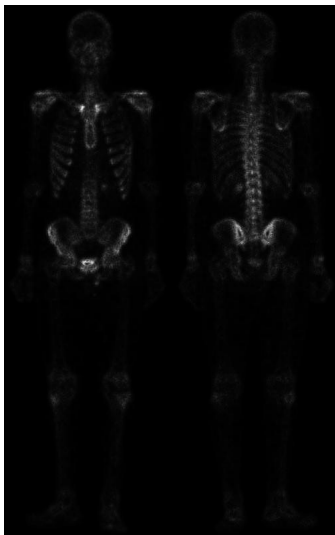


Figure 16: Product of smoothed Sobel gradient and of the previous sum of laplacian and original

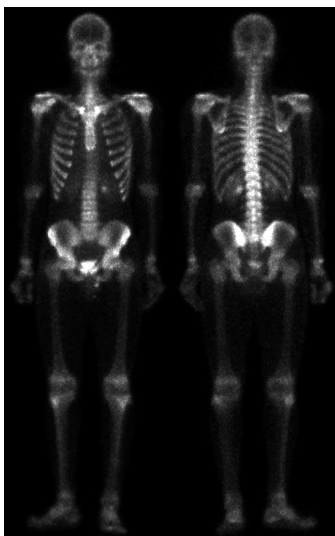


Figure 17: Sum of original image and previous image

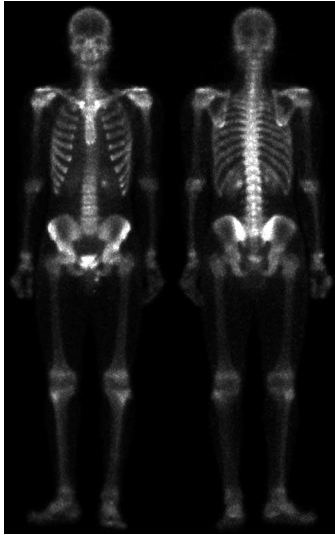


Figure 18: Power law of original image,  $\gamma = 0.5$ ,  $c = 1$

## 4 Exercise 3