UNIVERSITY OF TORONTO, DEPARTMENT OF ECE

ECE1512 - Homework 1

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Due Date: Sep 23, 2015

September 20, 2015

1 PART A

1.1 TECHNICAL DISCUSSION

Figure 1.1 shows a magnetic resonance image(MRI) of an upper thoracic human spine with a facture dislocation and spinal cord impingement. Because the original image is predominantly dark, an expansion of intensity levels is desirable. This can be accomplished with Log Transformation and Power-Low(Gamma) Transformation.

Figure 1.1: Original Image

1.1.1 Log Transformations

The general form of the log transformation is

$$s = clog(1 + r)$$

where r is the original pixel value between 0 and 1, s is the pixel value after log transformation and c is a constant. By observing the function we could find that this transformation maps a narrow range of low intensity values in the input into a wider range of output levels. We could use this kind of transformation to expand the values of dark pixels in the given MRI and compressing the higher-level values, which could show the details of the fractured part more obvious.

1.1.2 Power-Low(Gamma) Transformations

Power-law transformations have the basic form

$$s = cr^{\gamma}$$

Where where r is the original pixel value between 0 and 1 and s is the pixel value after transformation. c and γ are positive constants. By observing the equation we could find that power-law transformation also map a narrow range of dark input values into a wider range of output values. By analyzing, we could notice that when $\gamma > 1$, the produced image tend to be darker than the original image. However, when $\gamma < 1$, the produced image will show more details on dark area of original image. In the following experiments, we need to find appropriate c and γ to show more details of the given MRI.

1.2 Discussion of Results

1.2.1 Experiments of Log Transformations

The experiments results of log transformation shows below: As shown in Figure 1.2b, the pro-

(a) Original Image (b) $c = 1$ (c) $c = 3$ (d) $c = 6$

Figure 1.2: Experiments results of log transformation when $c = 1$, 3 and 6

duced image shows more details on the dark area compare with the given MRI. However, the fractured area on the dark side still not clear enough. When we have $c = 6$, we could find

even more details on the dark area as it shows in Figure 1.2d. But we could also notice that those area around the fractured point become totally white, which may result in missing of important information. As shown in Figure 1.2c When $c = 3$, we could have a relative desirable output image since it provides us enough information about the fracture also dark area. The reason behind it could be found in Figure 1.3. So, when $c = 3$ the output image could

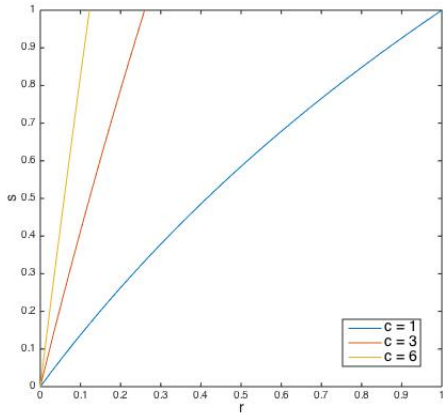

Figure 1.3: The curve of $clog(r+1)$ when $c = 1, 3$ and 6

have best visual enhancement.

1.2.2 Experiments of Power-Low Transformations

2 Part B

2.1 Technical Discussion

2.2 Discussion of Results