# HACETTEPE UNIVERSITY

Department of Computer Engineering

BBM415 Fundamentals of Image Processing Lab

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# Assignment – 1

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Fall 2021-2022

Due Date: 23:59:59, 14/11/2021 Sunday

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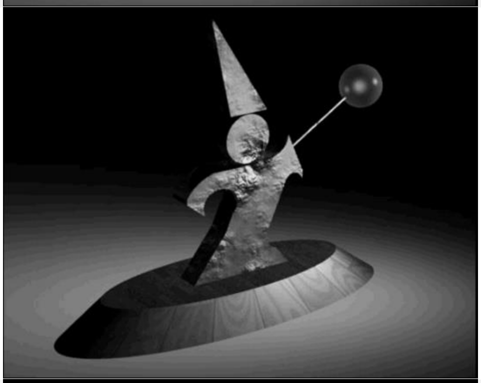
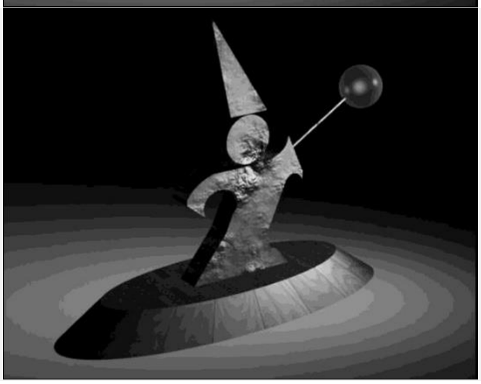
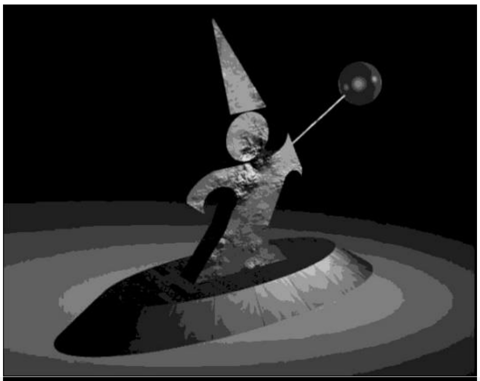
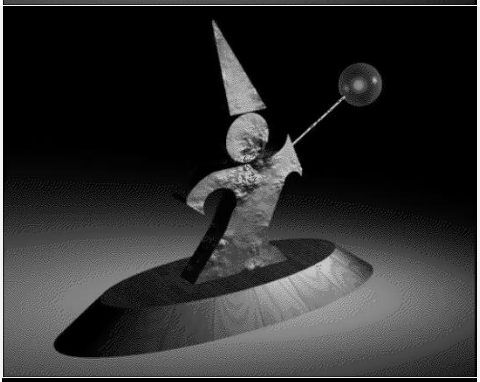
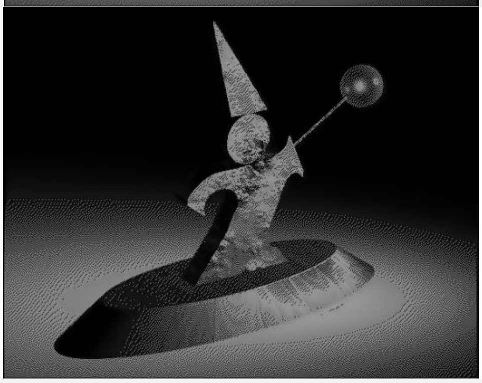
# PART 1: Dithering

Dithering is a technique that is used to prevent errors because of quantization. Quantization is a discretization method which can cause errors due to limited intensity resolution. We will implement Floyd-Steinberg dithering algorithm and analyze the results by comparing them with the quantized images without dithering.

| QUANTIZATION PARAMETER | QUANTIZED | FLOYD STEINGBERG |
|---|---|---|
| **4** |  |  |
| **8** |  |  |
| **16** |  |  |

| | | |
|---|---|---|
| **32** |  |  |
| **64** |  |  |
| **128** |  |  |

Direct quantization using the method yields bands and contours in the image, which do not look good to human eye. In order to create a better image for human eye we need to add some noise to the image before quantization. There are many algorithm to do dithering. One of them is Floyd-Steinberg. Floyd-Steinberg assigns quantization error to neighbour of current pixel. It assigns 7/16 of the quantiation error to the left neighbour, 5/16 to the bottom, 3/16 to bottom left and 1/16 to bottom right, as shown below.

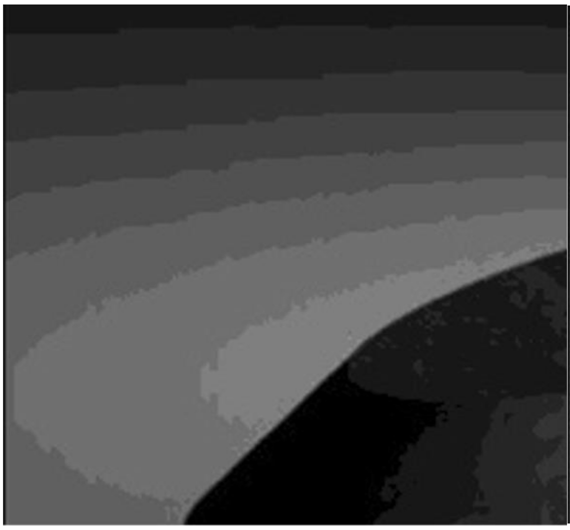
$$\begin{bmatrix} \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & * & 7/16 & \ldots \\ \ldots & 3/16 & 5/16 & 1/16 & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \end{bmatrix}$$

** represents current pixel*

For small quantization parameters, it s hard to distinguish quantized image and dithered image. When quantization parameter is 16, we can see color layers in quantized image as shown below and these layers differs from orijinal image. In Flody-Steinberg dithered image, we can not see the  se layers easily. This image more natural and similar to orijinal image compare to quantized image.

Original Image: 

16 – Quantized Image



16 – Floyd-Steingberg

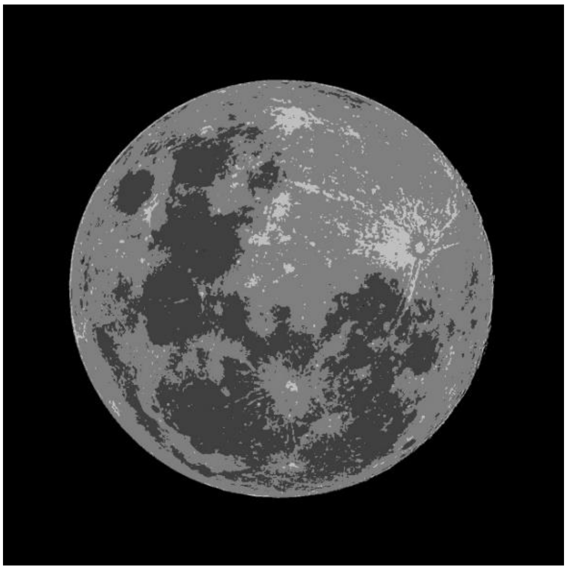
Similar results can be seen for different quantization parameters.

## Disadvantages of Floyd-Steinberg Dithering Algorithm

1- Adding noise around sharp lines can effect image negatively. I use different image to explain this with the same algorithms.

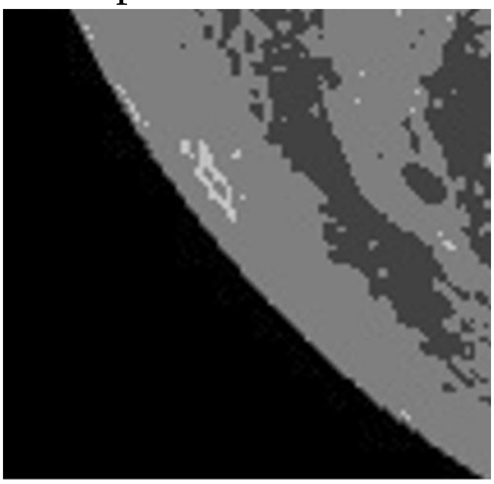
Original image : 

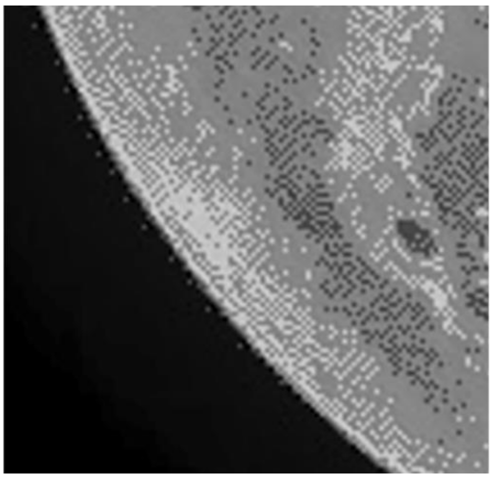
64 – Quantized



64 – Floyd-Steinberg

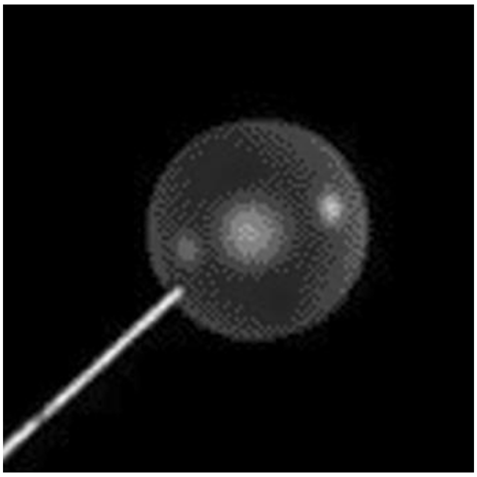
if the picture is zoomed in to the edges of planet

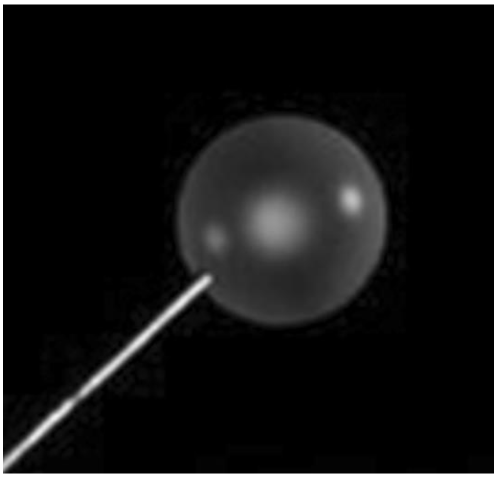




As a result, in the edges Floyd-Steinberg generates unnecessary noise. Quantization is better than Floyd-Steinberg around sharp edges.

2- In same level of greyness, Floyd-Steinberg doesn't produce clear output.





3- I didn't think only disadvantages of visualization. When I producing outputs of quantization and Flody-Steinberg with different quantization parameters. I have realized that Floyd-Steingberg always produces larges size images than quantization with different quantization parameters I have tried. The reason of that can be extra noises in Floyd-Steinberg. Aside from visualization, I think this can be counted as a disadvantages of Floyd-Steinberg

# Part2 – Color Transfer

RGB uses 3 channels which are red,green and blue.

RGB operates on three channels: red, green and blue. Lab converts same pixels to lightness component L* and color components which are named as a*(Red/Green) and b*(blue/yellow). As a result of lighteness separate from others, lightness can be adjusted seperately from others components.

Lightness is used to get images similar to human vision which is very sensitive to green but less to blue. Brightened lab spaces causes that output will look more similar to homan eye. In general we can say that when using positive values for the saturation slider in Lab space, the colors creates more 'fresh', while using the same amount of saturation in RGB makes colors look 'warmer'. To sum up, RGB is how displays perceive the world. Lab is how humans perceive the world. We use it to close to human visual system.

Results of my implementation for several image sets:



*1. Source Image* *Target Image* *Result of Color Transfer*



*2. Source Image* *Target Image* *Result of Color Transfer*



*3. Source Image* *Target Image* *Result of Color Transfer*

*4. Source Image* *Target Image* *Result of Color Transfer*

## Disadvantages of the Given Color Transfer Algorithm

Color transfer algorithm is not work well for high contrast images as you can see in 4th example set. That’s why I choose high contrast images in 4th image set.

In the 3rd image set. We have some grain effect loss especially near the shown places below.Morover, we have some color distortion and loss of details especially near the house in the images below

It is hard to analyze Lab images. “a” is the colour balance between green and magenta, “b” is the colour balance between blue and yellow. To analyze Lab images is hard than rgb images.

# References


1- https://www.youtube.com/watch?v=ico4fJfohMQ
2- https://arxiv.org/pdf/1612.08927v1.pdf
3- https://www.diyphotography.net/rgb-vs-lab-colour-what-it-is-and-how-you-can-use-it-when-processing-your-images/
4- https://hypjudy.github.io/2017/03/19/paperreading-color-transfer/
5- https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.156.1740&rep=rep1&type=pdf