# BBM 415 - Image Processing Practicum

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## 1 Part 1: Dithering

### 1.1 Quantization

In the first part, quantization algorithm was applied to the example pictures. Quantization of images is achieved by applying a simple rounding operation with a constant, which was "q" in this case.

**Algorithm 1** Quantization Algorithm

**for** pixel in image **do**
  $pixel \leftarrow round(pixel/q) * q$

In fig.1 and fig.2, the results of quantization can be seen clearly. As quantization factor "q" increases, the discretization of images increases while the resolution decreases.

### 1.2 Quantization with different values

In fig.1 and fig.2, different values of q has been applied to the images which produce images with lesser color, and therefore,reduces resolution of the image.

### 1.3 Dithering

Dithering is a type of image processing that gives the appearance of color depth in images with a limited color palette, as a result, decreases the effect of quantization. In this particular assignment, Floyt-Steinberg dithering is used with the following algorithm:

**Algorithm 2** Floyd-Steinberg Dithering Algorithm

**for** each y from top to bottom do **do**
  **for** each x from left to right do **do**
    $oldpixel \leftarrow pixels[x][y]$
    $newpixel \leftarrow find\_closest\_palette\_color(oldpixel)$
    $pixels[x][y] \leftarrow newpixel$
    $quant\_error \leftarrow oldpixel - newpixel$
    $pixels[x+1][y] \leftarrow pixels[x+1][y] + quant\_error 7/16$
    $pixels[x-1][y+1] \leftarrow pixels[x-1][y+1] + quant\_error 3/16$
    $pixels[x][y+1] \leftarrow pixels[x][y+1] + quant\_error 5/16$
    $pixels[x+1][y+1] \leftarrow pixels[x+1][y+1] + quant\_error 1/16$

To find the quantized value of the old pixel, below algorithm is used:

**Algorithm 3** Find quantized value

$quantized\_val \leftarrow round(old\_val(q1))(q1)$
$\boldsymbol{return} quantized\_val$ =0

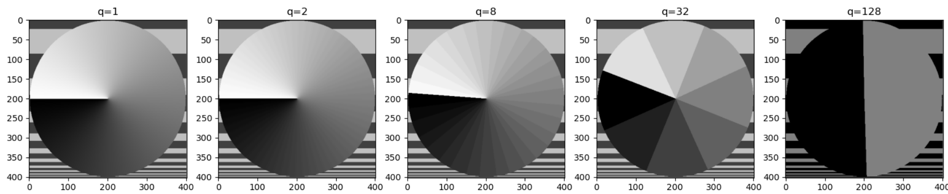


Figure 1: Quantization with different q parameters

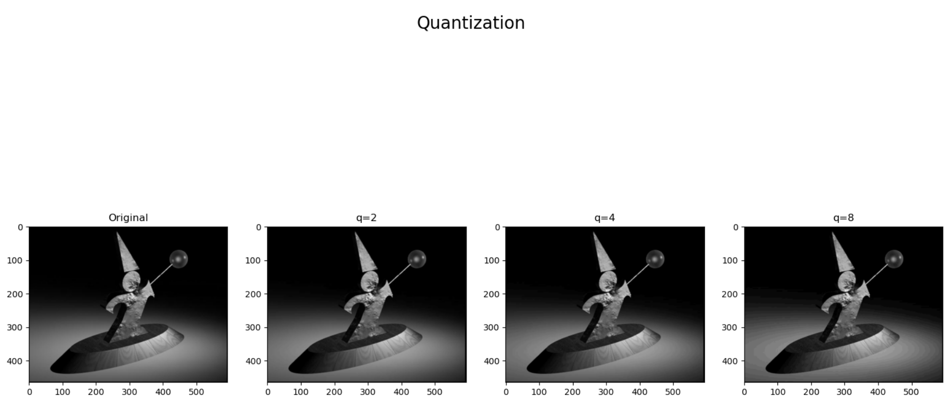


Figure 2: Quantization with different q parameters

## 1.4 How does it work?

Floyd-Steinberg dithering is based upon the diffusion of the error of neighbor pixels. It adds some of the residual quantization error of particular a pixel onto its neighbor pixels by multiplying it with constants. If it finds a pixel of 96 gray, it too determines that 96 is closer to 0 than to 255 - and so it makes the pixel black. Therefore, the resultant pixel values create an illusion to the human eyes which can be commented as reducing the effect of quantization.

Given different values of q values, as it increases, the resolution of the image increases. With small values of q, algorithm produces visibly spotted or stippled appearance (fig.4, first image), while high values of q produce smoother color distributions. Spotted appearance results from working with a small number of available colors.

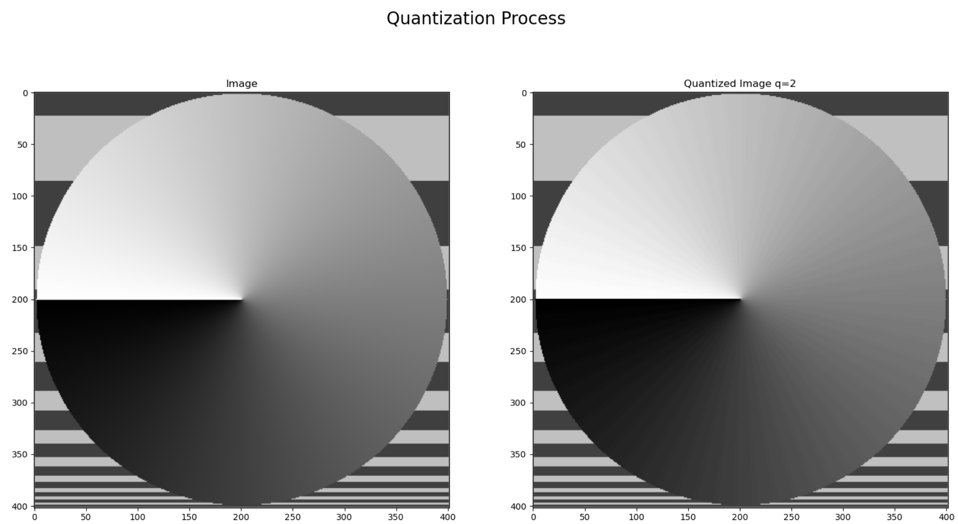


Figure 3: Quantization with q=2

In fig.4, the results of applying dithering to the quantized image (fig.3) with 4 different values can be seen. In the first resultant part, a stippled appearance stands out because of the small values of q. As the q increases, a visible improvement can be noticed. This example also applies to the second quantized image (fig.5) which is diffused with different values of dithering (fig.6).

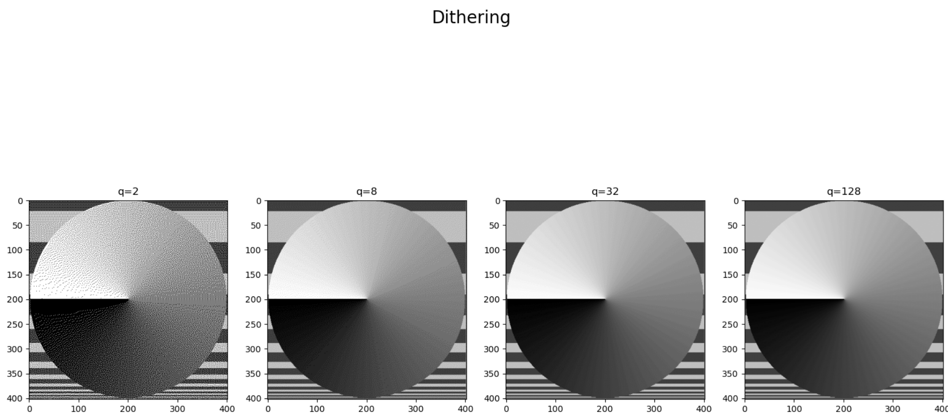


Figure 4: Dithering with 4 different values: 2, 8, 32, 128

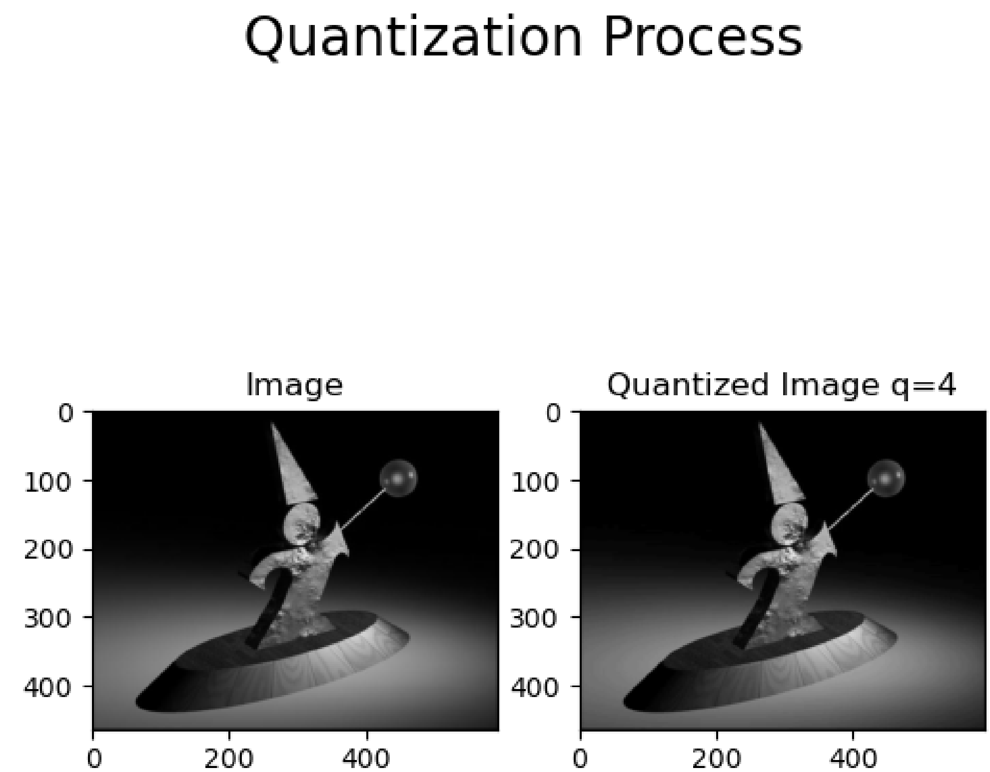


Figure 5: Quantization with q=4

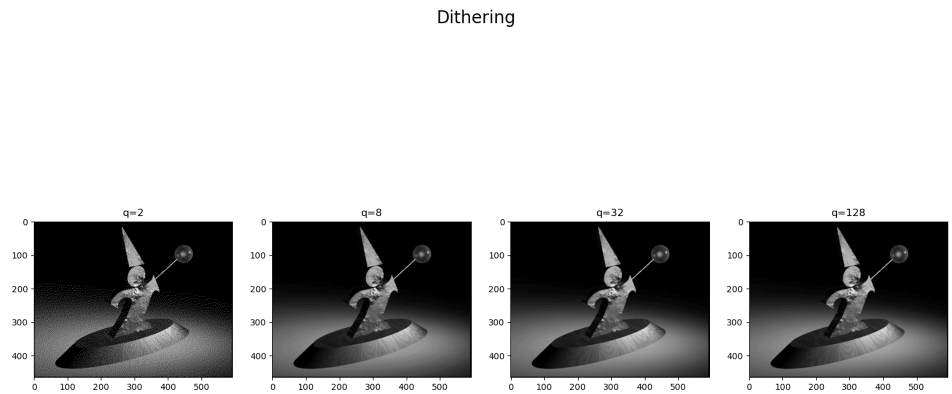


Figure 6: Dithering with 4 different values: 2, 8, 32, 128

# 2 Part 2: Color Transfer

## 2.1 Why LAB color space conversion?

LAB color is intended to be as close to human vision as possible and composes of 3 channels: one is dedicated to Luminosity, the other two are dedicated to the color information. Converting images from RGB to LAB color space reduces colors which results in the algorithm to run faster. Having a separate Luminosity channel lets us change the brightness of the image without actually having an effect on colors. However, these operations on images using RGB are difficult to apply.

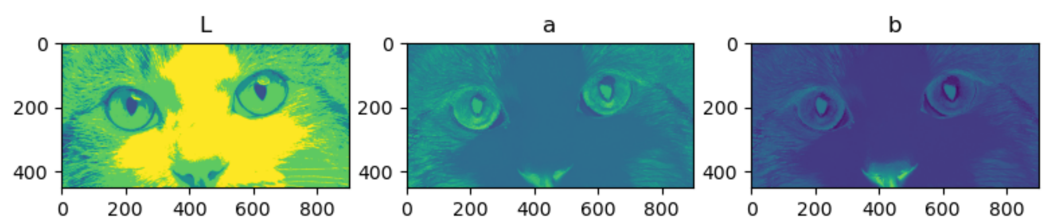


Figure 7: Lab channels of the cat image (fig.16): Luminosity, a and b respectively.

## 2.2 Failure Results

Algorithm gives the expected results when the reference images's color distributions are not so similar. In fig.18, two flower photos were used as reference images which have similar color distributions in terms of RGB values. The resultant image shows an unpleasant appearance. This may be a result of

Figure 8: Images to apply color transfer to (source image in left, target image in right

Figure 9: Color transferred image (src: Scotland House, tgt: Scotland plain)

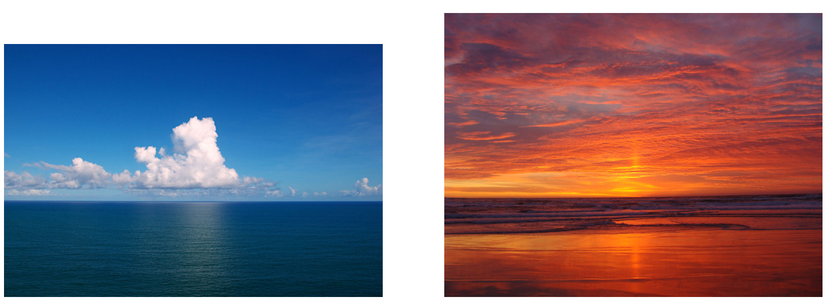

Figure 10: Images to apply color transfer to (source image in left, target image in right

Figure 11: Color transferred image (src: Ocean day, tgt: Ocean Sunset)

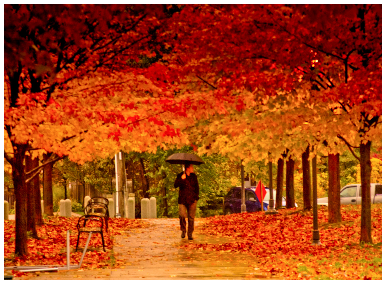

Figure 12: Images to apply color transfer to (source image in left, target image in right

Figure 13: Color transferred image (src: Autumn, tgt: Woods)

Figure 14: Images to apply color transfer to (source image in left, target image in right

Figure 15: Color transferred image (src: Tree, tgt: Dark Night)

Figure 16: Images to apply color transfer to (source image in left, target image in right

Figure 17: Color transferred image (src: Cat, tgt: Space)

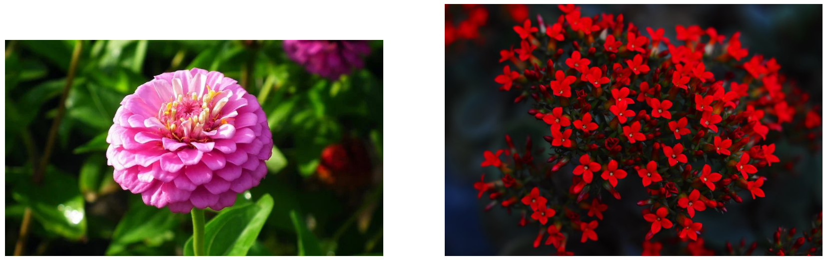

Figure 18: Images to apply color transfer to (source image in left, target image in right

Figure 19: Color transferred image (src: Pink Flowers, tgt: Red Flowers)