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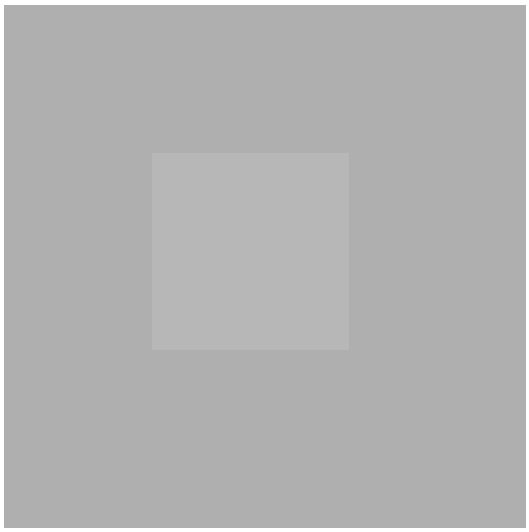
COL783

Assignment 0: Simultaneous Contrast Experiment

Problem statement : You are supposed to experiment changing the intensity of the background and observe the change in the contrast. You may also see how the **Weber ratio** (the ratio of the change in the intensity of the foreground with the respect to the background that makes it distinguishable) with respect to different values of the background intensity.

Solution:

- Weber Ratio : Contrast sensitivity = dI/I
  - dI = change of intensity
  - I = Intensity level
- Keeping the background intensity fixed we vary the foreground intensity this results in simulation of results at different dI (contrast levels). The minimum ratio of Weber at which user is able to observe the 2 boxes distinctively we stop.
- Save the result and write the weber ratio into the file name.
- Examples



175_183_0.0457.png

222_228_0.0270.png

- We can clearly observe 2 boxes distinctively and the weber ratio lies between 1% to 4% in maximum cases. For most cases approximately 2%

Assignment 1 - Part 1 : Implementation of Color Quantization Algorithms

Color quantization is a process of selection of a reduced number of distinct colors from the color space of source image. The resultant image formed appears similar to the source image. It benefits **compression** of image hence efficiently utilizing memory constraints without effectively reducing visual quality of the source image. Memory constrained devices and architectures with lesser bit space (such as 8 bit instead of 24 bit) take advantage of these approaches.

Definitions :

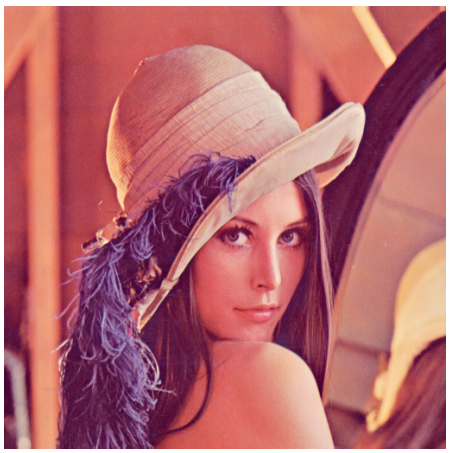
- Colormap : It is the set of distinct representative colors used for representing an image
- K-D Tree : Binary tree with every node as K dimensional point, and non leaf nodes splits the space into 2 subspaces. Useful for mapping and finding nearest neighbours.
- Dithering : Process of propagating error due to quantization on the forward direction to compensate for the quantization process.

- ### Popularity algorithm
    - In popularity algorithm we select top K colors out of all the distinct colors
    - Flattening the image into 1-D array
    - Getting index and count of unique colors in the image, set K = 128 or 64 etc.
    - Create a colormap of K popular colors.
    - Using K_D tree Algorithm for color mapping

Source Image

Quantized Image with K= 16

- **Median cut algorithm**
    - The median cut is a recursive algorithm.
    - Put all the colors in a bucket, select the color channel with max range.
    - Sort the bucket with respect to max color range
    - Find the median of the bucket and split recursively until Depth > 0.
        - Log_2 (K) = Depth
    - Take mean value of the lowest bucket, it represents the colormap : We have split color space in K cubes and mean of each cube is the Kth representative in the colormap



Source Image

Quantized Image with K=16

- **Floyed and Steinberg algorithm**
    - After acquiring the colormap through median cut / Popularity algorithm, we have added Dithering as per the paper in order to propagate error in forward directions this helps in producing colors effectively with very few colors used for quantization.
    - According to the paper, it produces a color halftoning effect.
    - Downwards propagation is e* ⅜, Right propagation is e* ⅜ and diagonal is e/4

Algorithm

```
#Floyd-Steinberg Dithering and color mapping
for i in range(x):
    for j in range(y):

        pixel = image[j,i,:]

        _,ii = tree.query(image[j,i,:],k=1)
        quantized_image[j,i,:] = colormap[ii]
        e = pixel - colormap[ii]
        if i+1 <x-1 and j+1 < y-1:
            image[j,i+1,:] += (e*3)/8
            image[j+1,i,:] += (e*3)/8
            image[j+1,i+1,:] += e/4
```

Source Image

Quantized Image with K=16

Assignment 1 - Part 2 : Color Transfer

Problem

Transfering of color from colored images to the grayscale images.

- **Global Image Matching technique**
    - Firstly we need to convert input image and target image to LAB space from RGB space.
    - LAB space provides 3 components where L represents Luminance (or lightness according to human perception) ,A and B are the color components.
    - We perform Luminance remapping :
        - ((L_source - mu_source) / sigma_source) * sigma_target + mu_target
    - Select 200 random samples using jittered sampling by applying a grid structure over the entire image.
    - Computing standard deviation for each pixel in a 5x5 neighbourhood after padding the sampled image boundary pixels.
    - Calculate the minimum weighted sum for each pixel in the target image and transfer corresponding chromatic (A,B) values to the target image.

- **Swatches**
    - Users will select swatches (diagonal points of the swatches) from source and corresponding target image.
    - Apply color transfer on to these swatches keeping 50 samples (similar to global image matching).
    - Texture transfer by defining 3x3 neighbourhood around the sampled swatch pixels to the target by using L2 error metric to find the closest match between swatches array(flattened colored swatches array with 3x3 window size neighbourhood) and target pixels using KD tree algorithm.

SWATCHES METHOD

Source Image

Target Image

Colorized Grayscale Image

GLOBAL METHOD

Source Image

Target Image

Colorized Grayscale Image

References

https://www.cse.iitd.ac.in/~pkalra/col783/assignment1/p297-heckbert.pdf

https://www.cse.iitd.ac.in/~pkalra/col783-2017/colorize.pdf