Personal details

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Assumptions

In this assignment we have the following assumptions:

- All the input images have 3 channels which are RGB.
- The images have color values in between 0 and 255.
- Images are in such file format that can be converted to *numpy array* by using *np.array()* method.

Methodology

In this assignment of Digital Image Processing we are processing the images such that we can do the following:

Simple Image Enhancement:

~ Shadow map generation:

Converting RGB images to HSI by using the given method

Computing the ratio-map or r-map

Computing the threshold for shadow map or s-map

Computing the shadow image using ratio of shadow map and original image

~ Line draft generation:

Implementing Bilateral filtering on a grayscale image

Edge detection of the image

~ Color adjustment step

Correcting the color using shadow image

Quantized Rendering:

~ Median cut

We implement median cut algorithm on Artistically Rendered Image or ARI

~ Dithering

We implement Floyd-Steinberg's dithering on the median cut image with ARI as ground truth

Artistic Style Transfer:

~ Without swatches:

In this we implement the color transfer without the use of swatches with the help of L*α*ß color space.

~ With swatches:

In this we implement the color transfer with the use of swatches and L*α*ß color space.

In this assignment we implement different methods of image enhancement and representation. The logic is written in code using python language. For testing of various algorithms I am using few example images which are:

Resolution: (1200, 818)

Size: 155 Kb

Type: JPG

Resolution: (1600, 1067)

Size: 503 Kb

Type: JPG

Resolution: (800, 584)

Size: 28 Kb

Type: JPG

Resolution: (728, 451)

Size: 68 Kb

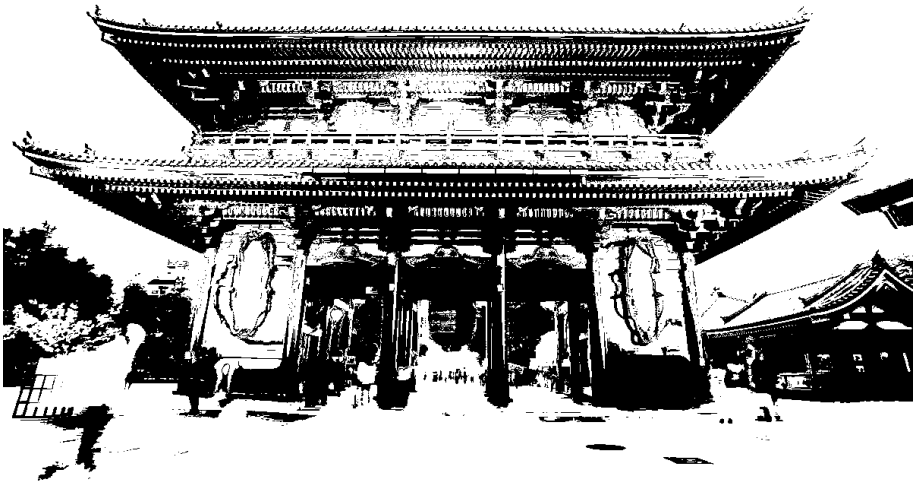
Type: JPG

Part 1: Simple Image Enhancement

1.1 In this part we apply different transforms on image and observe the results.

1.1.1 Shadow map generation

In this part we use the given procedure to get the following results



S-Map:

Threshold = 0.05*255

Shadow Image:

Lambda = 0.5

1.1.2 Line draft generation

Bilateral filtering:

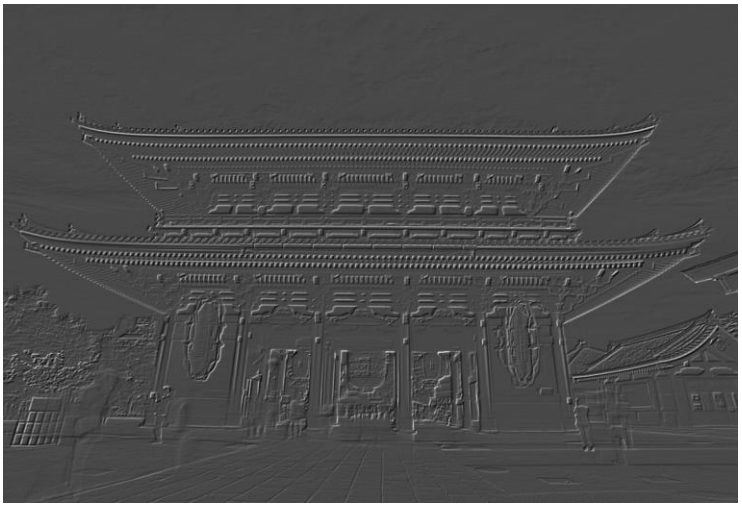
Bilateral image:

Filter Size = 10

Var(Gaussian):50

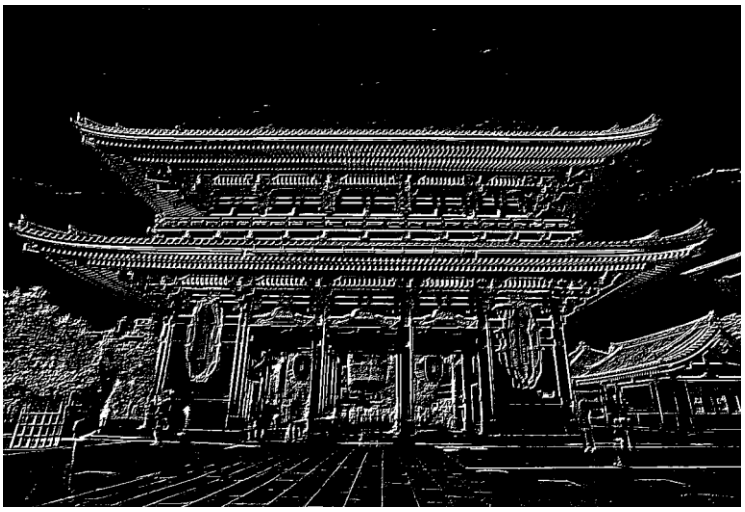
Var(Edge):10

Edge Map



Edge Map

Line Draft



Line Draft:

Threshold: 65

1.2 Color adjustment step

Saturation correction

Shadow Image after saturation correction:

ro = 0.5

Artistically rendered image

Artistically rendered image:

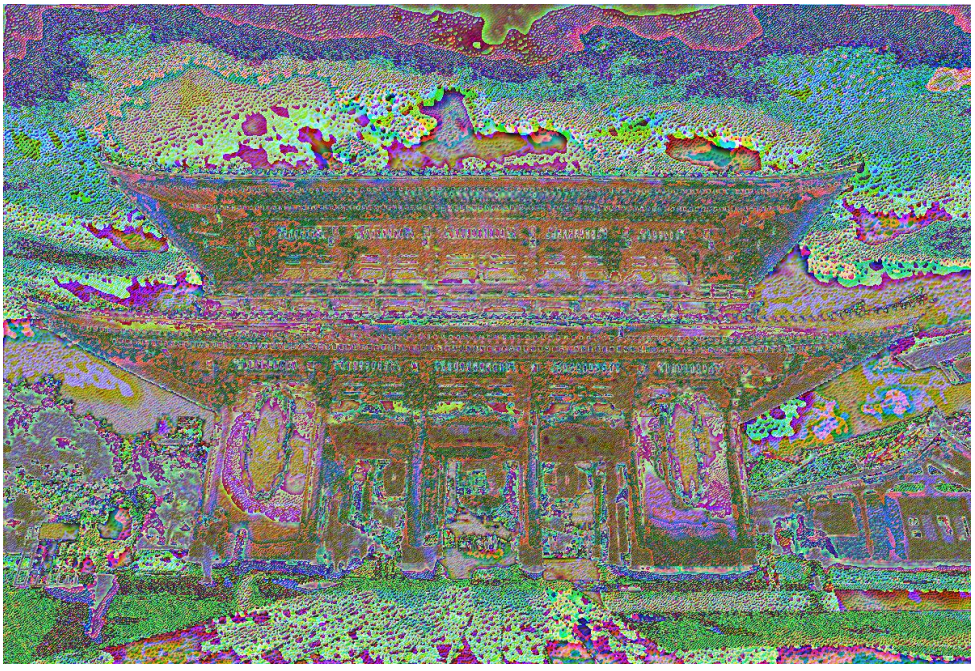
Beta = 0.75

Part 2: Quantized rendering

In this part we implement two quantization algorithms, i.e. Median Cut and dithering (Floyed Steinberg's dithering)

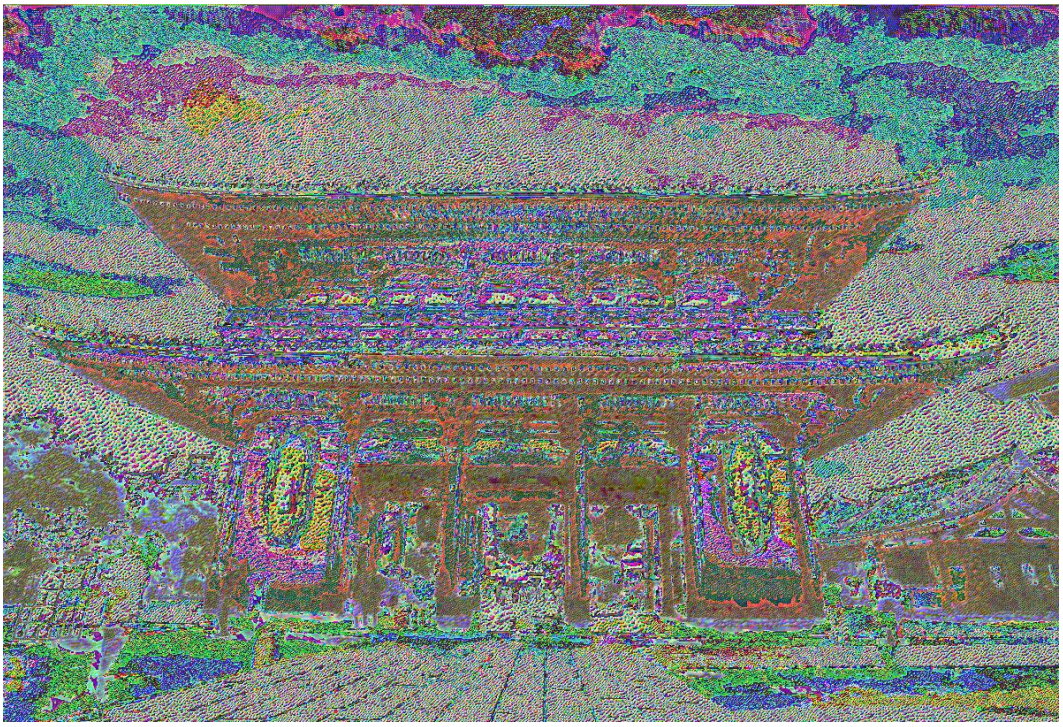
Median cut: With 4 cuts or 2^4 colors.

Dithering: With this image and ARI as ground truth



Median cut: With 8 cuts or 2^8 colors.

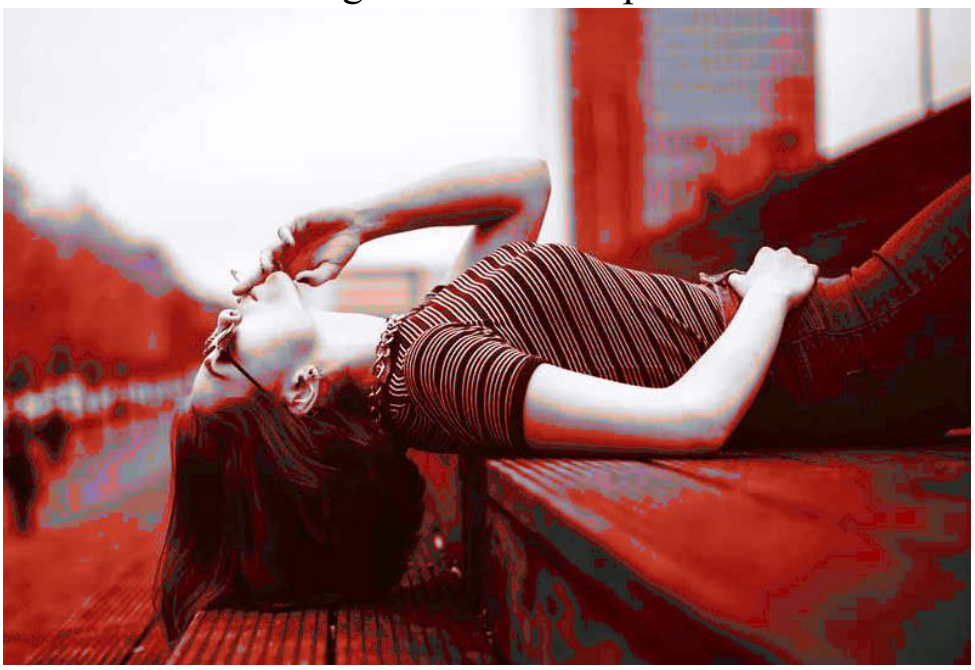
Dithering: With this image and ARI as ground truth



Part 3: Artistic Style Transfer

In this part we implement different methods of artistic style transfer or color transfer. First by mapping randomly chosen samples of source image and then transferring them to closest matching target image.

Luminance matching: With 100 samples from source image

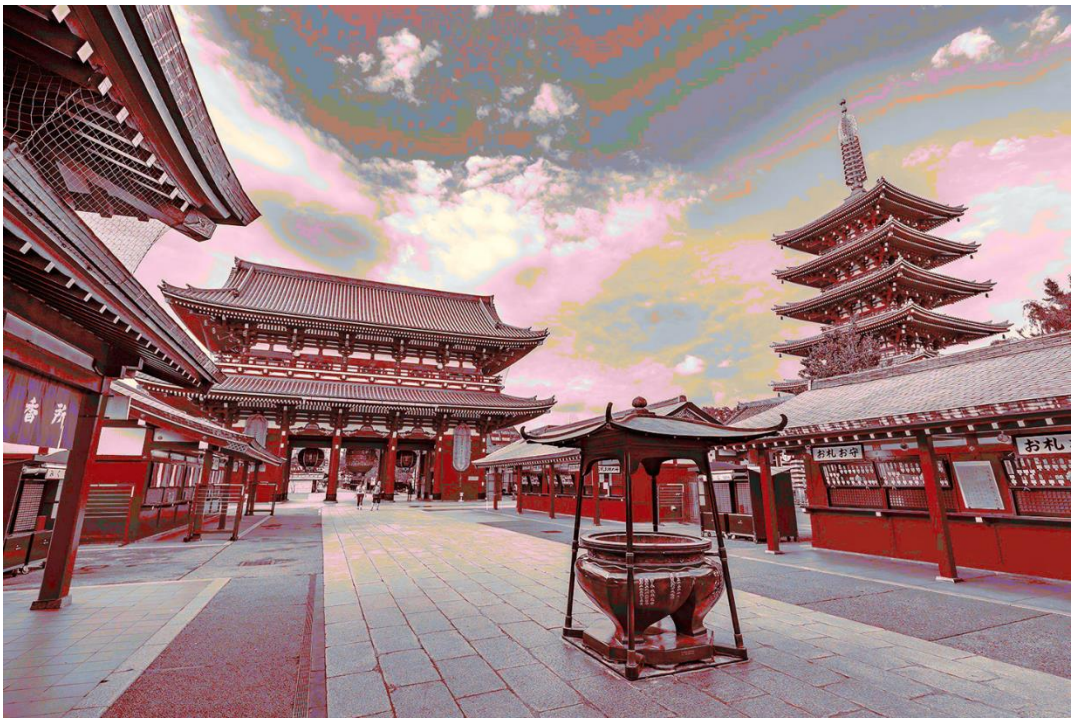


Luminance matching: With 20 samples from source image

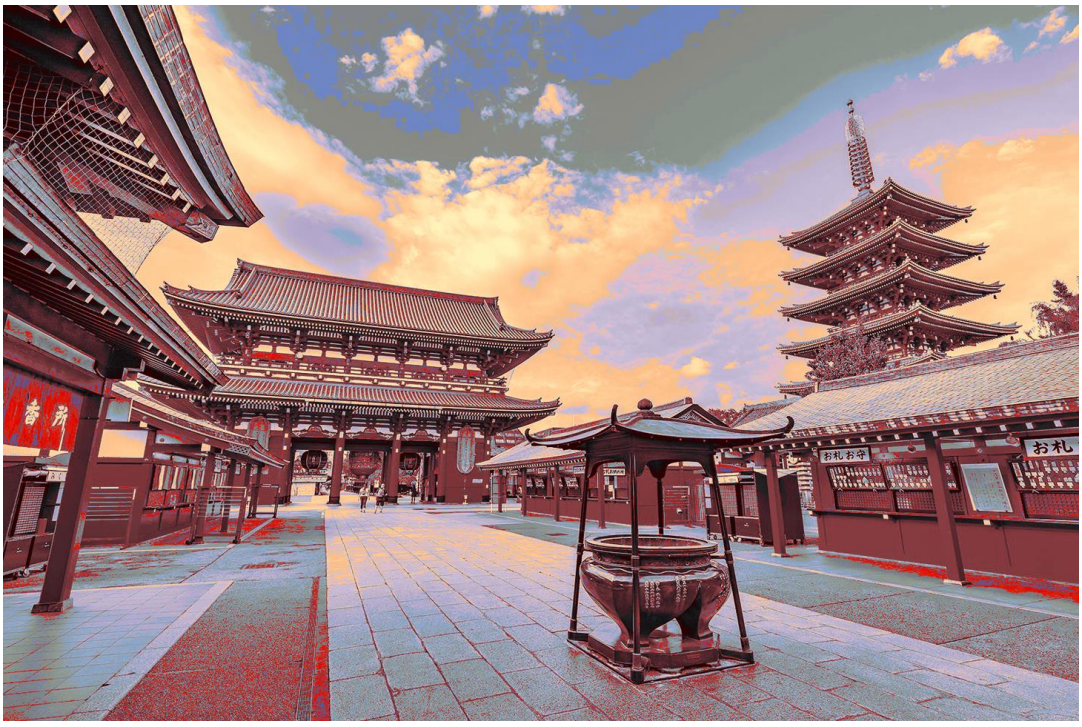
Luminance matching: With 50 samples from source image

Luminance matching: With 100 samples from source image

Luminance matching: With 200 samples from source image



Luminance matching: With 20 samples from source image



~ *USING SWATCHES* (3)

Intermediate image of 3 swatches transferring

Color transfer using 3 swatches with 10 samples from each swatch

Color transfer using 3 swatches with 5 samples from each swatch

Intermediate image of 2 swatches transferring

Color transfer using 2 swatches with 10 samples from each swatch

Color transfer using 2 swatches with 5 samples from each swatch

Results and discussion

In the given assignment we studied and applied multiple image processing algorithms and observed the following results:

- Shadow map generation is a simple process with no complexity or edge case.
- Calculation of threshold for s-map is computationally complex task, in our case the value was 208, but because of inverted image a value of 47 must be used.
- Shadow image are also simple to generate with lambda value being crucial for vibrant image.
- Bilateral filtering is somewhat complex algorithm as it requires the convolutional kernel to change at every step giving a complexity of $O(m*n*d^2)$.
- A threshold of 65 worked well for line draft, anything above or below gave visibly worse results.
- For artistically rendered image a beta value of 0.75 worked well as both components of the images are equally visible.
- In quantization of the image using median cut algorithm we saw a significant reduction in image quality for 4 cuts, but after using 8 cuts the images were more or less same as before with some noise like artifacts near detailed portions.
- Dithering is used to reduce quantization errors. In our case it was $4.738*10^6$ before dithering and became $2.969*10^6$ after dithering for 4 cuts and in case of 8 cuts it was $4.552*10^6$ before and after dithering it became $2.798*10^6$.
- Style transfer method without swatches yielded good results but they were neither consistent nor close to actual colors.
- Style transfer using swatches work a little better but require fine-tuned hyper parameters and also a lot of manual labor, also they are similar to non-swatches method as they are also difficult to reproduce.

Conclusion

The different methods of image enhancement used in this assignment can be improved using better algorithms or techniques, like learning based methods, which can give much better and consistent results.