COL 783, Assignment 1 report (2020CH70182)

Note: The images shown below can be generated again by running the code

Part 1, Q1.

a. To find out the most common intensity in the give logo ‘ʃ’ (as shown in Fig.01), I calculated the frequency of each intensity and then find out the maximum among them. The common frequency came out, $\boldsymbol{r}^{*}$ = 255.

Fig. 01

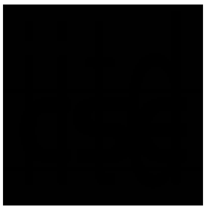

Fig. 02

To separate out the foreground pixels from background pixels, I checked with multiple tolerance value (t) and eventually at **t=10**, the separation was accurate. The produced ‘α’ is shown in Fig. 02. In ‘α’, It is hard to differentiate between foreground & background from naked eyes.

b. Since my chosen image has dimensions 1200x1200, so the dimension of ‘ʃ’ and ‘α’ after resizing should 300 (0.25*1200).

So, the scaling factor came out 3 (3x100=300). The result of ‘α’ and ‘ʃ’ after resizing are shown in below.

Fig. 03. Nearest neighbor interpolation on logo ‘α’.

Fig. 04. Bilinear interpolation on logo ‘α’.

Fig. 05. Nearest neighbor interpolation on logo ‘f’.

Fig. 06. Nearest neighbor interpolation on logo ‘f’.

c. To place the resized logo on chosen image at the bottom-right, created an empty array of dimensions same as chosen image and filled with corresponding pixel’s intensity.

   Run the two pointers i & j. when (1200 – i) <= 300 and (1200 – j) <= 300 then filled with $\alpha f + (1 - \alpha) g$. Otherwise, same as base image pixel intensity at that location. The results of the same are shown below.

Fig. 07. Nearest neighbor resized logo ‘f’ placed on chosen image.

Fig. 08. Bilinear resized logo ‘f’ placed on chosen image.

Part 1, Q2.

a. After averaging the 3 components of each pixel in memorial.hrd,

$$r_{min} = 0.000682830810546875$$
$$r_{max} = 204.6666717529297$$

$$\text{Contrast ratio} = {r_{max}}/{r_{min}} = 299{,}733.462$$

Pixels are mapped using, s = c*r

For r_{max} map to 255, c = ${255.0}/{r_{max}}$

For r_{min} map to 1, c = ${1.0}/{r_{min}}$

Fig. 09 and Fig. 10 show the result of r_{max} map to 255 and r_{min} map to 1 respectively. Both image intensities clipped to the valid range [0, 255].

Fig. 09. r_{max} map to 255

Fig. 10. r_{min} map to 1

b. Log transformation, s = a$\log r$+b

To transform the 'memorial.hdr' image to output range [0, 255],

$$a = {255.0}\Big/{\log \frac{r_{min}}{r_{max}}}$$
$$b = -a\log r_{min}$$

Fig. 11 is the output result.

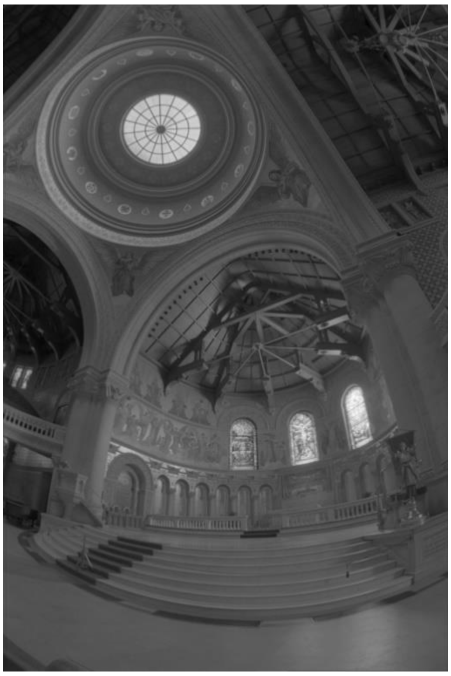

Fig. 11. Log transform

c. Transformation, s = exp(a$\log r$+b). To map the intensity to [1,255],

$$a = {\log 255} \Big/ {\log \frac{r_{min}}{r_{max}}}$$

$$b = -a\log r_{min}$$

The result of this transformation is shown in Fig. 12.

Fig. 12. Transform,

s = exp(a$\log r$+b).

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c

Deriation of ~~equal~~ equivalene of a gamma transformation -

$$s = \exp(a \log r + b)$$

$$s = \exp(a \log r) \exp(b)$$

$$s = (e^{\log r})^a \exp(b) = r^a \exp(b)$$

let $k = \exp(b)$

so, $s = r^a k = k r^a$

Hence, this is equivalent to gamma-transformation

d. Histogram equalization of ‘memorial.hdr’ is shown in Fig. 13. The same image result after taking log is shown in Fig. 14.

Fig. 13. Histogram equalization

Fig. 14. Histogram equalization after log transform.

Log transformation compresses the dynamic range of the image, particularly in the higher intensity values. This makes the intensity distribution more uniform and enhanced details in darker regions of the image. Hence, log transformation does significantly affect the results of histogram equalization due to its impact on the intensity distribution of the image.

e. On matching the histogram of ‘memorial.hdr’ image to image shown in Fig. 15, the result is shown in Fig. 16.

Fig. 15. Base Image

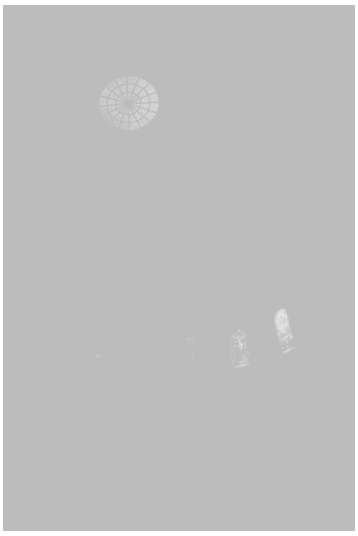


Fig. 16. Histogram matching result

Part 2, Q3

a. The Gaussian Filter applied on base image (shown in Fig. 17) and the results of two different σ are shown in Fig. 18 & Fig. 19.

Fig. 17. Base image

Fig. 18. Gaussian Filter (σ = 5)

Fig. 19. Gaussian Filter (σ = 10)

b. The input hdr image at very initial stage is shown in Fig. 20. After log transformation, it is shown in Fig. 21. All the other results are shown below like low contrast, high contrast, contrast reduction, recompose image and final undo log image.

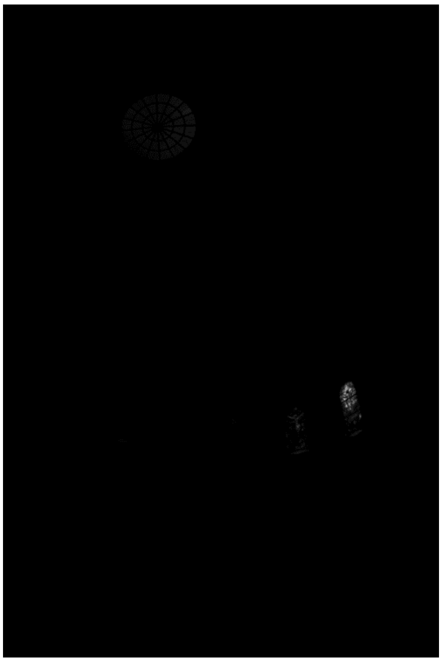


Fig. 20. Input Image

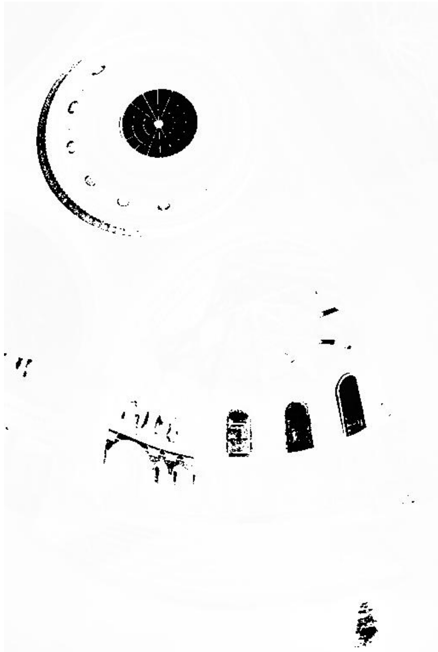


Fig. 21. Log transformation of input image

Fig. 22. Low contrast (Gaussian)

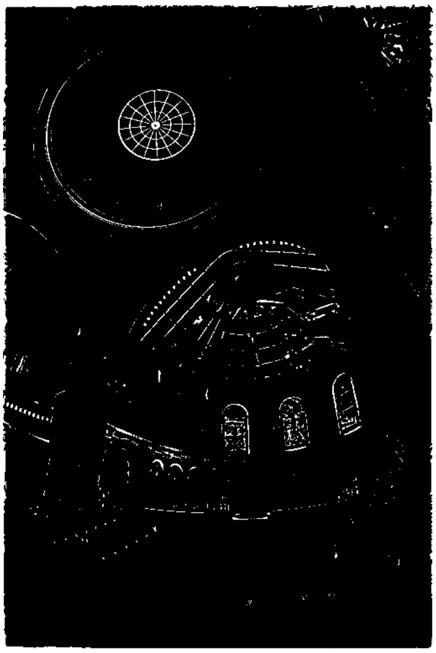


Fig. 23. High contrast

Fig. 24. After contrast reduction

Fig. 25. Recompose (lowpass and high pass)

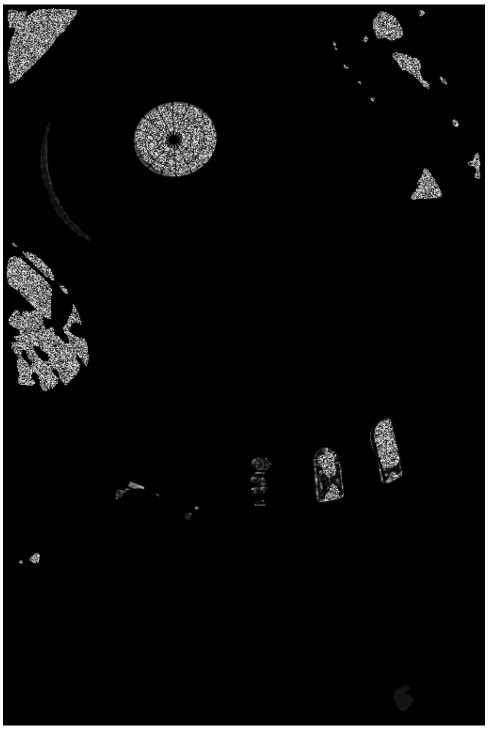


Fig. 26. Final Image (undo log)

c. Bilateral Filtering on image shown in Fig. 17. The result is shown in Fig. 27.

$$\sigma_s = 3$$

$$\sigma_r = 5$$

Fig. 27. After applying bilateral filtering

d. Repeated part (b) using a bilateral filter instead of a Gaussian filter. The results are shown below.

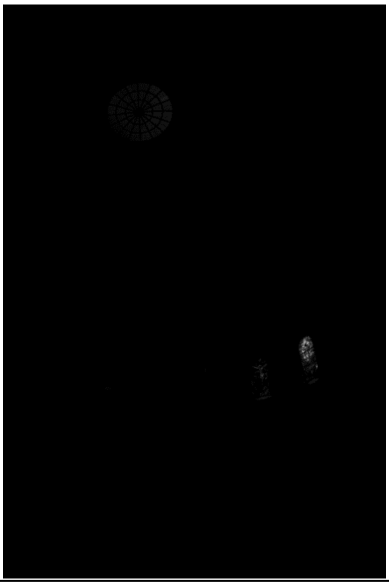


Fig. 28. Input Image

Fig. 29. Log transform

Fig. 30. Low contrast

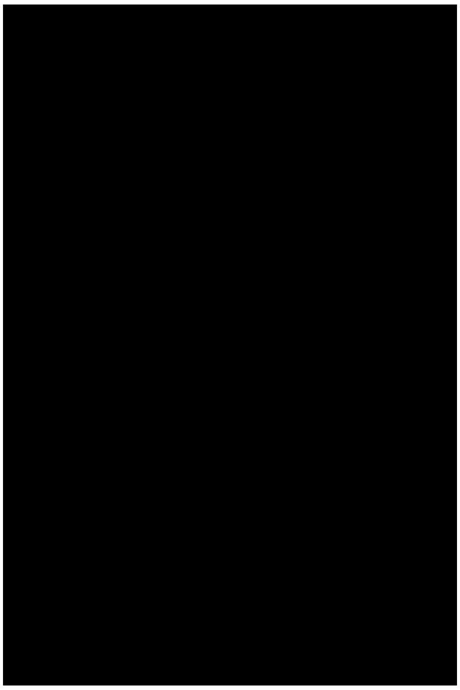


Fig. 31. High contrast

Fig. 32. Contrast Reduction

Fig. 33. Recompose

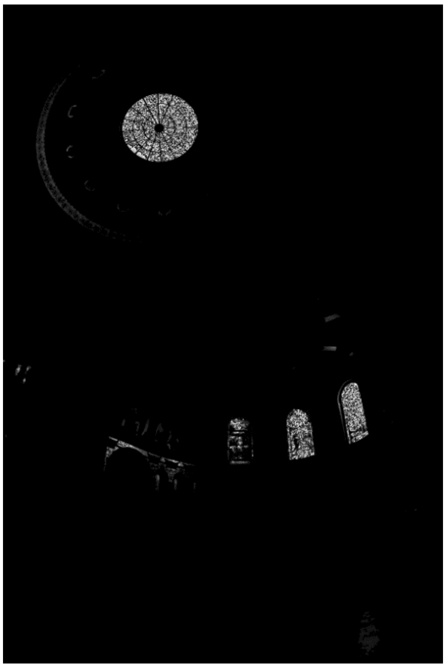


Fig. 34. Final Image (undo log)

Part 2, Q4

a. The results are shown below.

Fig. 35. Hue is constant. saturation increases horizontally from 0 to 1, and intensity increases vertically from 0 to 1.

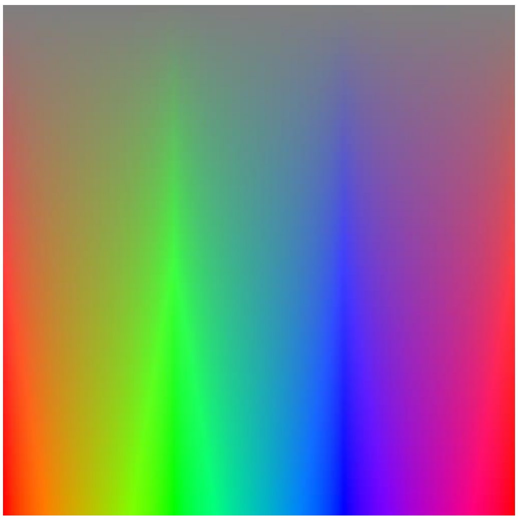


Fig. 36. Intensity is constant. saturation increases horizontally from 0 to 1, and hue increases vertically from 0 to 1.

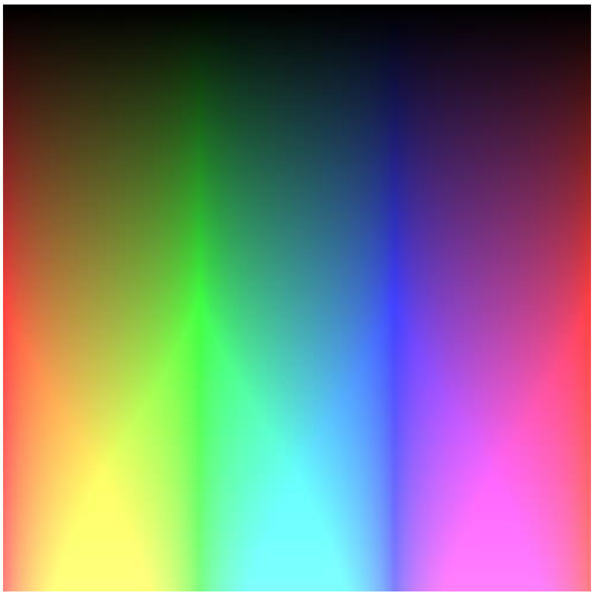


Fig. 37. Saturation is constant. Hue increases horizontally from 0 to 1, and intensity increases vertically from 0 to 1.

b. please find the proof at the bottom of this pdf.

c. Results are shown below.

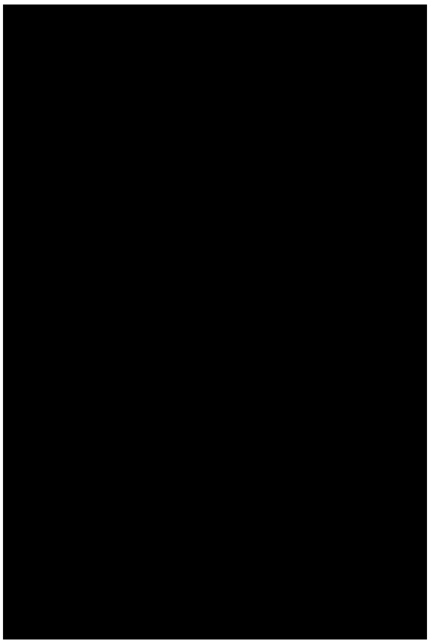


Fig. 38. Contrast reduction to component I.

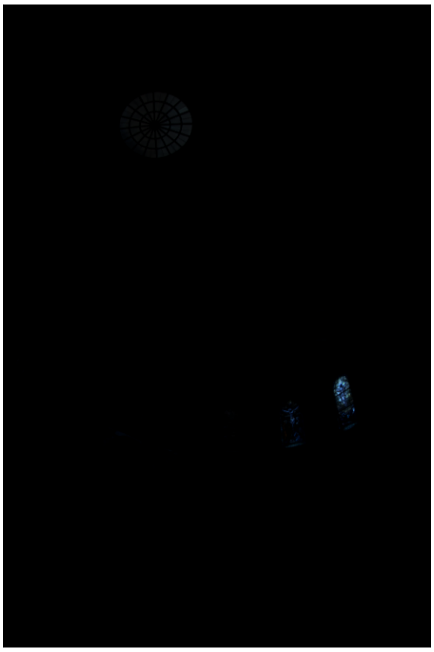
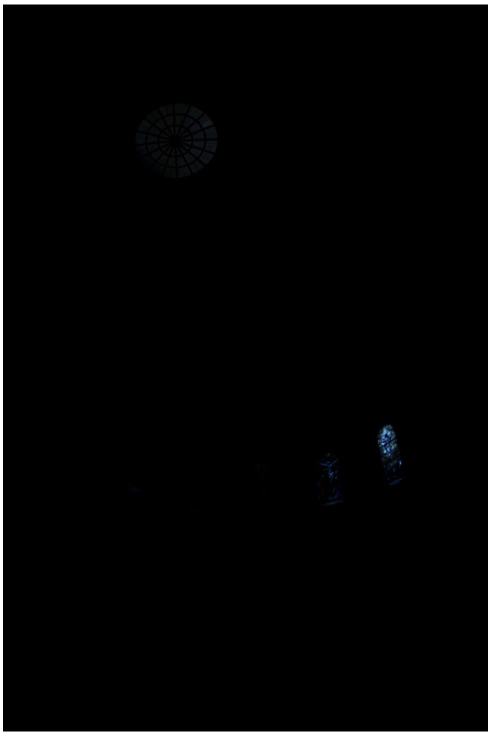


Fig. 39. Contrast reduction to component R.



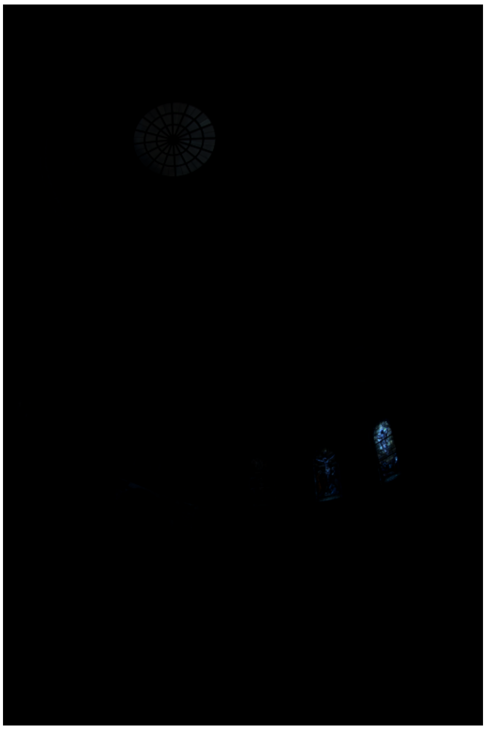
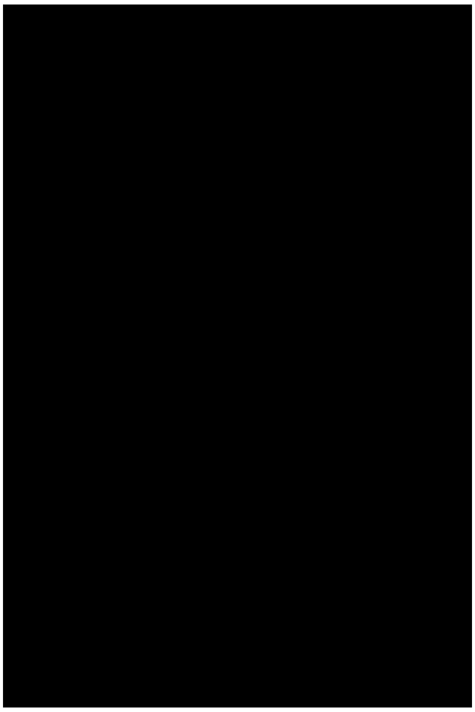


Fig. 40. Contrast reduction to component G.

Fig. 41. Contrast reduction to component B.

d. Applied a gamma transformation to result of part C.



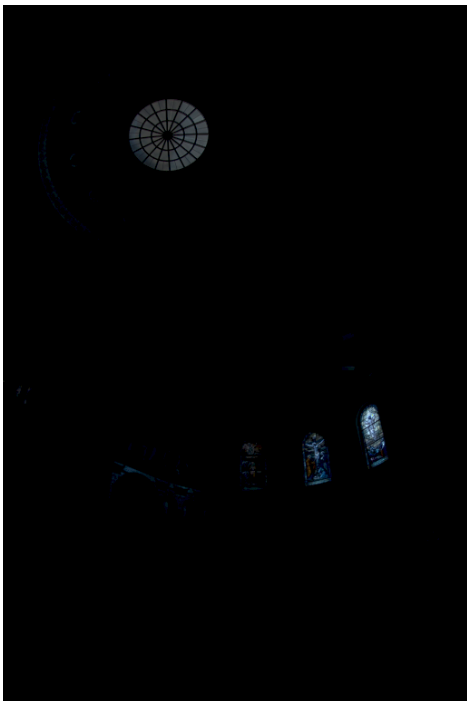


Fig. 42. Gamma transformation to component I.

Fig. 43. Gamma transformation to component R.

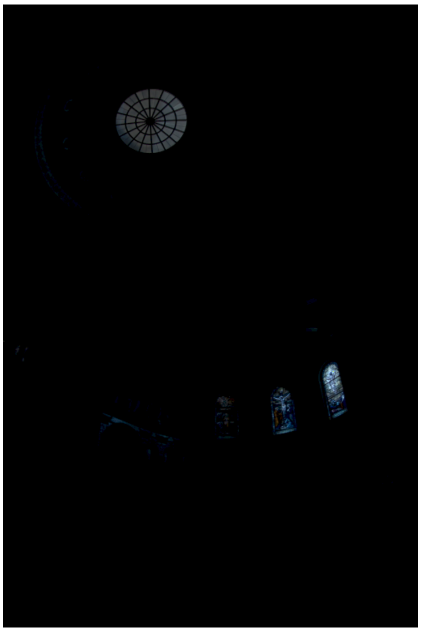


Fig. 44. Gamma transformation to component G.

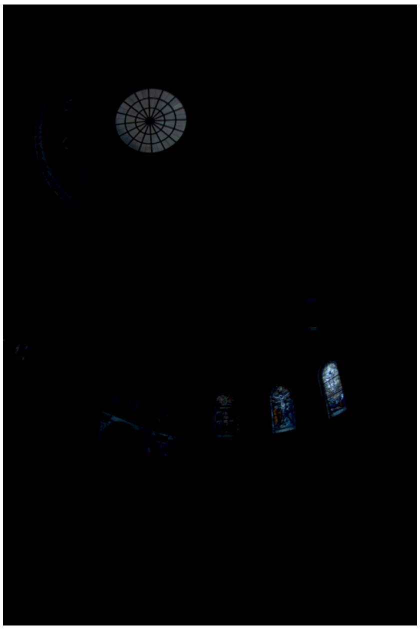


Fig. 45. Gamma transformation to component B.

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(4)
(b)

$$i = \frac{r+g+b}{3}$$

$$C' = (k.r, k.g, k.b)$$

$$i' = \frac{k.r + k.g + k.b}{3} = k\frac{(r+g+b)}{3}$$

$$\boxed{i' = ki}$$

$$S = 1 - \frac{3}{(r+g+b)} \min(r,g,b)$$

$$S' = 1 - \frac{3}{\cancel{k}(r+g+b)} \cancel{k} \min(r,g,b)$$

$$\boxed{S' = S}$$

h = hue is calculated based on the angle b/w the vector formed by the RGB component.

This angle is independent of magnitude of vector.

Hence, $\boxed{h' = h}$

Spiral