

Changing color scale

Let M be the maximum possible value for the coordinates of a color. In the representation that we have been using so far (this is: 8 bits), this value is 255. If we use 16 bits, the value will be 65535. In the model that we saw in class, this value was 1.

Let $a = (a_r, a_g, a_b) \in [0, M] \times [0, M] \times [0, M]$ be a color for which we want to change its scale.

The *saturated color* corresponding to a is the intersection of the line \overline{oa} with some of the faces of the color cube that intersect at the vertex (M, M, M) . This is:

$$\mathbf{S}(a) = M \cdot \frac{a}{\max\{a_r, a_g, a_b\}}$$

Let $k = (k_r, k_g, k_b)$ be a color that denotes the target color scale of the result of our calculation. Similarly, the saturated color corresponding to k is:

$$\mathbf{S}(k) = M \cdot \frac{k}{\max\{k_r, k_g, k_b\}}$$

We want to compute a point $b \in \overline{o\mathbf{S}(k)}$ such that

$$\frac{\|\vec{oa}\|}{\|\overrightarrow{o\mathbf{S}(a)}\|} = \frac{\|\vec{ob}\|}{\|\overrightarrow{o\mathbf{S}(k)}\|}$$

We have that

$$\vec{ob} = \frac{\|\vec{oa}\|}{\|\overrightarrow{o\mathbf{S}(a)}\|} \cdot \overrightarrow{o\mathbf{S}(k)}$$

It is easy to see that

$$\frac{\|\vec{oa}\|}{\|\overrightarrow{o\mathbf{S}(a)}\|} = \frac{\max\{a_r, a_g, a_b\}}{M}$$

Thus,

$$(b_r, b_g, b_b) = \frac{\max\{a_r, a_g, a_b\}}{M} \cdot M \cdot \frac{(k_r, k_g, k_b)}{\max\{k_r, k_g, k_b\}} = \boxed{\frac{\max\{a_r, a_g, a_b\}}{\max\{k_r, k_g, k_b\}} \cdot (k_r, k_g, k_b)}$$

Exercises

1.

Implement a function that converts an input (3-channels, color) image to grayscale. Example:



2.

Implement the same idea, but this time convert to scale of *any* color. For example: *scale of reds*, or *scale of blues*, or *scale of any other color*. Example:



3.

Use the exercise of the board with random colors (or create any other image that you want) to convert different regions of the input image into different scales. Example:



4.

[optional, possibly part of PC1] Implement a method that allows to replace a green background in an image (intentionally captured with green background). Find examples of images with green background, and change the green background by something else. Examples of application of this:





References

- [1] HUGHES, J. F., VAN DAM, A., MCGUIRE, M., SKLAR, D. F., FOLEY, J. D., FEINER, S., AND AKELEY, K. *Computer Graphics: Principles and Practice*, 3 ed. Addison-Wesley, Upper Saddle River, NJ, 2013.
- [2] VELHO, L., FRERY, A. C., AND GOMES, J. *Image Processing for Computer Graphics and Vision*, 2nd ed. Springer Publishing Company, Incorporated, 2008.
- [3] VELHO, L., AND GOMES, J. *Computação Gráfica: Imagem*, 2ª edição ed. IMPA, 2002.

Specifically:

- [2] - Chapters 4 and 14.
- [3] - Chapters 3 and 8.
- [1] - Chapter 17.