False Color in Grayscale Images

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February 26, 2020

1 False Color in Grayscale Images

People's eyes are able to perceive a wide spectrum of colors. However, gray scale cannot be distinguished so easily.

The ability of people to perceive a broad spectrum of colors is used in areas of science where it is necessary to analyze grayscale images. With a mathematical function, a grayscale image is represented in a new color image, in this way, important information can be identified in the original grayscale image.

2 Algorithm

First, a color model will be built to map each pixel of a gray scale image, to a value of the chosen color model. For the tests performed in this document, the following color model was chosen: Blue, Cyan, Yellow and Red.

Next, a palette is constructed with the four base colors chosen (Blue, Cyan, Yellow and Red). The base colors will be arranged equidistant in an array of four columns (the first column will be the position of the new color combination, the second column will be its red component, the third column will be its green component and the fourth column will be its blue component). Between each base color, there will be n new rows, each row will contain a new Red-Green-Blue color. Figure 1 shows a palette for the range of colors proposed in this document. The purpose of the false color algorithm is to map the pixels of a grayscale image, whose range is 0 to 255 to a color in the palette (Figure 2).

	Position	Red Component	Green Component	Blue Component	
	0	0	0	255	<-- Blue
n records:	⋮	⋮	⋮	⋮	
	n+1	0	255	255	<-- Cyan
n records:	⋮	⋮	⋮	⋮	
	2n+2	255	255	0	<-- Yellow
n records:	⋮	⋮	⋮	⋮	
	3n+3	255	0	0	<-- Red

Figure 1: Palette for Blue, Cyan, Yellow and Red color model.

Figure 2: Equivalence of a gray scale to a color palette.

The blocks of n rows in the palette are filled. A variable j will increase from 1 to n. For each row, the variable t is calculated by applying Equation (1). The first column of the color palette will be filled with a number from 0 to $(n * 3) + 3$. Each block of n new colors is surrounded by two base colors (Blue-Cyan, Cyan-Yellow or Yellow-Red). For each row of a specific block, let C_1 be the upper base color and C_2 the lower base color, the Equations (2), (3), and (4) specify the way to calculate the Red, Gray and Blue components of the row containing a new color.

$$t = \frac{j}{n-1} \tag{1}$$

$$Red\ _{component} = C_1^R * (1-t) + C_2^R * t \tag{2}$$

$$Green\ _{component} = C_1^G * (1-t) + C_2^G * t \tag{3}$$

$$Blue\ _{component} = C_1^B * (1-t) + C_2^B * t \tag{4}$$

Remember that C_1^R, C_1^G and C_1^B are the red, green and blue components of the upper base color. In the same way, C_2^R, C_2^G and C_2^B are the red, green and blue components of the lower base color.

If the color palette is already built, it is necessary to define our dynamic range of the grayscale image. The dynamic range is delimited with the lowest value pixel P_{min} and the highest value pixel P_{max} (Equation (5) and Equation (6)). It is also important to identify the first and last index of the rows in the color palette (first column) as shown in Equation (7) and Equation (8).

$$X_1 = P_{min} \tag{5}$$

$$X_2 = P_{max} \tag{6}$$

$$Y_1 = 0 \tag{7}$$

$$Y_2 = (n * 3) + 3 \tag{8}$$

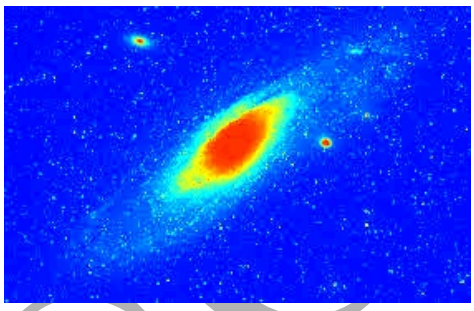
Finally, each pixel of the grayscale image p is mapped to some row of the color palette. The mentioned mapping is a linear function that preserves the meaning and shape of the image. Equation (9) will find the correct row index i in the color palette.

$$i = \frac{Y_2 - Y_1}{X_2 - X_1}(p - X_1) + Y_1 + 0.5 \tag{9}$$

3 Results

3.1 Image “Galaxy”

(a) Original grayscale image.



(b) False color image.

Figure 3: Original “Galaxy” grayscale image and the same image with its pixels mapped to the color palette.

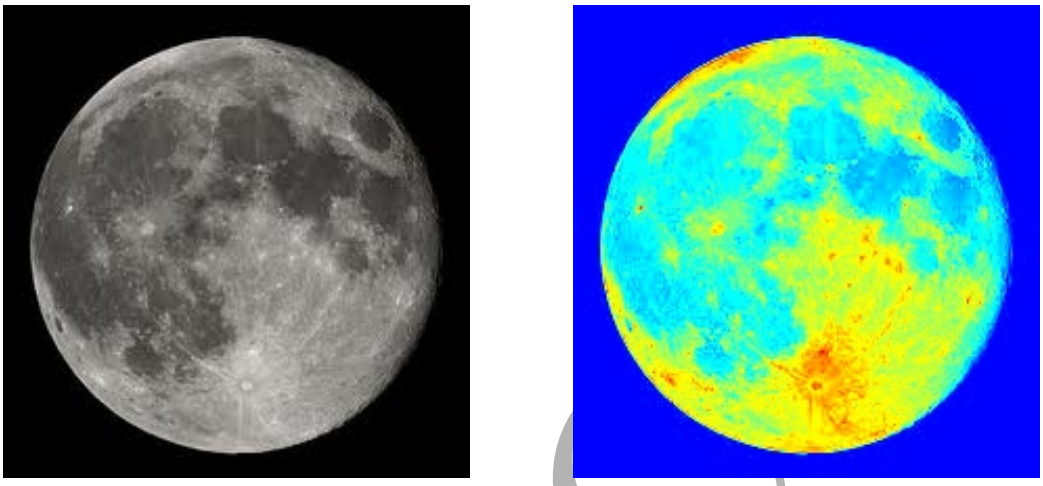
3.2 Image “Street”

(a) Original grayscale image.

(b) False color image.

Figure 4: Original “Street” grayscale image and the same image with its pixels mapped to the color palette.

3.3 Image "Moon"



(a) Original grayscale image. (b) False color image.

Figure 5: Original "Moon" grayscale image and the same image with its pixels mapped to the color palette.