

Proposed ZAH_BAU filter for RGB color image enhancement

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Abstract

Image contrast enhancement is an important step in almost every digital image preprocessing phase. The objective of image enhancement is to increase the visual perception of the image so that it is more suitable for human viewers and readers or machine vision applications. In this paper a new ZAH_BAU filter will be proposed, this filter can be used to control the brightness of RGB color image, and control individual channel in color image. The filter can be used also for different applications such as certain color removal and color image enhancement.

Keywords: RGB image, HSV image, ZAH_BAU filter, color removing.

1. Introduction

RGB color image is a 3 dimensional matrix [1], [2], [3], and it is an additive color model. It means that different proportions of Red, Blue and Green light can be used to produce color. The RGB color model was created specifically for display purposes (display screens, projectors etc).

HSV color system is based on the Hue shift, Saturation and Value. Unlike the RGB color system, which has to do with "implementation details" regarding the way RGB displays color, HSV has to do with the "actual color" components. Another way to say this would be RGB is the way computers treats color, and HSV try to capture the components of the way we humans perceive color. The main reason to work on the HSV version of an image is because using Hue component makes the algorithms less sensitive (if not invariant) to lighting variations. Because HSL and HSV are simple transformations of device-dependent RGB models, the physical colors they define depend on the colors of the red, green, and

blue primaries of the device or of the particular RGB space[4],[5],[6], table 1 shows some RGB values and there equivalents in HSV model.

To convert the R,G,B of the color image values are divided by 255 to change the range from 0..255 to 0..1 we can apply the following formulas:

$$R' = R/255$$

$$G' = G/255$$

$$B' = B/255$$

$$C_{max} = \max(R', G', B')$$

$$C_{min} = \min(R', G', B')$$

$$\Delta = C_{max} - C_{min}$$

Hue calculation:

$$H = \begin{cases} 0^\circ & \Delta = 0 \\ 60^\circ \times \left(\frac{G' - B'}{\Delta} \text{mod} 6 \right) & , C_{max} = R' \\ 60^\circ \times \left(\frac{B' - R'}{\Delta} + 2 \right) & , C_{max} = G' \\ 60^\circ \times \left(\frac{R' - G'}{\Delta} + 4 \right) & , C_{max} = B' \end{cases}$$

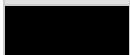



Saturation calculation:






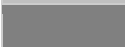






$$S = \begin{cases} 0 & , C_{max} = 0 \\ \frac{\Delta}{C_{max}} & , C_{max} \neq 0 \end{cases}$$

Value calculation:

$$V = C_{max}$$

Table 1: RGB values and there equivalents in HSV model

Color	Color name	(R,G,B)	(H,S,V)
	Black	(0,0,0)	(0°,0%,0%)
	White	(255,255,255)	(0°,0%,100%)
	Red	(255,0,0)	(0°,100%,100%)
	Lime	(0,255,0)	(120°,100%,100%)

	Blue	(0,0,255)	(240°,100%,100%)
	Yellow	(255,255,0)	(60°,100%,100%)
	Cyan	(0,255,255)	(180°,100%,100%)
	Magenta	(255,0,255)	(300°,100%,100%)
	Silver	(192,192,192)	(0°,0%,75%)
	Gray	(128,128,128)	(0°,0%,50%)
	Maroon	(128,0,0)	(0°,100%,50%)
	Olive	(128,128,0)	(60°,100%,50%)
	Green	(0,128,0)	(120°,100%,50%)
	Purple	(128,0,128)	(300°,100%,50%)
	Teal	(0,128,128)	(180°,100%,50%)
	Navy	(0,0,128)	(240°,100%,50%)

2. Related works

Image contrast enhancement is an important step in almost every digital image preprocessing phase. The objective of image enhancement is to increase the visual perception of the image so that it is more suitable for human viewers and readers or machine vision applications [4], [5]. One of the mostly used methods to examine the clearance of the gray image is to represent the image by a histogram [6]. The histogram in Fig. 1 represents the pixels in the image with a vertical bar for each of the 256 brightness levels from 0 to 255. The height of the bar indicates the relative number of pixels for a given brightness level. Brightness level 0 is at the far left side of the histogram, and level 255 is at the far right hand side. Shades of gray represented by different brightness levels range in between [7].

Because we have a limited amount of space for the histogram display, each vertical bar that represents an individual brightness level will be very narrow. The bars will be crowded touching each other without any space in between, if we do, in fact, we will have pixels for each possible level in the image. There are 256 different brightness levels to work with in an 8-bit image. Each level is represented by a vertical bar in the histogram's bar graph, but because there are so many to be displayed in such a limited space, individual bars cannot be differentiated because they all run together. By examining the histogram, we can tell if data has been lost, or if the brightness range of the image does not match the available dynamic range we have to work with[8], [9].

3. Unused Dynamic Range = Tones

Not Used Since we have a limited range of tones to work with in a digitized image (usually 256 in each channel), one of our main goals is to make sure we closely match the brightness range of the image to the available dynamic range of the tones we have to work with. Doing so optimizes the tonal data and maximizes the contrast of the image [10].

Clipped Data = Data Lost

If we overexpose a slide film, details will not be recorded in the important highlights. On the film where the highlights should be, the film will literally be transparent. There will be no data recorded there. If this happens, there is no way to restore these lost details later. Likewise, if we underexpose an image, no details will be recorded in critical shadow areas of the image [11], [12]. If such detail are not recorded when the exposure is made, there is no way to put it in later. Similar situations can occur when scanning an image. If some details present in the original film image are not recorded in the scan, then there is no recovery possible later unless it is re-scanned. Details in the shadows and highlights of an image can be lost by the scanner setting the wrong exposure for the clipped shadow detail (CSD) in the pre-scan, or by the scanner operator incorrectly setting the black and white points after the pre-scan, or by incorrectly adjusting the brightness or contrast of the scan.

Removing unwanted parts or colors [13], leads to image enhancement but we have still need to control the parts or colors in RGB image to be removed , Here an example of how we can control the process of color removing (Figure 1) by processing the following mat lab code:

```
myrgb = rand(50,50,3); imagesc(myrgb),figure
floatNorm = 255; tad = repmat(4, [50, 50, 3]);
target = repmat([105,112,175], 50*50, 1);
target = reshape(target, [50, 50, 3]);
threshold = (target + tad)/floatNorm;
myFilt = abs(myrgb - 1/2) <= threshold;
myrgb(myFilt) = 0; imagesc(myrgb)
```

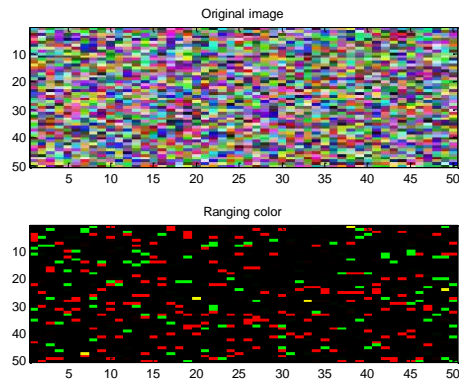


Figure 1: Color removing and enhancement

4. The proposed ZAH_BAU filter

The proposed ZAH_BAU filter (stands for Ziad Ashraf Hazem Al-Balqa' Applied University) can be implemented applying the following steps:

```

1: Acquire the input image
2: Get the R, G, B channels
3: Define the targets for each channel
4: Convert the required channel to HSV
4: Convert the original RGB image to HSV
5: Define the tad
6: Calculate the range(low and high)

    targetHLow = (targetHsv(1) - Tad + 1) - floor (targetHsv(1) - Tad + 1);
    targetHHigh = (targetHsv(1) + Tad) - floor (targetHsv(1) + Tad);

7: Create the filter with size = one channel size.

    % Fill the filter with zeros
    %Set the filter element to 1 according to the following condition

    hFilter(hFilter < targetHLow) = 1;
    hFilter(hFilter > targetHHigh) = 1;

8: Zero out the value channel.
9: Convert the modified HSV back to RGB.
    
```

Here we can control the tad, the rang (low and high values), the channel to be enhanced, thus giving more flexibility to the user to apply the filter for deferent application.

5. ZAH_BAU filter implementation

The following matlab code was written to implement the proposed algorithm

```

close all, clear all, clc
%step 1: Acquire the input image
a = imread('peppers.png');
raw_frame=a;
imshow(a), title 'Original image'
figure
%step 2: Get the R, G, B channels
redChannel = a(:, :, 1);
greenChannel = a(:, :, 2);
blueChannel = a(:, :, 3);
[redCount grayCount] = imhist(redChannel);
[greenCount grayCount] = imhist(greenChannel);
[blueCount grayCount] = imhist(blueChannel);
plot(grayCount,redCount,grayCount,greenCount,grayCount,blueCount)
legend('Original Red','Original Green','Original Blue')
tic
%step 3: Define the targets for each channel
targetRgb(1,1,1) = 105;
targetRgb(1,1,2) = 112;
targetRgb(1,1,3) = 175;
%step 4: Convert the required channel to HSV
targetHsv = rgb2hsv(targetRgb);
%step 5: Convert the original RGB image to HSV
frameHsv = rgb2hsv(raw_frame);
frameSize = size(raw_frame);
%step 6: Define the tad
hTad = 0.05;
%Step 7: Calculate the range(low and high)
targetHLow = (targetHsv(1) - hTad + 1) - floor (targetHsv(1) - hTad + 1);
targetHHigh = (targetHsv(1) + hTad) - floor (targetHsv(1) + hTad);
%Step 8: Create the filter with size = one channel size.
    % Fill the filter with zeros
hFilter = zeros(frameSize(1),frameSize(2));
    %Set the filter element to 1 according to the following condition
hFilter(hFilter < targetHLow) = 1;
hFilter(hFilter > targetHHigh) = 1;
%Step 9: Zero out the value channel.
frameV = frameHsv(:, :, 3);
frameV(hFilter) = 0;
frameHsv(:, :, 3) = frameV;
%Step 10: Convert the modified HSV back to RGB.
    
```

```

frameFiltered = hsv2rgb(frameHsv);
toc
figure,imshow(frameFiltered), title 'Filtered image'
figure
redChannel = frameFiltered(:, :, 1);
greenChannel = frameFiltered(:, :, 2);
blueChannel = frameFiltered(:, :, 3);
[redCount grayCount] = imhist(redChannel);
[greenCount grayCount] = imhist(greenChannel);
[blueCount grayCount] = imhist(blueChannel);
plot(grayCount,redCount,grayCount,greenCount,grayCount,blueCount)
legend('Filtered Red','Filtered Green','Filtered Blue')
    
```

Several RGB images with different sizes were treated using the proposed algorithm and the results of implementation satisfied the needed process of RGB color image enhancement, figure 2 to 5 shows some experimental results.



FIGURE 2: ORIGINAL INPUT IMAGE

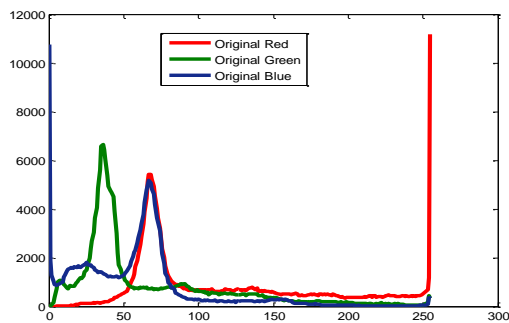


FIGURE 3: ORIGINAL IMAGE CHANNELS VALUES



FIGURE 3: FILTERED IMAGE

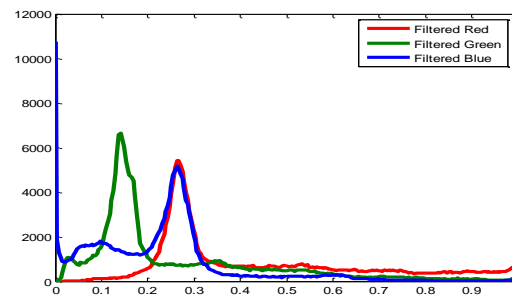


FIGURE 3: FILTERED IMAGE CHANNELS VALUES

The execution time of the filter does not exceed 0.156000 seconds.

6. Conclusions

Taking the results of implementation in consideration we can conclude the following facts:

- The proposed filter suits gray and color image enhancement.
- The proposed filter can be used to remove unwanted colors within RGB image or unwanted colors within a color channel.
- The parameters of the proposed filter (Low, High, range, Tad and channels) are controllable by the user.
- The proposed filter is flexible and efficient.

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