Color Image to Grayscale Image Conversion

C. Saravanan, Ph.D., Assistant Professor
Computer Centre, National Institute of Technology,
Durgapur, West Bengal, India
trysaran@gmail.com

***Abstract*— Conversion of a color image into a grayscale image inclusive of salient features is a complicated process. The converted grayscale image may lose contrasts, sharpness, shadow, and structure of the color image. To preserve contrasts, sharpness, shadow, and structure of the color image a new algorithm has proposed. To convert the color image into grayscale image the new algorithm performs RGB approximation, reduction, and addition of chrominance and luminance. The grayscale images generated using the algorithm in the experiment confirms that the algorithm has preserved the salient features of the color image such as contrasts, sharpness, shadow, and image structure.**

Keywords: color reduction, color to gray transformation.

I. INTRODUCTION

Image processing is a vital research area and the utilization of images increases in various applications. On different research areas, scientists are working on such as image compression, image restoration, image segmentation etc. to enhance the existing image processing techniques and invent new method of solving image processing problems. The latest image processing applications such as medical image processing, satellite image processing, and molecular image processing uses various image processing techniques. Conversion of color image to grayscale image is one of the image processing applications used in different fields effectively. In publication organizations' printing, a color image is expensive compared to a grayscale image. Thus, color images have converted to grayscale image to reduce the printing cost for low priced edition books. Similarly, color deficient viewer requires good quality of grayscale image to perceive the information, as the normal people perceive the color picture. Likewise, various image processing applications require conversion of color image to grayscale image for different purpose.

Conversion of a color image to a grayscale image requires more knowledge about the color image. A pixel color in an image is a combination of three colors Red, Green, and Blue (RGB). The RGB color values are represented in three dimensions XYZ, illustrated by the attributes of lightness, chroma, and hue. Quality of a color image depends on the color represented by the number of bits the digital device could support. The basic color image represented by 8 bit, the high color image represented using 16 bits, the true color image represented by 24 bit, and the deep color image is represented by 32 bit. The number of bits decides the maximum number of different colors supported by the digital device. If each Red, Green, and Blue occupies 8 bit then the combination of RGB occupies 24 bit and supports 16,777,216 different colors. The 24 bit represents the color of a pixel in the color image. The grayscale image has represented by luminance using 8 bits value. The luminance of a pixel value of a grayscale image ranges from 0 to 255. The conversion of a color image into a grayscale image is converting the RGB values (24 bit) into grayscale value (8 bit).

Various image processing techniques and software applications converts color image to grayscale image. However, the image processing techniques or applications are unable to handle the disparity in the chromaticity and the luminance. In the literature, several linear and non-linear techniques had discussed for converting color image to grayscale image. The recent techniques handle these disparities much better than the earlier techniques. Nevertheless, the techniques involve several computational procedures such as conversion of RGB space to XYZ space then approximations then mapping or other related techniques. Grayscale mappings of color images that are constructed by approximating spectral uniformity are often inadequate [1]. The recent technique used to convert from color image to gray image highly consumes computational time and memory. Thus, a new algorithm proposed to convert color image to grayscale image in a minimum amount of time.

II. RELATED WORK

There are several issues related to conversion of color image to grayscale image and different solutions to address these issues have addressed in the literature. The software such as Adobe Photoshop devised custom non-linear projections and required users to set image dependent parameters by trial and error [2]. The following writings discuss recent six prime research works focusing on the conversion of color image to grayscale image.

A technique proposed has utilized the L*a*b luminance chrominance representation [3]. The proposed technique introduces an additive correction term for spatial chrominance variations. The first step of this algorithm computes high pass filtered versions of all three channels, and the high-pass content from the two chrominance channels combined into a single signal that represents high frequency chrominance information. Another alternative, used in the implementation, is the slightly computationally simpler 1-norm metric. The main feature of this technique is

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the same color in the input image can map to different grayscale values depends on the spatial surround.

Another novel technique proposed to handle fluorescent colors effectively [4]. Source color image converted to uniform color space, then target differences were calculated, and finally least squares optimization technique has applied. The experiment shows that the isoluminant colors handled perfectly. The cost of setting up and solving the optimization problem is proportional to the size of the image. The proposed technique is highly resource (time and memory) consumable. In addition, the technique has not provided large improvements for scenes with high dynamic luminance range like natural scenes.

A technique proposed for re-coloring of images for color-deficient viewers without introducing visual artifacts [5]. The mapping of color to grayscale preserves contrasts and maintains luminance consistency. The quadratic objective function has defined for contrast preservation. Further, constraints added to enforce luminance consistency within narrow chrominance bands. The technique performed well for certain images and as standard for other images.

Another technique proposed enhances the contrast and converts color to grayscale [6]. The proposed technique used Gaussian pairing technique for image sampling, dimensionality reduction, and sampling color differences. The predominant component analysis used for analyzing color differences. The technique has satisfied Continuous mapping, Global consistency, Grayscale preservation, Luminance ordering, Saturation ordering, and Hue ordering. The process controlled by three parameters: the degree of image enhancement; the typical size of relevant image features in pixels; and the proportion of image pixels assumed to be outliers. First, the algorithm converts the RGB values into YPQ color space. Further, to analyze the distribution of color contrasts between image features, color differences between pixels considered using Gaussian pairing. Dimensionality reduction by predominant component analysis performed to find the color axis that best represents the chromatic contrasts lost when the luminance channel supplies the color to grayscale mapping. Next, has combined luminance and chrominance information. The final step used saturation to calibrate luminance while adjusting its dynamic range and compensating for image noise. The decolorize algorithm is effective at enhancing contrast. The algorithm avoids the noise, contouring, and halo artifacts. However, tuning on parameters required individually to suit each image.

A recent technique demonstrated color to grayscale conversion based on the experimental background of the Coloroid system observations [7]. A survey of the coloroid system to and from CIE XYZ system formulas completed. Observations based on the Coloroid system discussed. The seven basic Coloroid hues fixed. Relative gray-equivalent differences of the basic hue pairs calculated. Proposed two formulas based on the CIELab color space and the Coloroid color space for building the gradient field. Further, the inconsistency of gradient field corrected. Finally, 2D integration applied to get the grayscale image. From the demonstration noted that the isoluminant colors and bluish colors transformed to grayscale more realistic. The technique preserves overall appearance of the color image.

A most recent work converted the color image and video to grayscale [8]. The proposed technique converted the image and video perceptually accurate. First, H-K (Helmoltz-Kohlrausch) phenomenon predicted by a chromatic lightness term that corrects perceived lightness based on the color's chromatic component. The color image converted to linear RGB by inverse gamma mapping, then transformed to CIELUV color space. Its apparent chromatic object lightness channel calculated. Lightness channel to grayscale values mapped using reference white chromatic values. Gamma mapping applied to move from a linear space to a gamma-corrected space. Local contrast increased in the grayscale image to represent better the local contrast of original image. The work carried out using CIELab and CIELuv color spaces. This two step approach a good compromise between a fully automatic technique (first step) and user control (second step) making this approach well suited for natural images, photographs, artistic reproductions as well as business graphics. The main limitation of the approach is the locality of the second step. It cannot restore chromatic contrast between non-adjacent regions.

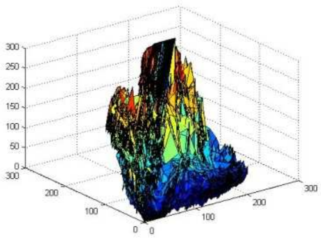
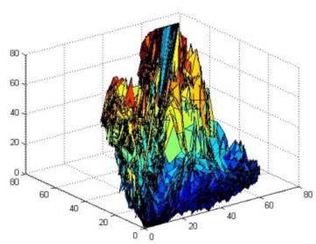
III. ALGORITHM

1. Y = (0.299 x R) + (0.587 x G) + (0.114 x B);
2. U = (B - Y) x 0.565;
3. V = (R - Y) x 0.713;
4. UV = U + V;
5. R1=R*0.299;
6. R2=R*0.587;
7. R3=R*0.114;
8. G1=G*0.299;
9. G2=G*0.587;
10. G3=G*0.114;
11. B1=B*0.299;
12. B2=B*0.587;
13. B3=B*0.114;
14. R4=(R1+R2+R3)/3;
15. G4=(G1+G2+G3)/3;
16. B4=(B1+B2+B3)/3;
17. I1=(R4+G4+B4+UV)/4;
18. END

The steps 1 to 3 calculate the luminance and chrominance values of the source color image. In the step 4 sum of chrominance value calculated. Steps 5 to 16 the RGB values are approximated using RGB components. Step 17 calculates the average of the four values R4, G4, B4 and UV. The `I1` represents the resulted gray color image. The color image, 3D plot of the RGB values of the color image, and 3D plot of the reduced RGB values of the color image have shown and compared.

Table 1. Comparison of source image RGB and reduced RGB values.

Source Color Image

3D plot of the source color image RGB values

3D plot of the reduced RGB values


The 3D plot of the source image and reduced RGB values compared. The RGB values of the source image ranging from 0 to 255 were reduced to a range of 0 to 85. The reduction enhances the color range and helps to calculate the grayscale in a better way. In the above picture observed that the color ranges are in the 3D plot of the source image RGB values are enhanced many colors are highly visible in the 3D plot of the approximated and reduced RGB values without any major changes in the colors and structure. The reduction process of RGB values retained the major values of the RGB at most of the points observed. The reductions made at the RGB color level so that the resultant grayscale image to retain the luminance and chrominance property at the maximum.

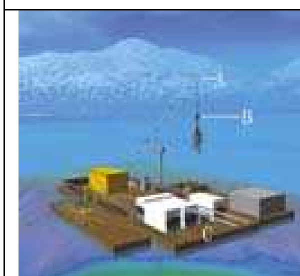
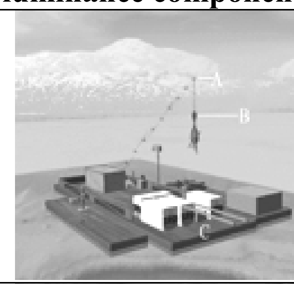
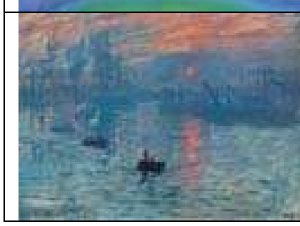
IV. RESULTS AND DISCUSSION

The proposed algorithm tested on thirty four number of different eight bit color images published in the recent research publications. The color values of the color images are in the range of 0 to 255 for each Red, Green, and Blue. In the images, seven are jpg in format and twenty seven are png in type. The Mat Lab software has used for testing the algorithm.

The results of the experiment carefully examined. The difference between the results of the proposed technique and recent techniques identified and discussed. The result revealed that the proposed algorithm yields grayscale image with better luminance and chrominance property for most of the cases and as standard for other few cases. However, there is a minimum amount of loss in the grayscale image due to reduction the algorithm preserved contrasts, sharpness, shadow, and structure of the color image in the reproduced grayscale image.

The following table shows four of the different color images used in the experiment and respective reproduced grayscale images using the proposed algorithm.

Table 2. Experiment Results

Color Image	**Grayscale Image using luminance components**
	
	

In the first grayscale image the letters A, B, and C are sharp as in the color image whereas it is not so in other earlier techniques.

In the second image, the shades of the different color reproduced as sharp as in the color image in the grayscale image than the recent algorithms.

V. CONCLUSION

The conversion of color image to grayscale image using the proposed algorithm uses approximation of RGB values using luminance RGB components approximated RGB reduced by three, added with chrominance value and average of these four value results perceptually and structurally good quality of grayscale images. First, the luminance and chrominance values are calculated. Further, the RGB values of the source color image reduced. Finally, the reduced RGB values have added chrominance values. The resulted grayscale images confirm that the luminance and chrominance properties and structure of the color images retained well in the grayscale image. The results confirm that the isoluminant images have handled as handled by other recent techniques. The proposed algorithm is helpful for different applications where good quality of grayscale image is highly required. The proposed algorithm results best quality of grayscale images using RGB reduction and chrominance addition in a short amount of time.

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