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Color variations in pseudo color processing of graphical images using multicolor perception

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Abstract
In digital image processing, image enhancement is employed to give a better look to an image. Color is one of the best ways to visually enhance an image. Pseudo-color image processing assigns color to grayscale images. This is useful because the human eye can distinguish between millions of colures but relatively few shades of gray. Pseudo-coloring has many applications on images from devices capturing light outside the visible spectrum, for example, infrared and X-ray. A Color model is a specification of a color coordinate system and the subset of visible colors in this coordinate system. The key observation in this work is variation of colors in Pseudo color images using multicolor perception. This technique can be successfully applied to a variety of gray scale images and videos.

Keywords: Pseudo color, color models, reference grey images, multicolor perception, image processing, computer graphics.

1. Introduction
This paper is based on the idea that the human visual system is more responsive to color than binary or monochrome images. We wanted to experiment the importance of pseudo-color. To create our images we use the color variations in pseudo color method. The purpose of this paper is to image enhancement with color. We use ultrasound images, digital images, satellite images as gray scale images and used pseudo color technique to enhance them using multicolor perception. The main focus is to convert the grey image into color image by using the color variations. By using this method we can describe color as accurately as possible. The fact that colors can be described by combinations of three basic colors, called primary colors improved to give better enhancement of the image. The idea behind this method is that to convert the black and white image into color without losing its content because by conversion of an image some data might be lost.
Gray scale image contains pixels which are not a RGB color pixels. Many applications convert a gray scale image into RGB color space but fail to preserve the original contents of a Gray Scale image. This project provides an emphasis on noise removal, color conversion and blur removing techniques. Colorization is computerized processes that adds color to a black and white print, movie, images and in other fields such as archeology dealing with historical Gray scale data and security dealing with gray scale images by crime prevention camera, we can imagine easily that colorization techniques are useful.

2. Preliminaries
2.1 Image Enhancement
Image Enhancement techniques are employed to improve the quality of images for human viewing. Color is important for image enhancement because the human visual system has the ability perceive thousands of colors in a small spatial area compared to only about 100 gray levels. In addition, color contrast can be more dramatic than gray level contrast and various colors have different degrees of psychological impact on the observer. Taking these advantages of human visual perception to enhance an image a technique is applied which is called pseudo color. Image enhancement techniques can be divided into two broad categories:

2.1.1 Spatial Domain Techniques:
Spatial domain techniques directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. Spatial domain techniques like the logarithmic transforms, power law transforms, histogram equalization, are based on the direct manipulation of the pixels in the image. Spatial techniques are particularly useful for directly altering the gray level values of individual pixels and hence the overall contrast of the entire image. But they usually enhance the whole image in a uniform manner which in many cases produces undesirable results. It is not possible to selectively enhance edges or other required information effectively. Techniques like histogram equalization are effective in many images.

(a) Point Operation: Point operations or image processing operations are applied to individual pixels only. The point operation is represented by $g(m,n)= T[f(m,n)]$ Where $f(m,n)$ is the input image, $g(m,n)$ is the processed image, and T is the operator defining the modification process which operates on one pixel.
(b) Mask Operation: In mask operation, each pixel is modified according to values in a small neighborhood.
(c) Global Operation: In global operation, all pixel values in the image are taken into consideration for performing operation.

2.1.2 Frequency Domain Techniques
Frequency domain techniques are based on the manipulation of the orthogonal transform of the image rather than the image itself. Frequency domain techniques are suited for processing the image according to the frequency content. The principle behind the frequency domain methods of image enhancement consists of computing a 2-D discrete unitary

transform of the image, for instance the 2-D DFT, manipulating the transform coefficients by an operator M, and then performing the inverse transform. The orthogonal transform of the image has two components magnitude and phase. The magnitude consists of the frequency content of the image. The phase is used to restore the image back to the spatial domain. The usual orthogonal transforms are discrete cosine transform, discrete Fourier transform, Hartley Transform etc. The transform domain enables operation on the frequency content of the image, and therefore high frequency content such as edges and other subtle information can easily be enhanced. Due to these ambiguities, we use multicolor perception which plays a large role in the colorization process. Where the mapping of luminance values to color values is automatic, the choice of the color map is commonly determined by a reference image.

3. Related Work

Pseudo color: Pseudo color (false color) image processing consists of assigning colors to gray values based on a specified criterion. The term "Pseudo color" emphasizes that the colors were assigned artificially opposing to the true (real) colors. The principal use of Pseudo color is for human visualization and interpretation of gray scale details on an image or their sequence. Intensity slicing and color coding is one of the simplest kinds of pseudo color image processing.

A. Intensity slicing:

First we consider an image as a 3D function mapping spatial coordinates to intensities (that we can consider heights).Now consider placing planes at certain levels parallel to the coordinate plane. If a value is one side of such a plane it is rendered in one color, and a different color if on the other side.

In general intensity slicing can be summarized as:

Let [0, L-1] represent the grey scale. l0 represent black [f (x, y)= 0] and let lL- 1represent white [f (x, y)= L-1]Suppose P planes perpendicular to the intensity axis are defined at levels l1,l2, …, lp. Assuming that $0 < P < L-1$then the P planes partition the grey scale into P +1 intervals V1, V2,…, VP+1.

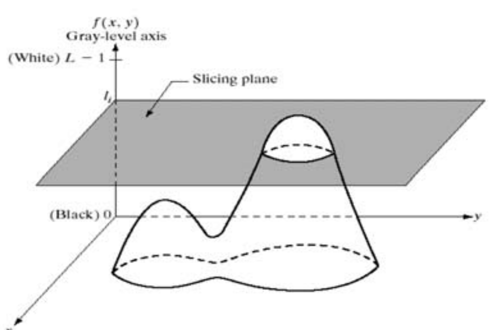

Fig 1: Intensity Slicing

Grey level color assignments can then be made according to the relation: where *ck* is the color associated with the *kth* intensity level *Vk* defined by the partitioning planes at $l = k -$ 1and$l = k$

3.2. Color models:

MODELS:

There are five major models that sub-divide into others, which are: CIE, RGB, YUV, HSL/HSV, and CMYK.

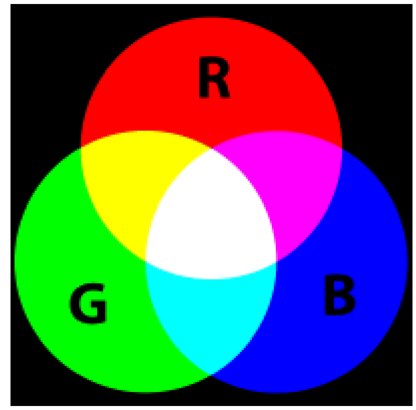

Fig 2: Additive color mixing

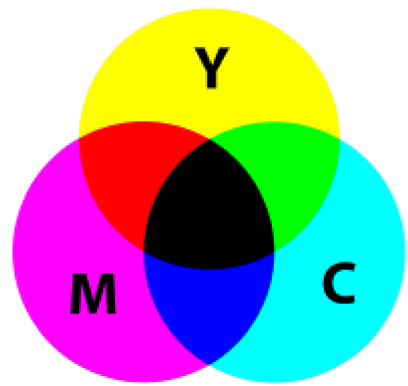

Fig 3: Subtractive color mixing

A. CIE

1. CIE 1931 XYZ

The first attempt to produce a color space based on measurements of human color perception and it is the basis for almost all other color spaces.

2. CIELUV

A modification of "CIE 1931 XYZ" to display color differences more conveniently. The CIELUV space is especially useful for additive mixtures of lights, due to its linear addition properties [1].

3. CIELAB

The intention of CIELAB (or L*a*b* or Lab) is to produce a color space that is more perceptually linear than other color spaces. Perceptually linear means that a change of the same amount in a color value should produce a change of about the same visual importance. CIELAB has almost entirely replaced an alternative related Lab color space "Hunter Lab". This space is commonly used for surface colors, but not for mixtures of (transmitted) light.

4. CIEUVW

Measurements over a larger field of view than the "CIE 1931 XYZ" color space which produces slightly different results.

B. RGB

RGB (Red, Green, Blue) describes what kind of light needs to be emitted to produce a given color. Light is added together to create form from darkness. RGB stores individual values for red, green and blue. RGB is not a color space, it is a color model. There are many different RGB color spaces derived from this color model, some of which appear below. RGBA is RGB with an additional channel, alpha, to indicate transparency.

1. sRGB

The **sRGB color space**, or **standard RGB** (Red Green Blue), is an RGB color space created cooperatively by Hewlett-Packard and Microsoft Corporation for use on the Internet. It has been endorsed by the W3C, Exif, Intel, Pantone, Corel, and many other industry players. It is also well accepted by Open Source software such as the GIMP, and is used in proprietary and open graphics file formats such as SVG. sRGB is intended as a common color space for the creation of images for viewing on the Internet and World Wide Web (WWW), the resultant color space chosen using a gamma of 2.2, the average response to linear voltage levels of CRT displays at that time.

2. Adobe RGB

The Adobe RGB color space is an RGB color space developed by Adobe Systems in 1998. It was designed to encompass most of the colors achievable on CMYK color printers, but by using RGB primary colors on a device such as the computer display. The Adobe RGB color space encompasses roughly 50% of the visible colors specified by the Lab color space, improving upon the gamut of the sRGB color space primarily in cyan-greens.

3. Adobe Wide Gamut RGB

The **Adobe Wide Gamut RGB color space** is an RGB color space developed by Adobe Systems as an alternative to the standard sRGB color space. It is able to store a wider range of color values than sRGB. The Wide Gamut color space is an expanded version of the Adobe RGB color space, developed in 1998. As a comparison, the Adobe Wide Gamut RGB color space encompasses 77.6% of the visible colors specified by the Lab color space, whilst the standard Adobe RGB color space covers just 50.6%.One of the downsides to this color space is that approximately 8% of the colors representable are imaginary colors that do not exist and are not representable in any medium. This means that potential color accuracy is wasted by reserving these unnecessary colors.

4. Other RGB spaces

There is an open ended set of RGB spaces; by picking new red, green, blue primaries and a gamma value, anyone can invent one.

C. Luma plus chroma/chrominance

1. YIQ, YUV, YDbDr

YIQ was formerly used in NTSC (North America, Japan and elsewhere) television broadcasts for historical reasons. This system stores a luma value with two chroma or chrominance values, corresponding approximately to the amounts of blue and red in the color. It corresponds closely to the YUV scheme used in PAL (Australia, Europe, except France, which uses SECAM) television except that the YIQ color space is rotated 33° with respect to the YUV color space.

2. YPbPr, YCbCr

YPbPr is a scaled version of YUV. It is most commonly seen in its digital form, YCbCr used widely in video and image compression schemes such as MPEG and JPEG.

3. *XvYCC*

xvYCC is an extension of YCbCr that extends the color gamut beyond the R/G/B primaries specified by BT.709.

D. Hue and saturation

1. HSV

(Hue, saturation, value), also known as HSB (hue, saturation, brightness), is often used by artists because it is often more natural to think about a color in terms of hue and saturation than in terms of additive or subtractive color components. HSV is a transformation of an RGB color space, and its components and Colorimetry are relative to the RGB color space from which it was derived.

2. HSL

(Hue, saturation, lightness/luminance), also known as HSL, HSI (hue, saturation, intensity) or HSD (hue, saturation, darkness), is quite similar to HSV, with "lightness" replacing "brightness". The difference is that the brightness of a pure color is equal to the brightness of white, while the lightness of a pure color is equal to the lightness of a medium gray.

E.CMYK

CMYK is used in the printing process, because it describes what kind of inks needs to be applied so the light reflected from the substrate and through the inks produces a given color. One starts with a white substrate (canvas, page, etc.), and uses ink to subtract color from white to create an image. CMYK stores ink values for cyan, magenta, yellow and black. There are many CMYK color spaces for different sets of inks, substrates, and press characteristics (which change the dot gain or transfer function for each ink and thus change the appearance).

3.3. Multi-color perception model:

Three types of cone cells exist in our eye, with each being more sensitive to either short(S), medium (M), or long (L) wavelength light. The set of signals possible at all three cone cells describes the range of colors we can see with our eyes. The diagram below shows the relative sensitivity of each type of cell for the entire visible spectrum. These curves are often referred to as “tristimulus functions” Different types of cones have different relative absorption characteristics. Long (red), medium (green) and short (blue) wavelength Cones

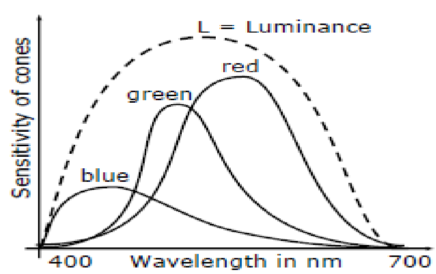

Fig 3: color perception model

Human eye can distinguish between some millions of different colors. At one time (level of adaptation), only 300 colors and 100-150 levels of brightness can be distinguished. Contrast sensitivity describes the size of details that can be distinguished. It is also a function of wavelength.

The perception of a color with spectral energy distribution $C(\lambda)$is described by the responses of the three primaries to that color:

$$a_i(C) = \int_{\lambda_{\min}}^{\lambda_{\max}} S_i(\lambda)C(\lambda)d\lambda,\ i = 1,2,3$$

The human brain only sees the brain response. As a matter of fact, different spectra look the same. Metamerism is the fundamental principle of color reproduction. Instead of reproducing the spectrum, the visual response is simulated by mixing primary colors

4. Applications

This pseudo coloring method is used for enhancing the quality of images. The applications of this method is widely used in Aerial imaging, Satellite imaging, Medical imaging, Digital camera application, Remote sensing etc.

5. Proposed Work

5.1. Objective:

Adding colors to gray scale image directly is not possible. The process of colorizing a grayscale image does not seems to be a straight forward method which involves various methods to apply color onto the colorless image. This technique is entirely different it is an adaptive system which emphasis on a gray scale image and converting them into color using color variations. Automatic selection of color in a particular gray scale image makes systems more impact and resultant image enhances the scale of colorization. In previous adapted method the mapping is done partially and the perception is done only by a particular perception. Here we propose a method that the mapping will be uniform and perception of the color in the image will be by using multicolor perception. So that the quality of the image can be improved and image can be viewed in a multi colored manner.

5.2. Algorithm:

Input: colorless image

Output: colored image by color variations

1. Select colorless gray scale image.
2. Split an Image into multiple segments.
3. Locate pattern for each segment.
4. If pattern located successfully, then goto step 5 else select default color reference image.
5. Insert reference image color to gray scale object.
6. Join all converted color objects.
7. Stop.

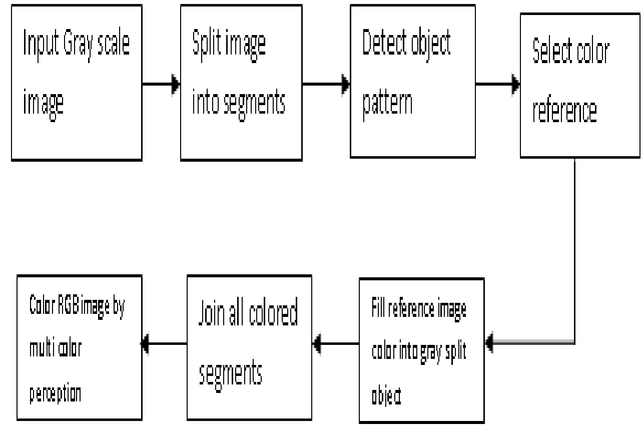

Fig 4: Proposed System Architecture

6. Experiments

The proposed approach was implemented and tested in a set of color images. The implementation of 3 basic color models such as 1.The RGB Model 2. The CMY Model 3.The YCbCr color Model is done. The pseudo coloring processing of graphical images has been implemented by using MATLAB and the images that we referred (gray scale) and convert into color are taken from x-rays, digital images and satellite images.

7. Conclusion

In the proposed system the color variations for pseudocolor processing of graphical images has been implemented and the results were analysed. The input graphs considered are random graphs. Colorization improves the perceptibility of grayscale image to great extent. The method of grayscale image colorization is proposed here with help of color variations. The technique helps to overcome the assumption of having source color image size bigger than the target grayscale for colorization algorithms given in earlier approaches.

Resultant image:

Fig 5: a) Grey scale image (b) RGB image c) CMY image

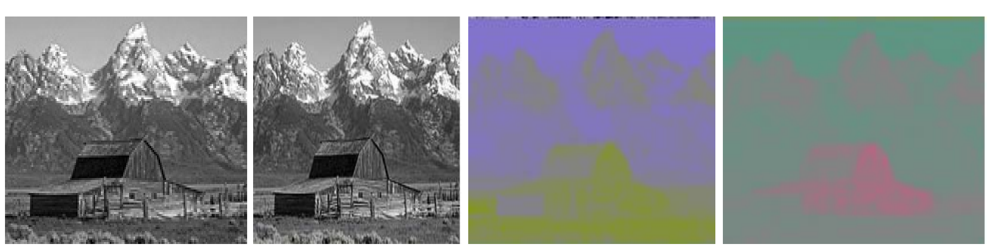

Fig 6: a) Black &white image b) Y image c) Cb image d) Cy image

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