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Research paper

A Color Map for Pseudo Color Processing of Medical Images

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Abstract

A color map is one which converts the colors of one image to the colors of another image. This paper says about a color map for pseudocoloring of medical image which converts gray scale medical images to color with the already existing color map. Converting a black and white image to color has no correct way or method, this method provides a direct way to choose, Red, Green and Blue (RGB) colors to individual components, but the color map conversion is done by converting the entire gray-scale image to color. By creating a color map then the color map is to be used to color the medical gray scale image. This method is applied for gray scale medical images such that the perception and quality of the image can be improved.

Keywords*: Color map, pseudocoloring, RGB images, and medical images.*

1. Introduction

Pseudocolor image processing is one transforms colors' to gray scale image based on particular criteria or method. By coloring an image certain feature can be identified easily by the observer because human eye can identify thousands of color shades instead of few gray shades. This can be done by use of color maps. These gray scale images are useful in medical imaging, in which body parts or organs are captured. Thus the images produced are with low contrast. So conversion of a gray scale into color the increases the visual clarity and can be understood easily.There are many types of medical images computed tomography (ct), mammography, molecular imaging, magnetic resonance imaging (MRI), X-radiation called as x-ray are some of the popular technologies in medical imaging [11]. Each imaging is used for its suitable purposes and applications usually come in gray shades with low contrast. So colorization is in need such that the perception of those images can be improved. There are already existing color maps available for color conversion. In this paper jet color map is used for medical images because multiple colors are displayed so that the bones, tissues, and organs are clearly visible and the defect can be found out clearly so colorizing of images is done

2. Related Work

Jamil and Hussein [1] proposed a color map to convert a gray scale image to color in which color map reduces the human work to choose RGB colors individually, the color map converts the entire black and white images into color, the color matrix is flexible such that it is easy to modify and use it again.
Sneha and Monika [2] used color map for clustering of pixels which is used in image segmentation this color map is also used for clustering purpose. By finding out the labels of an image the color map is obtained. To get accuracy in segmentation different window sizes with window based method is used.
Carrey [4] told that default color maps reproduce confusing color maps for color images he proposed a color map which automatically produces a aesthetic color map for grayscale images. Michelle ,Krzysztof Z [6] in his work Evaluated the Artery Visualizations for diagnosis of Heart Disease showed a real world example of rainbow color on users task, but also a way for counter this issue to users how color impacts the performance of task.
Asha**l,** &Krishan [8] proposed a method to improve a gray scale image using Fuzzifications by improving the pixel value. His approach enhanced the contrast and the noise is removed to increase the quality of image.Jaspreet,Amita [10] presented Several Contrast Stretching methods for Leukemia Images the methods used in his paper were global, local, partial, dark, bright contrast stretching methods and is used on leukemia images. This method improved the contrast of image and the images are better.

3. Methods

3.1. Image Enhancement

The main cause for enhancement of an image is to enhance an image that it is more appropriate for particular application. Image enhancement is grouped into two ways enhancement in spatial domain and enhancement in frequency domain enhancement[5] in Spatial domain refers to plane of the image itself and the approach is based on the direct calculation of pixels. Enhancement in Frequency domain is based on changing Fourier transformation of an image.

3.2. Enhancement in Spatial Domain:

The word spatial domain means combination of pixels of an image. Spatial domain method is denoted by h(a,b) =P[k(a,b)] where k(a,b) input image and h(a,b) is the image processed., P is the operator defined on k, defined in neighborhood of (a,b).

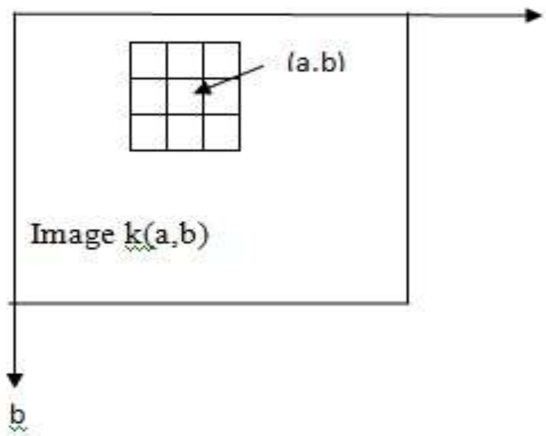


Fig 1: 3x3 neighborhoods in an image in spatial domain

3.3. Basic gray level transformation:

There are 3 basic types of function used for enhancement of an image linear, logarithmic and power law as shown in figure 2.

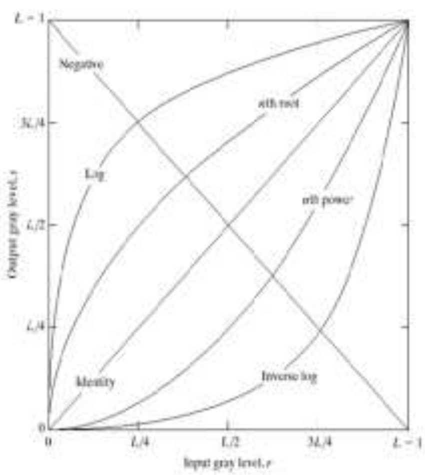


Fig 2: Intensity transformation function

3.4. Linear Transformation

The linear transformation is called as negative and identity transformation. The negative of the gray image is in limit [0, L-1] and is got from negative transformation in figure which is represented as S=L-1-r.this type of processing is used for enhancing white or gray level in dark.

3.5. Log Transformation

The log transformation is generally represented as S=c log (1+r), c is constant and r≥0, is shape of log is in figure this type of transformation is used for pixels dark shade in an image by the compression of high-level values.

3.6. Power-Law Transformations

The Power law transformation is expressed as $s=c(r+\varepsilon)^{\gamma}$ where c and γ are positive constants ε plot of this curve is represented as in figure this is used for contrast manipulation for general purpose.

3.7. Contrast Stretching:

Images which has less contrast had poor illumination, lack of contrast so to overcome this we go for a method called has contrast stretching. Contrast stretching is a way in which we expand the value of the intensity level of an image [10].

4. Conversion of Color:

Color conversion is the method of changing the gray scale image into colored image. Different methods for conversion of color exits. This can be done by use of color maps. A color map [13] is in matrix of range 0 and 1 which says the colors for surfaces, images, and patch objects. MATLAB [9] draws the graphics objects by representing values of the data's to color in the color map. There are already predefined color maps in Matlab.

4.1. Coloring Methods:

Bone:
Bone is a color map with gray scale in which blue color has a higher value. Bone color map is helpful for adding an electronic view to grayscale images as shown in figure 3

Fig 3: The bone color scale

Jet:
Jet [15] spans from blue color to red color, and goes from cyan, yellow, and then to orange. 256 colors can be applied to jet color map.jet is used where we are in need of multi colors.

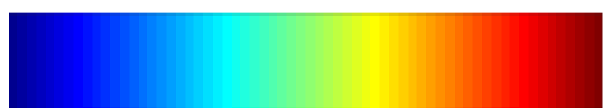


Fig 4: predicts the jet color scale

Summer:
Summer color map has tones of yellow and green as in figure 5.

Fig 5: The summer color scale

Winter:
Winter color map has colors that are tones of green and blue as in figure 6.

Figure 6: The summer color scale

5. Pseudocoloring

Pseudocolor image processing [14] is one which converts gray values to colors based on particular method. The word “Pseudocolor” indicates that the colors are assigned unnaturally opposing to the real colors. The main purpose of Pseudocolor is used for clear human perception and clear gray scale details on an image. Intensity slicing and Gray level to color transformation are two ways in which pseudocoloring is done [5].

5.1. Intensity Slicing:

An image is considered as a 3D spatial coordinates to intensities which is considered as heights. Planes are placed at particular levels side by side to the coordinate plane. If range is one side of such a plane one color is shown, and a different color is shown on another side.

In short intensity slicing can be represented as, [0, L-1] is grey scale L- 1 represents white [f (x, y) = L-1], 0 represents black [f (x, y) = 0].Suppose P planes are vertical to intensity axis are defined at levels l1, l2,LP. Assume that 0 < P < L-1the P planes divides the grey scale into P +1intervals V1, V2, VP+1. Grey level colored value is where *Vk is in* partition planes at $l = k$ –1and $l = k$, *ck* is the color with the *kth* intensity level.

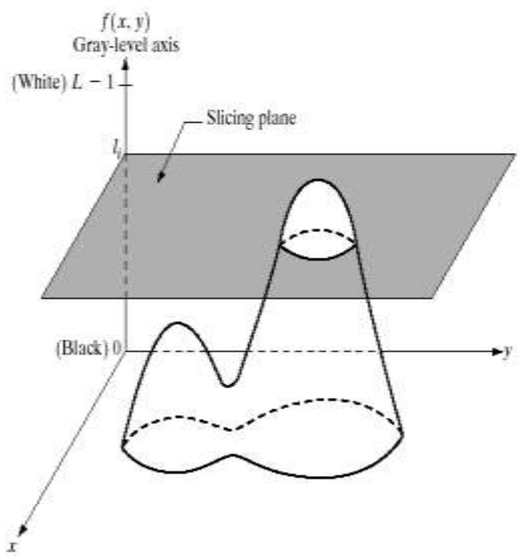


Fig 7: Intensity Slicing

By using this method we divide Intensity range into number of intervals and for particular location we assign color to intensity image which is obtained by intervals, is Pseudo color image which we slice the intensity levels and to that various slices we assign various colors.

5.2. Gray Level to Color Transformation

Gray Level to Color Transformation is done to achieve wide values of pseudo color enhancement. Three level independent transformations are performed on gray levels values for any input pixels; these values are sent separately into the red, green, and blue channels of a color television monitor. (Fig. 8) this can be based on smoothing, nonlinear functions, which based on a single monochrome image. Various degree of enhancement is obtained (Fig.6.24) by changing the frequency and phase of the gray scale.

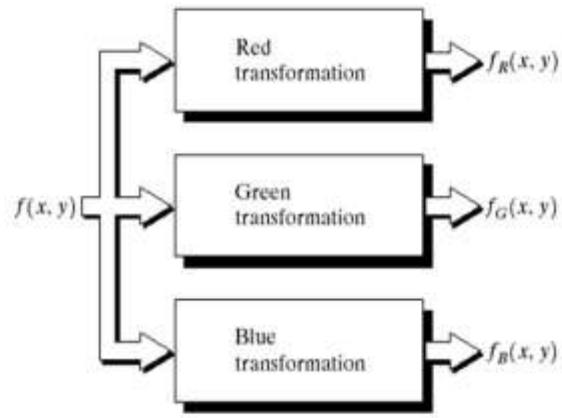


Figure 8: Block diagram for pseudocolor image processing

6. Proposed Method

A colormap is one which changes its value of one source image to another target image. There are many colormaps which already exists jet colormap is used for medical images because Jet is appealing because it is attractive, bright colored, and we need not consider about the color scale: even though we have just a few details, we still get "all the features" in our plot.: jet practically never lacks contrast.

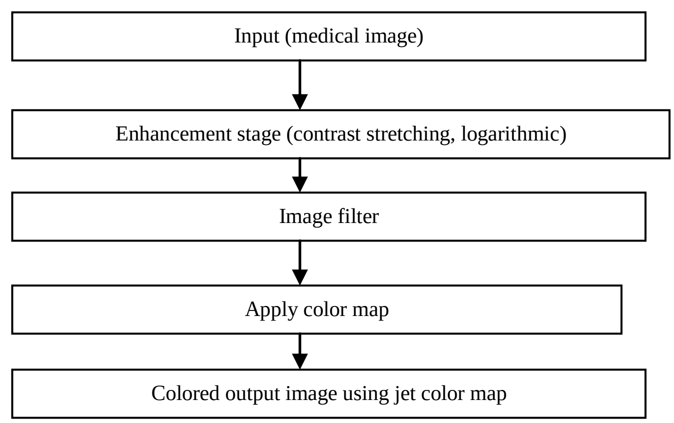
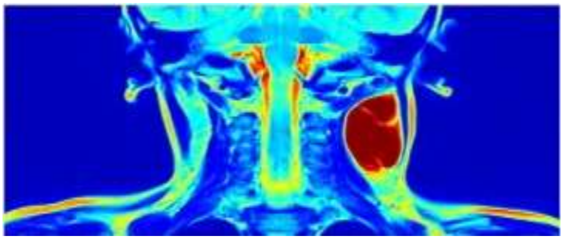


Fig9: Flow chart for the proposed work.

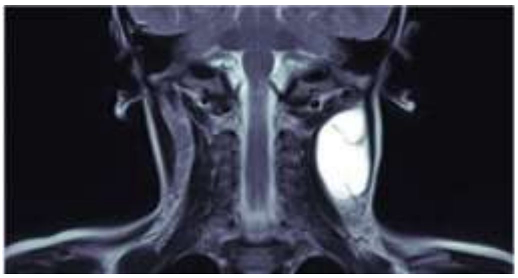
The figure 9 says that we get medical images as input, and then the enhancement stage is done which is contrast stretching and logarithmic, image filtering is done to remove any unwanted noise in the image, then we apply our jet colormap,and finally we get the colored image using the jet color map.

7. Simulation Results

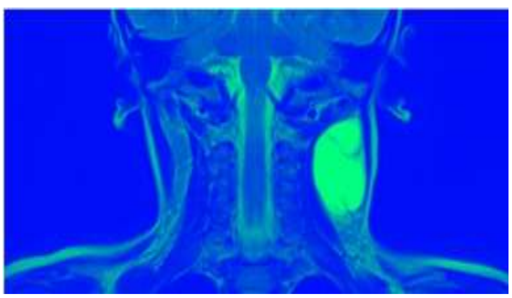
In this section, we present experimental results of applying our pseudocoloring the medical images using different color maps. The images are obtained by using DICOM [3] viewer and converted into jpeg format. DICOM viewer is Digital Imaging and Communications in Medicine (DICOM) is a format for storing and sending medical images which enables the combination of medical images which stores MRI, CT, ultrasound images along with patients details in one file.. The colormaps used are JET, BONE, summer, winter. Our experiments are explored in two ways one way is that the values are compared by histogram of the particular image and the other one is time taken by different colormaps. For the first, method we compare different histogram values of the colormaps for the second approach we calculate time taken by, each method to execute is shown in Table 1 and Table 2.Table 1 and Table 2 says about the comparison of the different color maps, time taken by various color maps. The proposed method is done by using MATLAB.



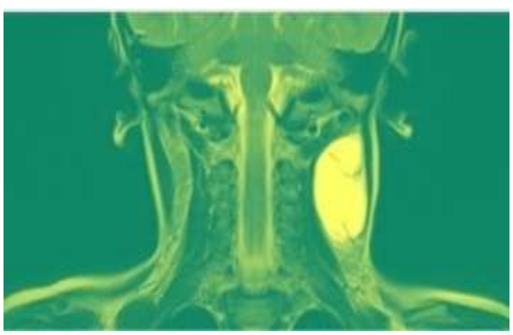
(a)



(b)



(c)



(d)

Figure 10: a) Original image, Pseudocolor using b) jet c) bone d) winter

From the figure 10 it is clear that jet colormap produces multiple colors, figure b says about the bone color map which has only colors of blue and gray shades. Figure c give a prediction by using summer color map which get colors of blue and green and then by using summer colormap we get shades of yellow and green. The proposed method gives significant results that jet color is best when compared to other color maps and the perception of image is clear in jet colormap. Because color is a way which an image can be perceived clear. The comparisons are done by using histogram [12] values of color maps which is shown in table 1.

Table 1: Comparison of color maps using histogram.

Images	Size of the image(KB)	JET	BONE	SUMMER	WINTER
1	81.8	(16,2), (20,1)	(18,8), (9,4)	(90,10), (92,3)	(33,4),36,2)
2	59.4	(7,1)	(14,10)	(72,5)	(36,3),20,4)
3	47.6	(13,1)	(17,13)	(82,9)	(20,5)
4	35.6	(10,2)	(19,12.3)	(80,12)	(18,3)
5	60.8	(10,3)	(31,15)	(43,64)	(19,21)
6	39.8	(6,1)	(10,19)	(90,21)	(21,6)
7	37.4	(14,15)	(21,34)	(1,9)	(35,43)
8	38.3	(20,17)	(20,8)	(18,12)	(22,13.8)
9	41.5	(0,5)	(15,20)	(80,23)	(22,3)
10	36.4	(15,1)	(3,5)	(82,23)	(93,32)

Table 2: Time taken by different color maps

Images	JET(Sec)	BONE(Sec)	SUMMER(Sec)	WINTER(Sec)
1	1.392	1.258	1.745	1.021
2	1.089	1.198	1.209	1.288
3	1.157	1.289	2.248	1.251
4	1.148	1.301	1.180	1.389
5	1.319	1.341	1.609	1.139
6	1.140	1.300	1.591	1.351
7	1.371	1.448	1.037	1.252
8	1.259	1.340	1.088	1.519
9	1.349	1.248	1.091	1.222
10	1.070	1.350	1.062	1.270

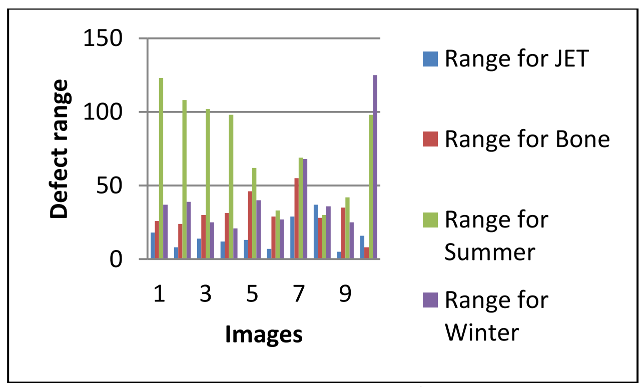


Figure 10: Graphical representation for color maps.

In the above graph x axis represents the image y axis range at which defect will be identified as shown in figure 10.

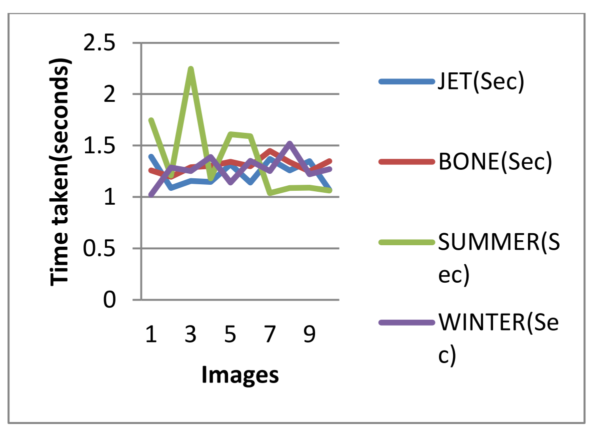


Figure 11: Time taken by different color maps.

Graph 2 says about the time taken by each color map which is clearly says time taken by Jet color map is less when compared to other methods such as bone, summer, winter is shown in figure 11.

8. Conclusion

This paper presents a pseudocolor method for coloring and enhancing a grayscale medical image into color. The color improves the quality and perception of the image and visual quality is also clear. The proposed algorithm generates a color map from a gray scale medical image. The quality of the generated colormaps jet algorithm showed the better performance in terms of metrics as well as in terms of visualization. This proposed approach can be used for low contrast images too. The reason jet is best when compared to other color maps is that the chromaticity and luminance for visualization of image is best when compared to other colormaps.

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