

Enhancement of Medical Images Using Various Pseudocoloring Techniques

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Abstract: A medical image is one which is used for picturing the internal parts of the human bones, tissues, body parts which used for clinical examination and treatment of patients. Medical imaging is used in field of radiology, optical imaging and image guided surgeries. Applications of medical images have been increased remarkably for investigation of diseases. To improve the clinical efficiencies of a medical image enhancement of an image plays an important role for analyzing an image. Image enhancement is used to gain or improve the precision of an image. The approach that we use in this method improves the visual perception and the quality of the image is increased. By enhancing an image it has better performance results than the original image. One way of enhancement of image is to add colors the image. One such method of colorization of images is pseudocoloring. The major advantage of this method is that the luminance and chromaticity of the image is improved.

Keywords: Medical image, image enhancement, perception, pseudocoloring.

I. INTRODUCTION

In Digital image processing image enhancement[1] is a way by which we can visually improve the quality or the perception of the images. Those types of methods are useful for medical and satellite images. Because the images that we get from the medical images are mostly black and white in color. Color is the best way by which an image can be improved. Medical images are very important for identification of the defects of the internal organs. We can get those images by means of CT, MRI, X-ray; etc. Medical imaging is a way in which the different parts of human body such as bones, tissues, organs are useful for doctors to analyze the disease of the patients and it's useful for treatment to patients. These imaging methods are used in Radioscopy, optical tomography surgeries which needed guidance using images etc. The perception of human eye is that it can differentiate only a few shades of gray but can identify million or trillions of color so it is it important that we need colored images. Thus for clearer view of the image and for better understanding we are in need of coloring them.

Revised Manuscript Received on March 25, 2019.

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Adding direct coloring of the images leads to change in the content of the images. So we are need of some methods for coloring images. One such method is Pseudocoloring. The main objective of this paper is to add colors to the medical images by using various pseudocoloring techniques without loss of information. The final image obtained by this method is applied to medical images irrespective of the size of them.

II. EXISTING METHODS

A. Gray scale image:

Grayscale image is the representation of the ranges of gray shade without apparent color. The color present in this type of image is in shade of gray and white. Gray scale image [2] produces few light sources. The Images that are produced through grayscale image is mostly in black and white in color. The figure 1 says about the grayscale images that are few shades of black and white in color. An example of such type of image is shown in figure. Gray scale image contains value of one or more color image. Gray scale image contains information only on brightness but it does not contain any information about the color. The gray scale intensity value of black color image is at weakest level while white color has strongest level intensity value. The pixel value of gray image is 8 bits per pixel, and the value of image is from 0 to 255 which represent brightness value.

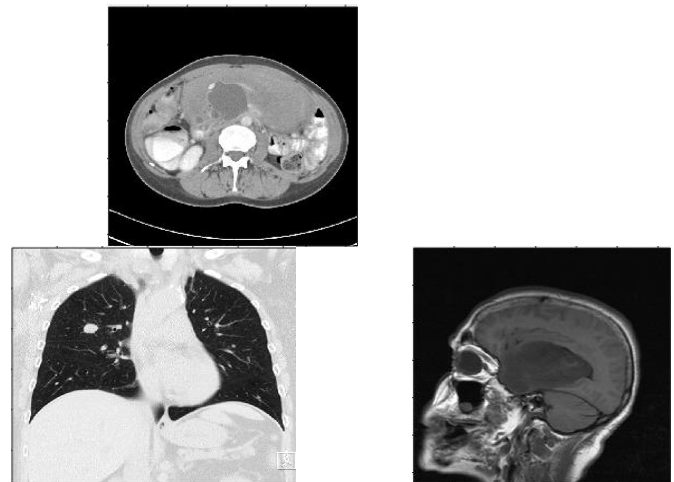


Figure 1: Representation of gray scale images

The application of gray scale image is used in satellite images, aerial images, medical images and photography.

Color scales:

Conversion of color is the method or approach in which we can convert the image based on specific color scales. This is done for converting a gray scale image into color. There is various methods for color conversion. Color conversion can be done by using color maps. A color map is a set of colors used to map the data pixels to the value of the color of the image. These maps can be applied to surface of the image, color patches and surface of the image.ays the colors for surfaces, images, and patch objects. These color maps exists already in Matlab [3] which is predefined already.

Some of the existing colormaps are JET, Bone, summer, winter, autumn etc.

Bone:

The bone color map is one in which the blue color has higher value. This bone color map is used for the grayscale image. The image obtained by this color map is in the electronic view. The representation of the bone color map is as shown in figure 2.



Figure 2: The bone color scale

Summer:

The summer colormap consists of value of shades of yellow and green. This is as shown in figure 3.



Figure 3: The summer color scale

Winter:

The winter color map consists of shades of green and blue. This is as shown in figure 4.



Figure 4: The winter color scale

JET:

The JET color map is otherwise called as rainbow color map because the jet color map uses array of colors from blue to red, from cyan to yellow and then to orange. Jet spans from blue color to red color, and goes from cyan, to yellow and then orange.256 colors are used or applied in Jet color map. This color map is useful when are in need of applying multiple colors. This is as shown in figure 5.



Figure 5: The Jet color scale

Masking:

Masking an image is a way in which we divide an image from its background by which the particular part is split into a different background. A mask is also known as filter. Masking [4] is used for filtering an image. Binary masking is useful for binary images where the pixel value is 0 within the intensity and remaining portion is non-zero. We can also mask an image by using Region of Interest (ROI). ROI of the individual part of the image can be masked. Thus we can also mask the image by using ROI.

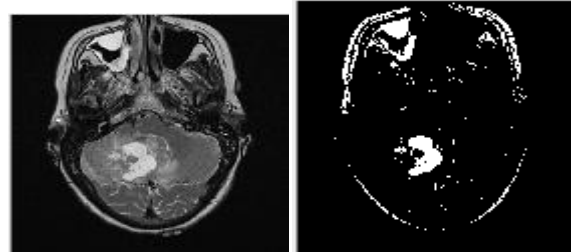


Figure 6: a) Original medical image b) Masked image

Importance of masking:

We need to mask an image because when we are in need to split or edit some part of the image that particular part alone can be masked or clutched[5][6].The representation of such an image is in figure 6. The figure 6 (a) says about the MRI image, and 6 (b) image after masking. Suppose some pixels in the image needed to be white in color. An example where masking is used when some white parts of the medical image are needed but it may not be visible; to get a clear picture we are in need of masking. Because a defect can be even on a small white portion in a medical image to get a clear picture of the white part masking can be used.

Binary masking:

The region of interests (ROIs) of the image can be done by using binary masking. If the range of the masked pixel is 1 it says the value of pixel, if the masked pixel value is 0 it says about the image which belongs to ROI.



The pictorial representation of intensity slicing [8] is as shown in figure 8.



Figure 7: a) Gray scale image b) Binary masking using ROI

Any type of binary images can be masked [16], which is in figure 7(a), (b).

Morphological Structural Element and Dilate (MSED):

Morphology based image processing says about the image processing which is based on shapes. Operations done on morphological image processing is applied to a structural element of the input image, by which the image created by output is the same size of the input image [7]. The value of the output is done by the comparison of each pixel. There are many morphological operations but the most common one is dilation and erosion. In Dilation pixels are added to the object boundary of the image meanwhile in erosion the pixels of the object boundary is removed. The addition or removal of pixels depends upon the size and shape the structural element which is used for image processing.

Uses of morphological operations:

The shape of the objects can be changed by using nearby operations. For post processing in segmentation unwanted effects can be removed. Objects can be linked; holes can be filled in object thinning etc.

Pseudocoloring:

Pseudo color image processing is a way in which we assign colors to grey scale image based on a particular standard or method. The term "Pseudo color" means that the colors are added unreally. The main purpose of this Pseudo color method is that it used for the better human perception and understanding the minute details of gray scale image. Intensity slicing and grey level to color transformation are two ways by which pseudo color image processing is done.

Intensity slicing:

An image of 3D function of image intensities is assigned as height. Planes are assumed at specified level of coordinate plane. The range of one color is obtained in one plane and different color is obtained at other side of the plane.

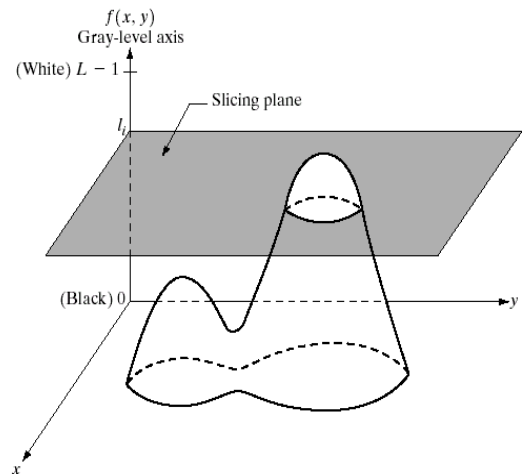


Figure 8: Intensity Slicing

In short intensity slicing is represented as, $[0, L-1]$ is grey scale $L-1$ represents the white color $[f(x, y) = L-1]$, 0 represents black color $[f(x, y) = 0]$. Suppose P planes are vertical to intensity axis are defined at levels l_1, l_2, \dots, l_P . Assume that $0 < P < L-1$ the P planes divides the grey scale into $P+1$ intervals V_1, V_2, \dots, V_{P+1} . Grey level colored value is where V_k is in partition planes at $l = k-1$ and $l = k$, c_k is the color with the k th intensity level.

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

Grey level to color assignments:

For a wide range of enhancement of pseudocolor image Grey level to color assignments is done. Three independent transformations of gray levels are done and are given separately fed into red, green and blue channels. This is based on a monochrome image. Input image is represented as $f(x,y)$. and three independent color transformation are fed namely red, green and blue and the output is $fR(x,y), fG(x,y), fB(x,y)$. Figure 9 says about the block representation of pseudocolor image processing.

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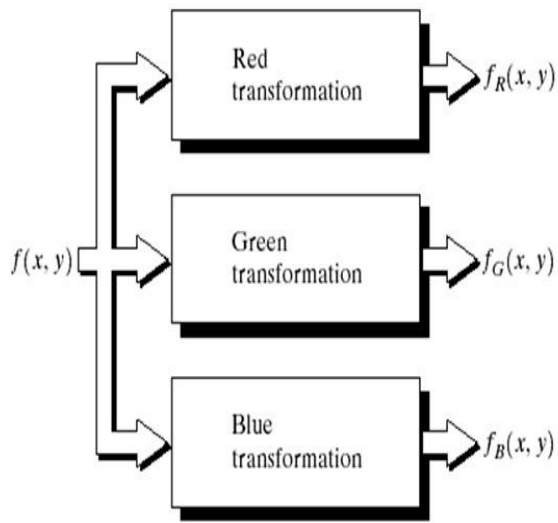


Figure 9: Block diagram for pseudocolor image processing

III. Literature Survey

Jamil and Hussein [2] suggested a method to convert a gray scale image to color in which color map reduces the human work to choose RGB colors separately, this color map converts the whole black and white images into color; the color matrix is adaptable that it is easy to modify and use it again.

Sneha and Monika [3] uses color map for clustering of pixels in their approach which is used for segmentation of image this color map is also used for purpose of clustering. By discovering the labels of an image the colormap is obtained. To get accuracy different size of windows are used with window based method which is used for segmentation.

Jaspreet, Amita [9] proposed Several Contrast Stretching methods for Leukemia Images the stretching methods used in their paper were global, local, partial, dark, bright contrast stretching methods and is applied on leukemia images. This proposed method improves the contrast of image and produces the better images.

Boopathi and Thiagarasu [4] put forward a segmentation of masking methods in colour images in their method the novel segmentation method is combined in the form of masking, thresholding and noise removal methods. The methods used is Otsu method which is used in color image segmentation for thresholding. This approach used different merging of masks which scans over to find out the boundary and makes the work easier.

Ahmed B Salem [10] suggested about analysis of gray level and RGB channels of an image on brain tumor images. The speed of processing of image is done by means of separating the colors of the image. Segmentation and binarization is applied to red, green, blue color of the original image for detection of object this method is used for different MRI images.

Hua, Chuanbo, Shaohong, Shengrong [8] conferred new method for segmentation of MRI brain images by using

pseudo-color based segmentation with Non-symmetry and Anti-packing Model with Squares (NAMS). The gray scale MRI image is converted into colored MRI by pseudocoloring. The content of the image is not changed and data redundancy is reduced and storage space is less.

Prezmyslaw, Bogdan [11] said about colorization of medical images which converts the gray scale medical image into color by which the visual appearance of the image is clear. The approach used is luminance keying and motion estimation. The result obtained is there is no change in intensity of the original image without chromaticity component.

Shah, Mikita, Shah [12] in their method of colorization for medical images is done by an optimized technique where the appearance of image is clear and improved. The results obtained by this method, there is no change in the content of the original image without any difference in intensity.

Ugrasenamaharaj, Syeda Sana [13] presented a method for region of interest which is based on advanced image compression technique which can be used for telemedicine system. In their method the process is based on encoder and decoder using region of interest using discrete wavelet transform. The region of interest is vital because it says about the area of diagnosis of diseases. This method is mainly used in assistance of telemedicine system where data storage is reduced.

Priya, Kadhar [7] in their paper told about morphological image processing technique which is used for reconstruction of image the approach used is to process the pixel which is based on dilation for erosion. The morphological image processing is useful for removing undesired details and reconstruction of images.

IV. Proposed Method

In the proposed method we present three ways of pseudocoloring implementation. They are **Color map using JET:**

A colormap consists of change in its value from source image to target image. There is variety of colormaps which already exists such as jet, summer, winter etc. we use jet colormap is because Jet is interesting because it is attractive features, colors are bright and many colors can be used and it not necessary to think about the color scale. Just a fewer details is enough to get the features within the plot. jet colormap never loses contrast. This is done by contrast stretching [9]. The figure 9 says about the input medical images, and then the output image is the jet colorization using pseudocoloring which is done by image enhancement methods such as logarithmic and contrast stretching and to remove the unwanted noise in image filtering is done. Then we apply the jet colormap and get the colored image.

Colored Binary mask of image

An image is a way in which we observe the visual appearance of a particular thing. Those information can be collected and be stored such a thing is a image. In medical province it called as medical images these medical images are used for visual observation of the human bones, body, tissues etc; because it's internal features cannot be seen by naked eye or directly so we are in need of using medical images. The types of medical images are MRI, CT, and X-ray is mostly in black and white. Color is a way in which we can enhance an image. Because our human eye can distinguish millions of color but only fewer shades of gray. So we are in need of colorizing the images. This can be done by means of pseudocoloring [8]. If coloring is done just like to the whole image then the information might be lost or can be a cumbersome one. So some part or portion of the image can be edited and colored one such way of approach is masking. In our method the implementation of the colorization is done by the following approach. The medical image is retrieved from DICOM viewer the original gray scale image is converted into Red Green and Blue (RGB) image in gray scale toolbox, and the RGB channels are applied, to white parts of the medical image and binary masking is done for particular part and then individual RGB channel is obtained, and then the coloring is done on the masked area. This type of segmentation falls under region based segmentation [15].

Colorization using desired color:

An image is a representation of the internal or external form of a particular thing in form of picture. The information which is needed is collected form of pictures. In medicinal field images are used for diagnosis of disease in patient for defects in bones, organs, tissues etc which cannot be seen by naked eye so we are in need of medical images. So these type of images can be perceived by MRI, CT, X-ray [1] etc and the images which is got from those ways are mostly in gray scale format. So to get a clear view we are in need of colorizing the images because human eyes can percept only few colors of shade but can identify millions of colors. So we are in need of coloring it. This is done by a method called pseudocoloring [9]. Coloring the entire image can be difficult because the image can be changed so we are selecting a particular area by masking using the Region of Interest (ROI) [13].the gray image is got from DICOM viewer. Then we will extract the individual RGB channels [5], color specification is done then we will recombine the separate color channel into a single RGB image then finally the colored medical image is obtained. The process of the proposed work is shown in flow chart.

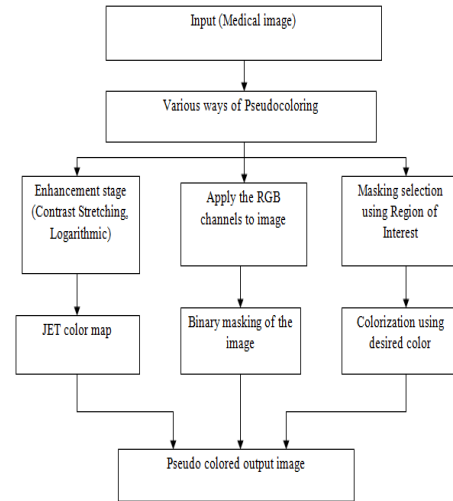


Figure 10: Flow chart for various Pseudocoloring techniques.

The work flow is shown in flow chart. The flow chart for the enhancement of various pseudocoloring techniques is as shown in figure 10. The methods used are color map by JET, colored image by using binary mask, colorization by using desired color using Region of Interest.

V.Simulation Results and Analysis

The proposed approach is applied from images which are collected from hospital and the implementation is done by using Matlab. The images are read by using DICOM viewer [16]. In this approach the Image Processing Toolbox (IPT) [17] from Matlab is used.

The simulation result of the proposed work is as shown in figure 11, 12, 13. In this paper we apply to set of brain images. This method can be applied to different types of medical images. The figure says about pseudocoloring using Jet color map, figure says about pseudocoloring using masking, Figure says about Pseudocoloring using desired color. Table 1 gives the results that are obtained during the simulation of colored images which is carried out using Matlab.

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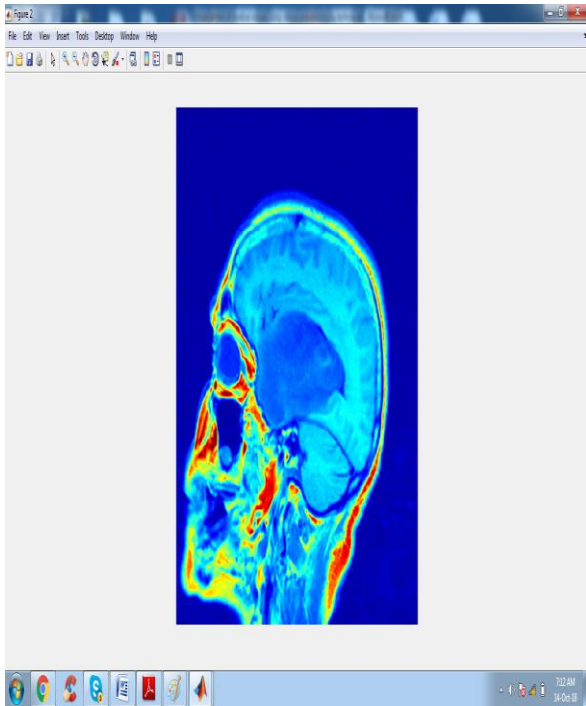


Figure 11: Pseudocoloring using Jet color map

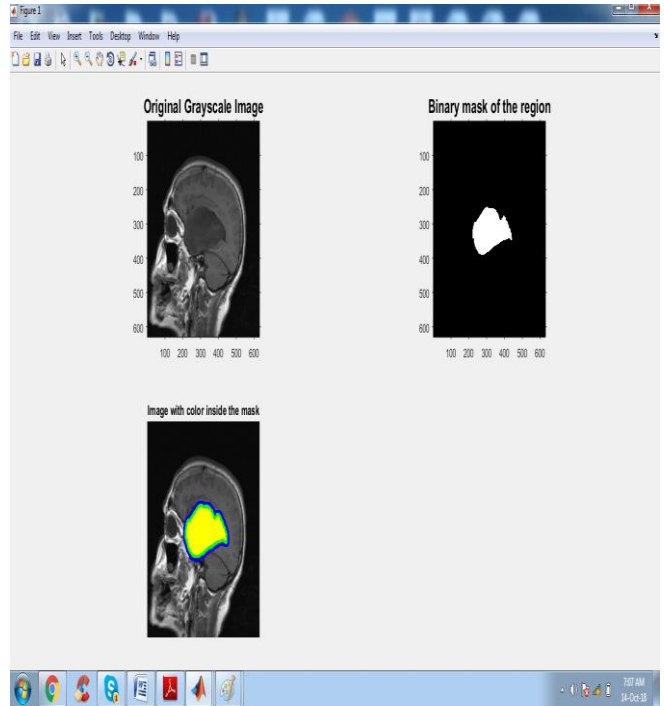


Figure 13: Pseudocoloring using desired color

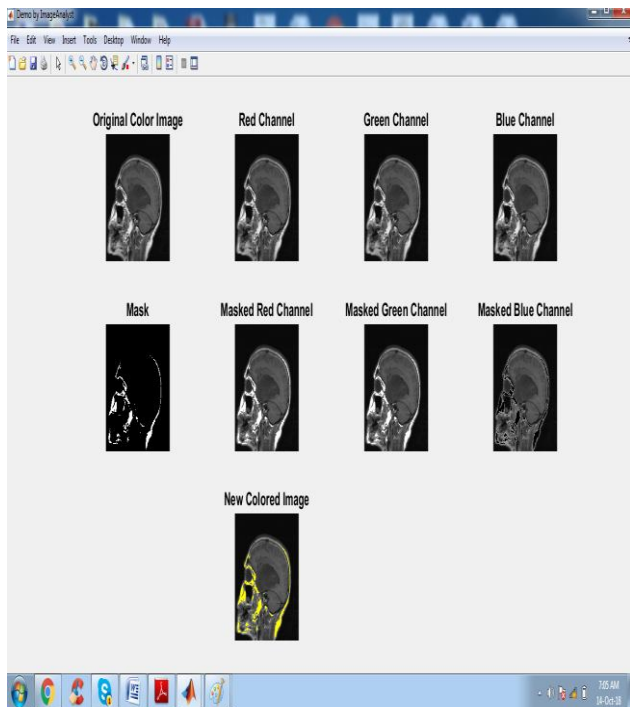


Figure 12: Pseudocoloring using Masking

S.no	Various Pseudocoloring methods	Graphical values
1.	JET	(14,1), (17,2)& (19,5)
	MASK	(5,1) &(4,1)
	COLORIZATION	Y=(6,5),(4,5), (5,5) G=(7,1),(7,2), (6,2) B=(0,0),(0,0), (0,0)
2	JET	(9,4.8), (8,1.2)& (9,5)
	MASK	(0,5)
	COLORIZATION	Y=(5,5) G=(6,3) B=(9,1)
3	JET	(12,4)
	MASK	(0,5)

	COLORIZATION	Y=(5,5) G=(6,2) B=(8,1)
4	JET	(9,4)
	MASK	(18,4)
	COLORIZATION	Y=(5,5) G=(6,4) B=(8,2)
5	JET	(9,1)&(10,4)
	MASK	(8,2) &(9,3)
	COLORIZATION	Y=(6,5) G=(7,3) B=(0,0)

Table 1: Histogram values obtained from brain images

VI. Conclusion

This paper presents a method for enhancement of medical images using different pseudocoloring techniques. By applying this method we get colored image. The output obtained by this method does not give any change in the shape and size of the input image. The proposed approach generates the colored medical images from gray scale images. Thus the generated images enhance the visual characteristic and insight of image is improved. This method can be used for coloring entire image by using jet color map, only white parts colorization using masking and for selecting the defective area using ROI. So we can say that this method can be used for different colorization techniques either for entire image, or a particular portion or part of the images.

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