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A Study on Image Enhancement Techniques using YCbCr Color Space Methods

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***Abstract*— *We propose an image enhancement scheme by using YCBCR color space method. It shows the better feature of the processed input image. The acquired images are classified into three types, word document image, MRI image and scenery image. At first, the acquired inputs are converted to the gray scale to plot with the normalized histogram. Then, using the color space methods, the images are converted into YCBCR characteristics and there components are separated into individual modules(Y, CB, CR components). The processed image separates its in-features of luminance and chrominance components such as Y component, CB component and CR component. In Gray scale image, the Y is said to be the luminance feature also known as single component. In Color image, CB and CR is said to be the chromaticity of blue and red components. Further we find Hue, Saturation and Intensity components are classified from the same samples. Then the proposed technique shows its better performance than the other methods in the enhancement of images corrupted by Gaussian noise. The Experimental result shows that the proposed methods makes good enhancement in visual quality.*

Keywords*— *Gaussian noise, Normalized histogram, Normalized chrominance and luminance, YCBCR components.

I. INTRODUCTION

Image enhancement can be performed for several reasons, producing digital images with good brightness/contrast and detail is a strong requirement in several areas like vision, remote sensing, biomedical image analysis, and fault detection. Producing visually natural images or transforming the image such as to enhance the visual information within, is a primary requirement for almost all vision and image processing tasks. Methods that implement such transformation are called image enhancement techniques [1].

The YCBCR is a technique of color spaces used for digital video and photography systems. Luminance (Luma Y) is the brightness that occurs using black and white gray shades. Chrominance (chroma [CB and CR]) is the color information in a signal mainly concentrated on "YCBCR" either in red or blue signal. Study on human eyes says that, luminance is so sensitive but not the same to the chrominance. Thus the YCBCR color space method makes use of its effect to show the variation of luminance and chrominance by sorting out the modules of the specified images.

Fecker et.al [2] proposed that, significant advances have recently been made in the coding of video data recorded with multiple cameras. However, luminance and chrominance variations between the camera views may deteriorate the performance of multiview codes and image-based rendering algorithms. The best coding results are achieved when time-constant histogram calculation and RGB color conversion are combined. Jing et.al[3] discussed that ,The RGB (three primary colors, red, green, and blue) chrominance information from the dark-field image can be directly converted into the diameters of the GNPs using the relationship between the particle size and the scattering light peak wavelength; this conversion was carried out using Matlab program based on an RGB-To-Wavelength (RTW) process. Morley et. al [4] suggested that , Many of the current and proposed video systems make use of digital encoding techniques. Aspects of this field include image coding, image restoration, and image feature selection. Image coding represents the attempts to transmit pictures of digital communication channels in an efficient manner, making use of as few bits as possible to minimize the band width required, while at the same time, maintaining distortions within certain limits. Image restoration represents efforts to recover the true image of the object. The coded image being transmitted over a communication channel may have been distorted by various factors.

NSCT performed and Kong et.al [5] said that, the grey-scale visible light image is colourised by utilising a reference image, and then, the values of components I, H and S can be obtained via IHS transform, which can separate intensity information from spectrum information of the image. Then the multi-scale and multi-directional decompositions of the infrared image and the component I of the grey-scale visible light image. The red-green-blue colourised fused image is reconstructed by the inverse IHS. Liu et.al [6] proposed that, the multi-resolution decompositions of the intensity of multispectral image and panchromatic image are performed in non sub sampled mode using the three-channel non-separable wavelet filter bank. The approximation images and the detail images of the multi-resolution pyramids are fused. Cantrell et.al [7] suggested that, this parameter has been compared to red, green, blue (RGB) intensity and RGB absorbance along with differences and ratios of both intensity and absorbance and has been demonstrated. The *H* value maintains this superior precision with variations in indicator concentration, membrane thickness, detector spectral responsivity, and illumination. Because this parameter is stable, simple to calculate, easily obtained from commercial devices and bound between values of 0 and 1, it shows great promise for use in a variety of sensing applications .Sun et.al [8] discussed that , A new method of color distance measurement is presented .A novel color edge detection method is designed. The edge information of hue, saturation and intensity are calculated, and the color edge information is obtained combining the component edge information.

In this paper we propose a technique to study and analyse of YCBCR color space methods and we compare with generated results with existing results in section 1. Our proposed algorithm in section 2 produces better results. The proposed system context diagram is presented in section 3. Experimental results are discussed in section 4 and finally the conclusions are drawn in section 5.

II. PROPOSED METHODOLOGY

We propose an approach to the YCBCR image can converted to/from RGB image. There’re several standards defined for the conversion at different context. The conversion below is based on the conversion used in JPEG image compression.

$$\left.\begin{aligned} Y &= 0.299\,R + 0.587\,G + 0.114\,B \\ CB &= 128 - 0.168736\,R - 0.331264\,G + 0.5\,B \\ CR &= 128 + 0.5\,R - 0.418688\,G - 0.081312\,B \end{aligned}\right\} \quad (1)$$

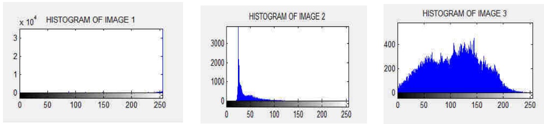
2.1. Initialization

(a) (b) (c)

Fig. 1: some sample acquired images

In Fig. 1: The acquired images are sample images, those are classified into three types, (a) word document image, (b) MRI image and (c) scenery image in Figure 1 and those are converted into gray scale image which is the input for the system.

The normalized histogram is used to classify the acquired images. The histogram is been plotted in 2-dimentional axes. The normalized histogram for the sample acquired images is shown in Figure 2.



(a) (b) (c)

Fig. 2: Normalized Histogram for acquired images

In Fig. 2: (a) Normalized histogram of Word Document Image (b) Normalized histogram of MRI Image and (c) Normalized histogram of Scenery Image.

Normally, the normalized histogram shows the range or the ratio between color range of values from -128 to +128 and also plot the ratio between the gray scale range [0,1]. The range of histogram in the word document image does not show much variation in the slot since its value ranges in gray scale. Whereas the range of histogram in the MRI image shows slight variations in the slot since its maximum value ranges in dark value of gray scale. As well the range of histogram in the Scenery image shows much variations in the slot since its maximum value ranges lies upon the chromaticity values.

2.2. Pre-Processing Stage of YCBCR Components

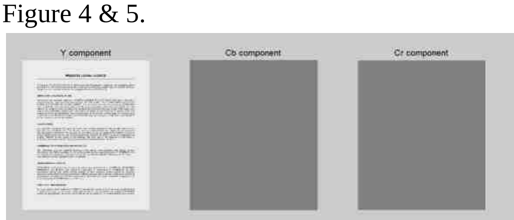
YCBCR is a commonly used color space technique in digital video domain. it is used in image and video compression standards like JPEG,MPEG. The YCBCR technique is used to show the better view of the image reported in Figure 3.

(a) (b) (c)

Fig.3: YCBCR for acquired images

In Fig. 3: The input Images are converted into YCBCR images for (a) Word Document Image , (b) MRI Image, and (c) Scenery Image .

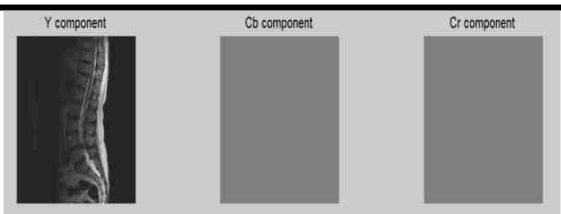
After the YCBCR conversion, the images are iterated to separate the in features of YCBCR components such as Y component, CB component, and CR component shown in Figure 4 & 5.



(a) (b) (c)

Fig. 4: YCBCR Components

In Fig 4: The Word Document Image is classified into (a) Y component, (b) CB component, and (c) CR component.

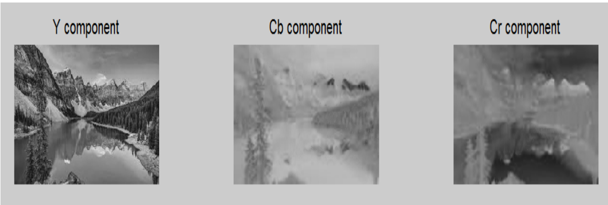


(a) (b) (c)

Fig. 5: YCBCR Components

In Fig. 5: The MRI Image is classified into (a) Y component, (b) CB component, and (c) CR component.

Since the Word Document Image and MRI image are the single component images, which is also known as luminance black and white gray shaded image called as LUMA (Y). Only the Y component signal is visible and color information of CB and CR signal is been hided shown in Figure 4 & 5.



(a) (b) (c)

Fig. 6: YCBCR Components

In Fig 6: The Scenery Image is classified into (a) Y component, (b) CB component, and (c) CR component.

Now , the Colored Scenery Image are classified into single component , which is also known as luminance and Chrominance information which is stored in two different color components called CB (difference between the blue components) and CR (difference between the red components) signals are shown in Figure 6.

2.3. HSI components (Hue, Saturation, Intensity)

We found out Hue, Saturation and Intensity of the YCBCR image and we find the depth, width, and range of three different images. The Hue component describes the color itself in the form of an angle between [0, 360] degrees. Hence 0^o= red, 60^o= yellow, 120^o=green, 240^o=blue, 300^o=magenta. Hue is the angle measure on a color wheel. The Saturation component signals is how much the color is polluted with the white color. The range of the Saturation component is [0, 1]. Saturation is the measure of a color's purity or greyness. The Intensity is used to describe the brightness and purity of a color. When a hue is strong and bright, it is said to be high in intensity. When a color is faint, dull and gray it is said to be low in intensity. The intensity ranges between [0, 1], Where as 0 is said to be black shade and 1 is said to be white shade. [12] Shown in Figure 7, 8 & 9.

The RGB color space can be transformed to HSI color space as Equations (2) ~ (6). The S value of HSI color space can be increased then. At last, the new HSI signals should be transformed back to RGB color space again. However, that scene image saturation enhancement method is a little bit complicated. [11]

$$\left.\begin{array}{l} R = Y + 1.402\,(Cr - 128) \\ G = Y - 0.34414\,(Cb - 128) - 0.71414\,(Cr - 128) \\ B = Y + 1.772\,(Cb - 128) \end{array}\right\} \quad (2)$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)] \quad \text{---- (3)}$$

$$H = \begin{cases} \theta & if\ B \le G \\ 360 - \theta & if\ B > G' \end{cases} \quad \text{----- (4)}$$

$$\theta = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{\frac{1}{2}}}\right. \quad \text{----- (5)}$$

$$I = \frac{1}{3}(R+G+B) \quad \text{----- (6)}$$

(a) (b) (c) (d)

Fig. 7: HSI Components

In Fig. 7: The Word Document Image is classified into (a) Original Image , (b) Hue component , (c) Saturation component and (d) Intensity component.

(a) (b) (c) (d)

Fig. 8: HSI Components

In Fig. 8: The MRI Image is classified into (a) Original Image , (b) Hue component , (c) Saturation component and (d) Intensity component.

Here in the Fig 7 and 8 the Word Document image and MRI image are classified into hue, saturation and intensity components. Since the images acquired are in single component LUMA (Y) , the intensity is alone made visible in the HSI model. The colored features are in the hidden mode.

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(a) (b) (c) (d)

Fig. 9: HSI Components

In Fig. 9: The Scenery Image is classified into (a) Original Image, (b) Hue component, (c) Saturation component and (d) Intensity component. Since the images acquired is color image it has all three representation.

2.4. Comparison of Proposed methodology with existing methodology

As a Pre-process the existing method is being extracted with the values for the Word Document image and Color Scenery image as shown in the table 1and 2 as follows. [11]

Existing method:

Image types	Name	Mean (or) Average for Original Image	SD of Original Image	Mean (or) Average for Proposed Image	SD of Proposed Image
Word document Image	1 (a)	181.13	33.15	242.05	43.67
Word document Image	1 (b)	188.97	31.39	240.58	41.81
Word document Image	1 (c)	159.82	51.24	235.23	48.14
Word document Image	1 (d)	155.14	49.43	236.76	54.89

Table 1: Existing method of Word document image and its calculated values.

Image types	Name	R . SD of Original Image	G . SD of Original Image	B . SD of Original Image	R . SD of Proposed Image	G . SD of Proposed Image	B . SD of Proposed Image
Scene Image	2 (a)	19.62	23.78	28.42	93.94	75.99	75.41
Scene Image	2 (b)	66.66	67.52	68.36	88.38	88.17	100.97
Scene Image	2 (c)	59.99	82.02	75.35	80.85	84.64	76.84
Scene Image	2 (d)	61.83	64.85	68.14	85.05	85.89	105.08

Table 2: Existing method of Scenery image and its calculated values.

Proposed method:

Image types	Minimum value of Probability	Maximum value of Probability	Sum of Image Probability	Mean (or) Average	SD of Original Image	SD of YCBCR Image
Word document Image	0.00000	0.82875	1.00000	238.848	44.006	49.024
MRI Image	0.00000	0.81543	1.00000	43.238	39.173	40.415

Table 3: Proposed method of Word document image and MRI image with its calculated values.

Image types	Minimum value of Probability	Maximum value of Probability	Sum of Image Probability	SD of Original Image	R . SD of Proposed Image	G . SD of Proposed Image	B . SD of Proposed Image
Scenery Image	0.00000	0.85810	1.00000	76.535	61.681	56.051	81.946

Table 4: Proposed method of Scenery image and its calculated values.

2.5. ALGORITHMS

ALGORITHM_1:

BEGIN PRE_PROCESS ( )

Step 1: Initialization
    Input: Image (X)
Step 2: Check if: Image (X) = Gray Image
    Then
    Plot: Histogram (Image(X))
    Else
    Convert: RGB to Gray Scale (Image (X))
    Else
    Image (X): Invalid.
Step 3: Go to YCBCR Conversion ( )

END PRE_PROCESS ( )

ALGORITHM_2:

BEGIN YCBCR CONVERSION ( )

Step 1: Input: Check _ if: Gray Scale (Image (X))
    Else
    Image (X): Invalid
Step 2: If Input: Image (X) = Gray Image
    Then
    Calculate: Probabilities of Original
        Image (X)
    Probabilities: Min, Max, Sum and SD of
        Original Image (X)
    Convert: YCBCR
    Else
    Convert: Aborted
    Image (X): Invalid / check whether it's Gray Scale Image.
Step 3: Image (YCBCR)
    Calculate: Mean, SD of YCBCR Image
    Else
    Go to Step 2.

END YCBCR CONVERSION ( )

ALGORITHM_3:

BEGIN COMPONENTS SEPARATION ( )

Step 1: Check _ if Image: Gray Scale (Image (X))
    Go to Step 2
    Else
    Exit
Step 2: Check if Image: YCBCR Image (X)
    Then
    Separate: Y Component;
        CB Component;
        CR Component;
    And then
    Separate: H Component;
        S Component;
        I Component;
    Else
    Go to Step 1

END COMPONENTS SEPARATION ( )

ALGORITHM_4:

BEGIN ENHANCED IMAGE ( )

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Step 1: Input: Separated Components
Check _ if: Gray Components
Then
Go to Step 2
Else
Step 3
Step 2: Inverse ( )
Check _ if: Gray Scale (Image x)
Then
Separate: Gray 0 and Gray 1
Else
Go to Step 3
Step 3: Exit ( )
Close all;
END ENHANCED IMAGE ( )

ALGORITHM_5:
BEGIN GRAY SHADE ( )
Step 1: Input: New Gray (Image x_1)
Check _ if: Gray Value is (0); then
Color Shade: Black
Else
Color Shade: White
Its Gray Value is 1;
END GRAY SHADE ( )

III. BLOCK DIAGRAM

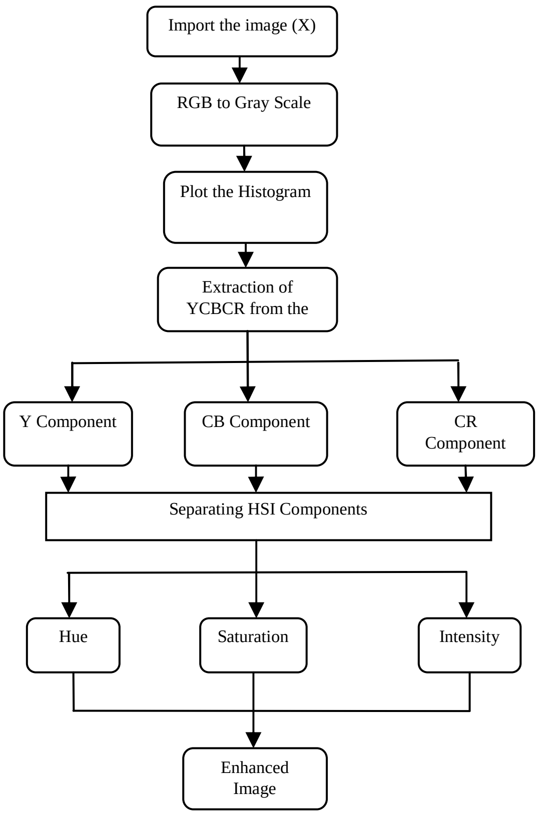


Fig. 10: Block Diagram of Proposed system

IV. EXPERIMENTAL RESULTS

To measure the performance of the enhanced system, we have tested the system with various images. The Gaussian noise with standard deviation σ = 0.1, 0.3, 0.5, 0.7 is added to the original input image. The results are reported in figures Word document image, MRI image and Scenery image. In tables 5, 6, 7 we have shown the MSE, PSNR, and SNR values corresponding to the selected standard images and their pictorial representations are shown in Graphs 1, 2, 3.

The Analysed Results are divided into sub modules called as Y, CB, CR components. Again the images are revised to HSI components separation. Then using the iterative process the components are merged to form gray images. The gray images are separated to gray black and gray white to show the enhanced image retrieval in the form of histogram.

The simplest and most widely used performance measures are peak signal to noise ratio (PSNR) and Mean squared error (MSE). Let f (x, y) and f ' (x, y) are the reference and test images respectively. Let e(x, y) be the error signal between f(x, y) and f '(x, y). It is computed pixel-by-pixel by adding up the squared differences of all the pixels and dividing by the total pixel count. If MxN is the size of the image, then [9]

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\big(e(x,y)\big)^2$$

$$= \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}\big(f(x,y) - f'(x,y)\big)^2 \quad \text{---- (7)}$$

The PSNR quality assessment metric is defined as follows:

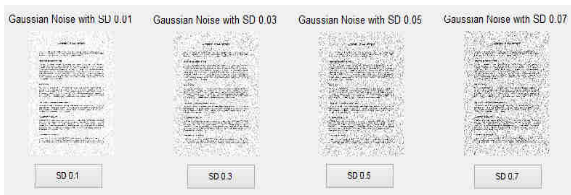
$$PSNR = 10\log_{10}\frac{MAX_1^2}{MSE} \quad \text{------ (8)}$$

Here, MAX_1 is the maximum possible pixel value of the image. The higher the PSNR, the closer the test image is to the original. [9]

SNR compares the level of desired signal to noise ratio. The higher the SNR values, lesser the noise in the image. [10]

$$SNR = 10\log\frac{\sigma_g 2}{\sigma_e 2} \quad \text{------- (9)}$$

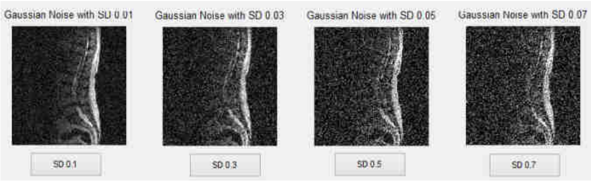
Here, σ_g^2 is the variance of the original image and σ_e^2 is the variance of error between original image and the error image. [10]



(a) (b) (c) (d)

Fig. 11: Added Gaussian Noise to Word Document Image

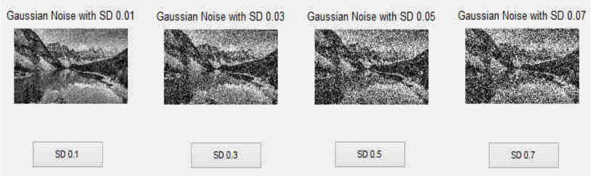
In the Fig 11: The Word Document image is added with Gaussian noise of SD_0.1, 0.3, 0.5, 0.7 in (a), (b) , (c) , (d).



(a) (b) (c) (d)

Fig. 12: Added Gaussian Noise to MRI Image

In the Fig 12 : The MRI image is added with Gaussian noise of SD_0.1 , 0.3 , 0.5 , 0.7 in (a) , (b) , (c) , (d).



(a) (b) (c) (d)

Figure 13: Added Gaussian Noise to Scenery Image

In the Fig 13: The Scenery image is added with Gaussian noise of SD_0.1, 0.3, 0.5, 0.7 in (a), (b), (c), (d).

The variance is been retrieved from the above shown Gaussian noise added images to show the better features of the acquired images.

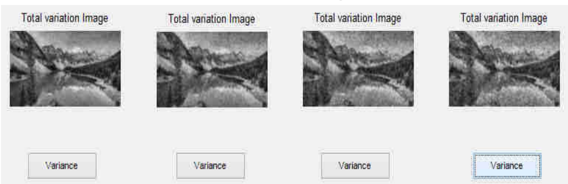
In the Fig. 11, 12, 13 shown that our algorithm enhanced the system without eliminating noise in Word Document Image, MRI image, and Scenery Image.

(a) (b) (c) (d)

Fig. 14: Retrieved variance Image of Gaussian Noise for the Word Document Image

(a) (b) (c) (d)

Fig. 15: Retrieved variance Image of Gaussian Noise for the MRI Image



(a) (b) (c) (d)

Fig. 16: Retrieved variance Image of Gaussian Noise for the Scenery Image

In order to assess that the performance of the proposed system, experiments with the selected images are used. The Results are reported in figure 17. We have used MatlabR2009a Software for our experiment.

IMAGE	WORD DOCUMENT IMAGE			
Method	SD_0.1	SD_0.3	SD_0.5	SD_0.7
MSE	0.054706	0.096489	0.10896	0.11914
PSNR	68.0954	65.631	65.103	64.7151
SNR	65.4388	62.4716	61.8086	61.3169

Table 5: Table showing the result of MSE , PSNR , SNR values for Word Document Image .

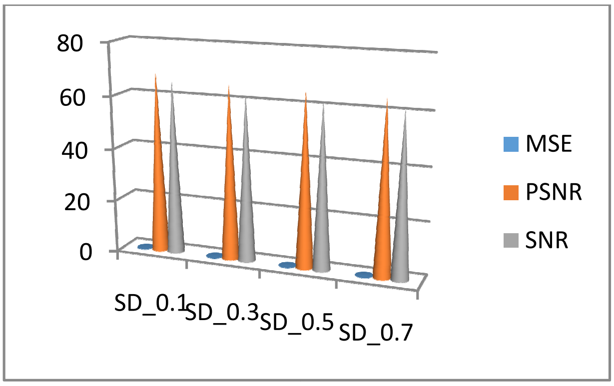


Fig. 17: Pictorial representation of MSE, PSNR, and SNR values of Word Document Image With SD = 0.1, 0.3, 0.5, 0.7

IMAGE	MRI IMAGE			
Method	SD_0.1	SD_0.3	SD_0.5	SD_0.7
MSE	0.12492	0.13711	0.14742	0.15683
PSNR	56.0388	55.6343	55.3194	55.0507
SNR	43.9795	44.5317	44.9602	45.2876

Table 6: Table showing the result of MSE , PSNR , SNR values for MRI Image.

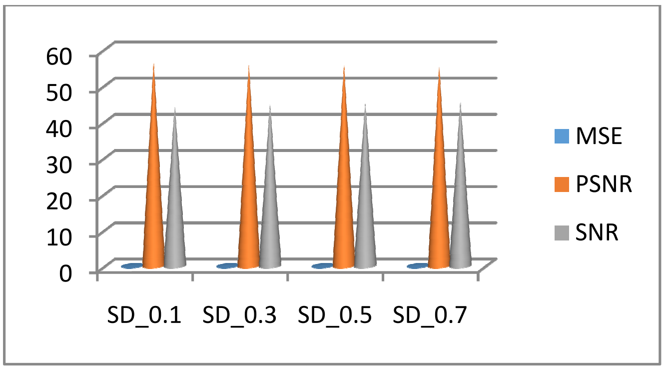


Fig. 18: Pictorial representation of MSE, PSNR, and SNR values of MRI Image With SD = 0.1, 0.3, 0.5, 0.7

IMAGE	SCENERY IMAGE			
Method	SD_0.1	SD_0.3	SD_0.5	SD_0.7
MSE	0.21388	0.21625	0.21789	0.22002
PSNR	51.1526	51.1047	51.072	51.0296
SNR	49.8506	50.115	50.3582	50.5137

Table 7: Table showing the result of MSE , PSNR , SNR values for Scenery Image.

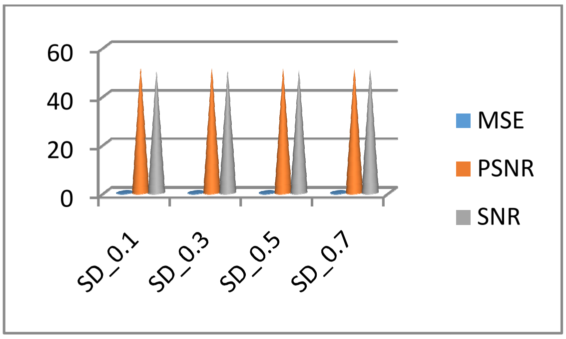
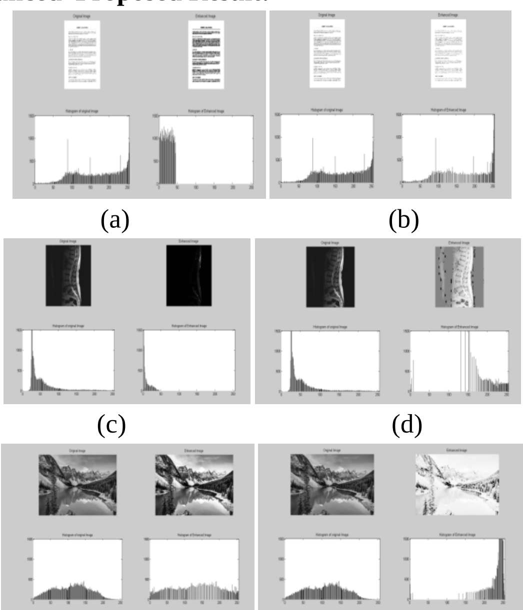


Fig. 19: Pictorial representation of MSE, PSNR, and SNR values of Scenery Image
With SD = 0.1, 0.3, 0.5, 0.7

Based on the proposed method, the enhanced image is been produced on the basis of gray scale lowest resolution , its value is 0 or its scale color is coded with black and highest resolution , its value is 1 or its scale color is coded with white. Here, the light shaded pixels are shown in enhanced manner with white resolution and dark shaded pixels are shown in enhanced manner with black resolution.

Enhanced Proposed Result:



(a) (b) (c) (d) (e) (f)

Fig. 20: Enhanced proposed result

In Fig. 20 (a) The Word document image black of its gray value is 0 (b) The Word document image white of its gray value is 1 (c) The MRI image black of its gray value is 0 (d) The MRI image white of its gray value is 1 (e) The Scenery image black of its gray value is 0 (f) The Scenery image white of its gray value is 1.

5. CONCLUSION

We have presented an Image Enhancement Technique based on YCBCR Color Space method. In our work, we proposed for enhancing Y Component, CB Component and CR component using HSI reference model in features separation. Then we added Gaussian Noise with different standard deviation, and Sharpened the performance of algorithm has been compared with the Existing method. The Experimental results have shown that the proposed scheme as a very satisfactory result.

REFERENCES

[1] Tong, Lijing, et al. "Classified Image Enhancement Method Based on Histogram Characteristics in YCbCr Color Space." Computer Modelling & New Technologies 19.5A (2015): 14-20.

[2] Fecker, Ulrich, Marcus Barkowsky, and André Kaup. "Histogram-based prefiltering for luminance and chrominance compensation of multiview video." IEEE Transactions on Circuits and Systems for Video Technology18.9 (2008): 1258-1267.

[3] Jing, Chao, et al. "Chrominance to dimension: A real-time method for measuring the size of single gold nanoparticles." Analytical chemistry 84.10 (2012): 4284-4291.

[4] Morley, Steven A., and Vijayalakshmi R. Raveendran. "Selective chrominance decimation for digital images." U.S. Patent No. 7,965,775. 21 Jun. 2011.

[5] Kong, Weiwei, Yingjie Lei, and X. Ni. "Fusion technique for grey-scale visible light and infrared images based on non-sub sampled contourlet transform and intensity-hue-saturation transform." IET signal processing 5.1 (2011): 75-80.

[6] Liu, Bin, Weijie Liu, and Jiaxiong Peng. "Multispectral image fusion method based on intensity-hue-saturation and non sub sampled three-channels non-separable wavelets." Chinese Optics Letters 8.4 (2010): 384-387.

[7] Cantrell, K., et al. "Use of the hue parameter of the hue, saturation, value color space as a quantitative analytical parameter for bitonal optical sensors." Analytical chemistry 82.2 (2009): 531-542.

[8] SUN, Hui-xian, Yu-hua ZHANG, and Fei-lu LUO. "Color edge detection based on HSI color space [J]." Optical Technique 2 (2009): 014.

[9] Gopinathan, S., Radhakrishnan Kokila, and P. Thangavel. "Wavelet and FFT Based Image Denoising Using Non-linear Filters." International Journal of Electrical and Computer Engineering 5.5 (2015).

[10] Gopinathan, S., and S. Poornima. "Image Enhancement for Impulse Noise Reduction On Images Using Various Filters."International Journal 4.4 (2015).

[11] Thangavel, P., and S. Gopinathan. "Image enhancement system using wavelet transform and a non-linear piecewise filter." ICGST International Journal on Graphics, Vision and Image Processing, GVIP 11.2 (2011): 1-7.

[12] Digital image processing (2 edition) by Rafael C. Gonzalez, Richard E. Woods., Prentice Hall, and Upper Saddle River, New Jersey 07458.

[13] Gopinathan, S., and P. Thangavel. "A non linear technique for image enhancement based on discrete wavelet transform." European Journal of Scientific Research 79.3 (2012): 328-336.

[14] Gopinathan, S., and P. Deepa. "Enhancement Of Image Segmentation Using Automatic Histogram Thresholding ,"International Journal on recent and innovation trends in computing and communication, Vol 3,Issue 4, pp 1836 - 1872, ISSN 2321 - 8169.

[15] Gopinathan, S., and S. Poornima. "Enhancement of images with speckle noise reduction using different filters." International Journal of Applied Science and sEngineering Research 4.3 (2015): 333-352.