An Enhanced Approach for Image Segmentation with Pre-Processing with Kuwahara Filter

Manpreet Singh Minhas
Research Scholar, Department of Computer Science & Engineering, R.I.E.T , Phagwara (Punjab), India

Varinderjit Kaur
Head of Department of Computer Science &Engineering, R.I.E.T, Phagwara (Punjab), India

Dr. Naveen Dhillion
Principal, R.I.E.T, Phagwara (Punjab), India

Abstract – Medical image segmentation has gained the higher popularity in medical science in order to derive the more reliable and accurate decision on the basis of the medical images. The various authors have considered medical image segmentation as their research domain and has developed different image segmentation techniques. This study introduces the novel approach for image segmentation by using adaptive histogram equalization, kuwahara filters and fuzzy c-mean clustering technique. The objective of this work is to segment the images by enhancing the image contrast. The results of the proposed work are evaluated in the terms of accuracy and the accuracy of the proposed work is obtained nearby 99.5.

Index Terms – Image Segmentation, Contrast Enhancement, Adaptive Histogram Equalization, Fuzzy C-Mean.

1. INTRODUCTION

Enhancement of image is basically processing image to enhance its details and information contained in the image. The deterioration of the image quality is the result of either low quality provided by the device or due to the surrounding conditions [1]. The Image enhancement is the most important phase and the output result majorly depends upon image enhancement. The Image enhancement consists of intensity and contrast manipulation, noise reduction, edge sharpening and filtering etc. Image details can be improved by enhancing the contrast of the image [2]. Dynamic range in the image determines the contrast of the image which is the difference between the low intensity of the image and high intensity of the image. Image enhancement in this work is done by applying the image segmentation and image contrast enhancement.

The procedure of segmentation is to segmenting or dividing the digital image into a number of sections that are known as pixels [3]. After segmentation the resultant image achieved is more instructive, unambiguous and meaningful which simply represents the data there in the pixel [4]. The image segmentation process is used to detect the lines, boundaries and curves that are occurred in the image. The image segmentation provides the output of segmented section or the set of the shapes that are also taken from the image [5].Due to various properties (like color, texture or intensity) the pixels of the image are linked to each other. The image segmentation plays a vital role in the medical imaging. So in the medical imaging various consumers of the image segmentation is illustrated as below [6]:

(a) It is used in measuring the tissue and their volumes

(b) Diagnosis

(c) Studying of abnormal structure

(d) Tumors detection process

(e) Surgery done by using computer systems.

(f) Treatment plans

The other applications of image segmentation are listed as:

(a). Fingerprints recognition

(b). Detect objects in satellite images like mountains, tracks, trees, etc.

(c) Automatic traffic controlling systems

(d) Face recognition

(e) Machine vision

2. PROBLEM FORMULATION

The process of image segmentation is defined as the technique via which a given photograph is segmented into several parts in order to further analyse every of these components present in the photo. In segmentation, without a doubt image is represented in to greater understandable form. Segmentation essentially used to hit upon the gadgets, obstacles and other applicable facts in the digital snap shots. There are exceptional tactics to enforce segmentation like threshold, clustering and remodel strategies etc [10]. The reason for

the popularity of image segmentation is because of its importance in the area of image processing.

The traditional method was applied to segment images and it was found to improve processing speed (which the traditional FCM algorithm failed to do). This also has the advantage of detecting bimodal histograms, such as stones and black beans. The drawback of the traditional work was that it did not apply any kind of image pre-processing mechanism to the input image. Therefore the mage with less sharp edges could become more difficult to segment. Thus there is a need to develop an advanced mechanism that work to enhance the quality of the image before segmenting it.

3. PROPOSED WORK

Image segmentation is important element in many sign processing method and its applications. The segmentation technique is to discover the higher positions of the shape factors consistent with the arrival records. The prime task of the researchers working in the field is to develop a method for efficient and better image segmentation. There are certain factors that affect the process of image segmentation like the intensity of image to be segmented, colour type, less sharpness in edges, issues related to the brightness and the noise present in the image.

In this study we have considered related to less sharp edges. Thus to enhance the sharpness of the image, the proposed work implements the Kuwahara Filters and along with this the contrast enhancement technique is also planned to applied so that the brightness of the image can be preserved and the image become more superfluous for segmentation.

1) Techniques Used

a) Kuwahara Filter

The kuwahara filter is applied to reduce the adaptive noise from the image. The Kuwahara filter is a non linear filter that divides the image into four sub blocks and evaluates the mean of these blocks. The block division is shown as follows:

Figure 1 Block Division of Kuwahara Filter [17]

b) Adaptive Histogram Equalization

This technique is used to enhance the contrast of the image. In this technique, several histograms were computed in order to process the image. The conservation strategy used is Root mean separation which leads up to 100 % conservation. This section shows various images which results of this technique. This technique has various issues like slow speed due to large number of calculations [14]. Consumer electronics like Liquid Crystal Display and Plasma Display panel utilize this technique. Figure below represents the equalized and un-equalized image

The step wise procedure of proposed work is defined as follows:

1. Input Image: the first step is to select an image from available dataset of images for the purpose of segmentation. In proposed work user has the power to select the image for this. The medical images, images of beans, black beans etc are available in the proposed dataset of the images.
2. Pre-processing: After electing the input image, the pre-processing is applied to the input image in order to enhance the quality of the image so that the more enhanced and efficient results can be obtained.
3. Filtration: the pre-processing of the image is followed by the filtration of the image. The kuwahara filter is applied for the filtration. The filtration is done to remove the noisy content from the image.
4. Equalization: the adaptive histogram equalization technique is applied to the filtered image. Then, the more enhanced image is received.
5. FCM: after equalization, the fuzzy c-mean technique for image segmentation is applied. After applying the FCM, the final segmented image is received. The accuracy metrics is evaluated for the purpose of performance analysis.

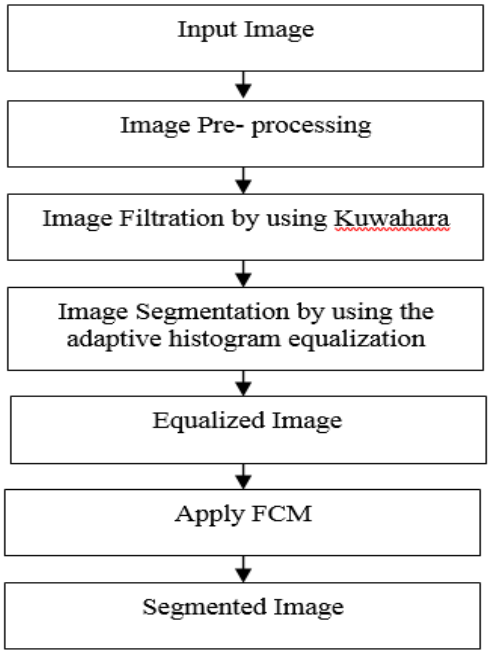

Figure 2 framework of proposed work

4. RESULTS

This section represents the input images that are used for simulating the proposed work. This section delineates the results that are obtained after implementing the proposed image segmentation and contrast enhancement technique in MATLAB. The figure 3 represents the sample images that are used for simulation. The sample images comprised of two types of images one is medical images i.e. images is tooth and stone and other is image of bean, black bean and groundnut.

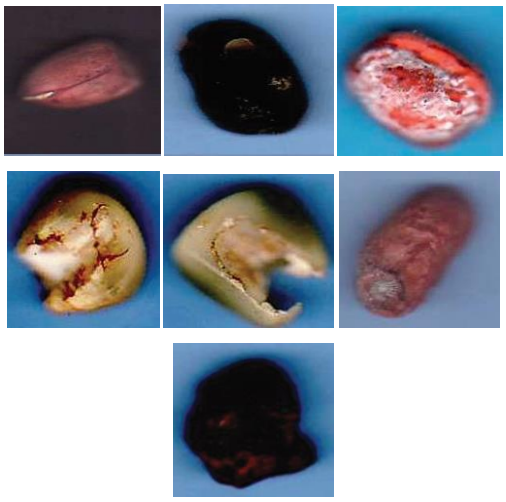

Figure 3 Sample Images for Simulation

The image in figure 4 shows the original image that is used for simulation. Before starting the procedure of image segmentation the first step is to select an image as an input for the purpose of simulation. Thus in proposed work, the system asks the user to select the image.

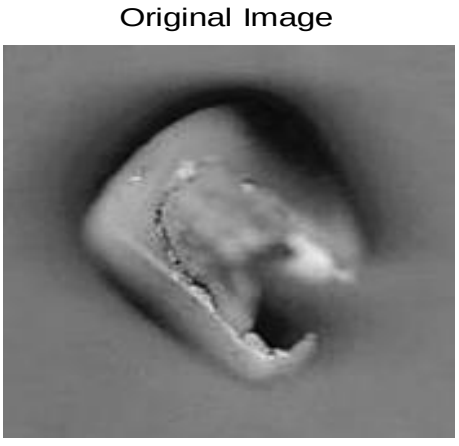

Figure 4 Original Image

The graph in figure 5 shows the histogram of original image that is shown in above figure. A histogram is a graphical formation of the distribution of numerical data. It is an approximation of the probability distribution of a constant variable.

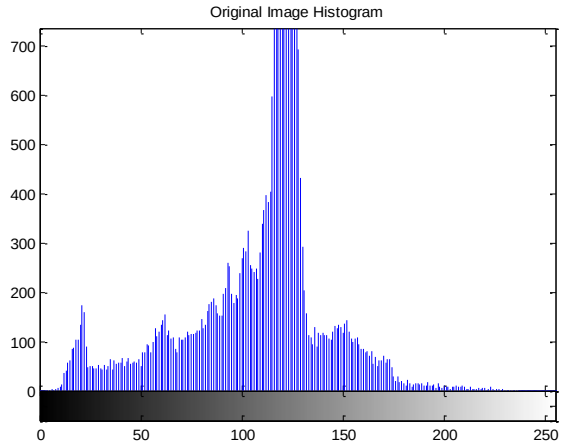

Figure 5 Histogram of Original Image

To build a histogram, the first step is to split the intact series of values into series of intervals and then count no. the values fall into interval. The intervals must be adjacent, and are often of equal size. Image histograms show frequency of pixels intensity values. In image histograms, it has two axes one is x-axis and other is y-axis. The histogram shown in this work has two axis graphs on which the x axis stands for number of pixels in the histogram of the image and the y axis stands for the number of count.

The original image is further processed by using the kuwahara filters. The kuwahara filter is applied for the filtration of original image and shown in figure 6. The graph in figure 7 shows the histogram of filtered image.

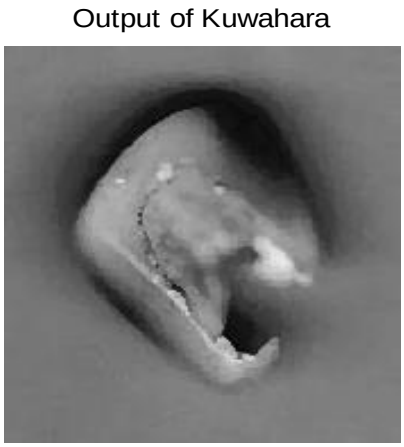

Figure 6 Filtered Images by Kuwahara Filter

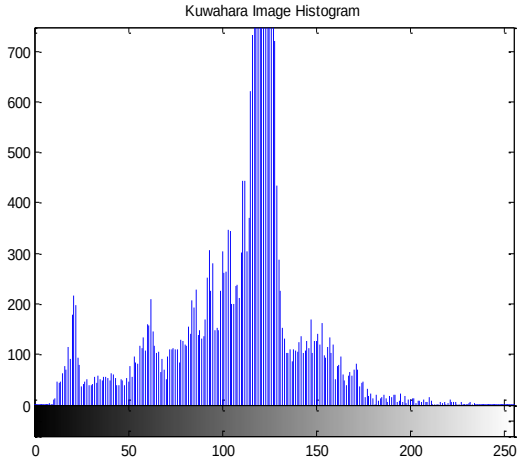

Figure 8 Histogram of Kuwahara Filtered Image

The image in figure 8 shows the enhanced image that is observed after applying the adaptive histogram equalization to the filtered image.

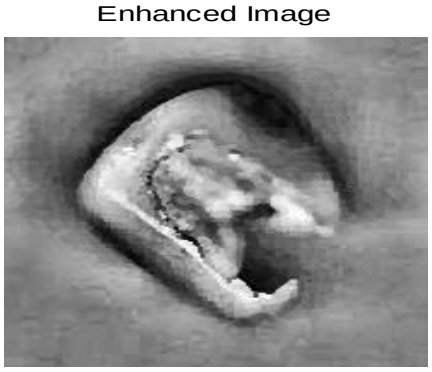

Figure 8 Enhanced Image

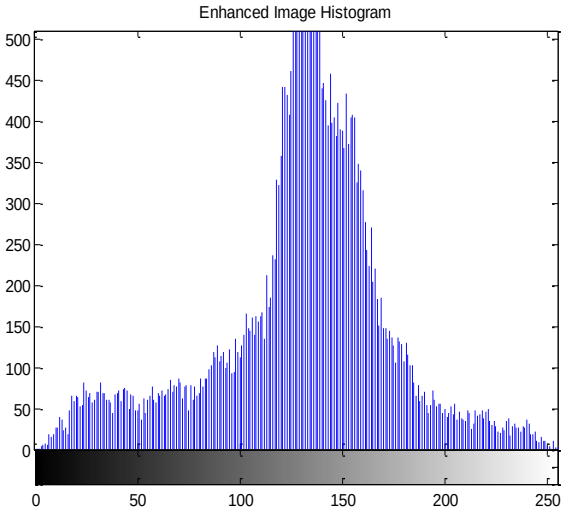

Figure 9 Histogram of Enhanced Image

Adaptive histogram equalization is a contrast enhancement technique which evaluates the multiple histograms corresponding to the different section of the image. Then these histograms are used to re-distribute the lightness in the image. Therefore, the adaptive histogram equalization is referred as most suitable technique to enhance the contrast and definition of the edges in the image. Similarly, the figure 9 defines the histogram for enhanced image.

After enhancing the contrast of the image, the fuzzy c-mean is applied to the enhanced image for the purpose of image segmentation. The image in figure 10 shows the segmented image after applying FCM.

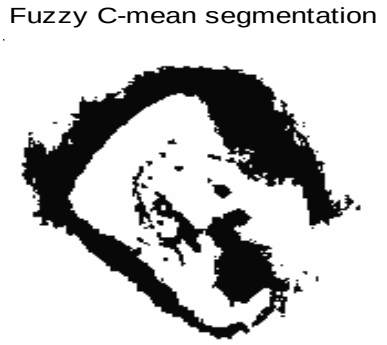

Figure 10 FCM segmented image

The graph in image 11 shows the accuracy comparison of different segmentation methods with respect to the image of stone. The x axis in the graph shows the various segmentation method i.e., HIST FCM IT and proposed work. The y axis in the graph calibrates the data for accuracy and it ranges from 0 to 100. On the basis of the graph, it is observed that the accuracy of 2D entropy technique is quite lower in comparison to other considered techniques. The highest accuracy is obtained for proposed work.

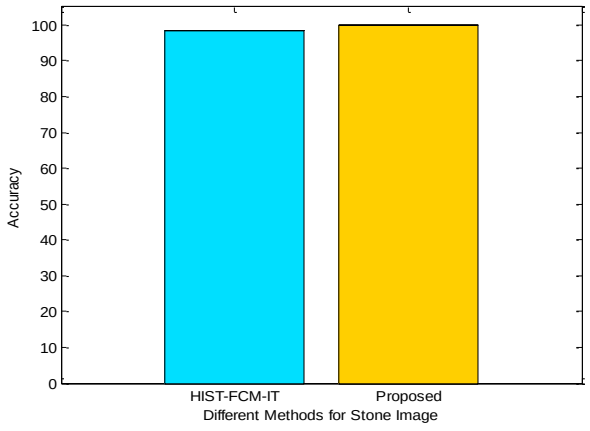

Figure 11 Accuracy Analysis of Stone image

The graph in figure 12 shows the comparison of accuracy for black bean image by using traditional and proposed technique.

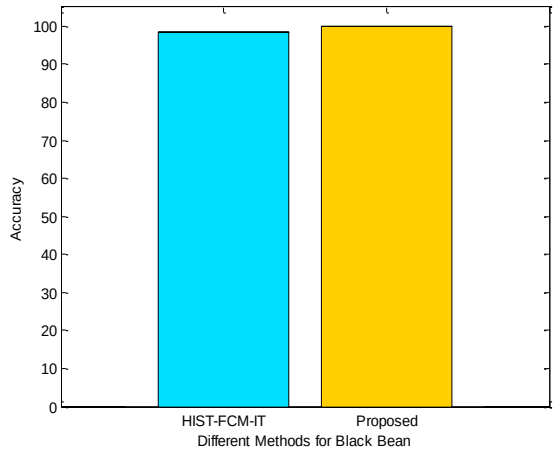

Figure 12 Accuracy Analysis of Black Bean image

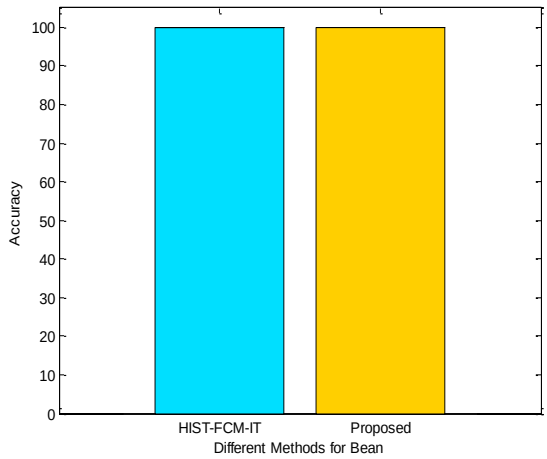

Figure 13 Accuracy Analysis of Bean image

Similarly, the graph in figure 13 shows the accuracy for bean image over traditional and proposed work. The graph shows that the proposed work has the highest accuracy.

The table 1 shows that the proposed work has the highest accuracy i.e. 99.5; the 2D entropy has the lowest accuracy i.e. 27.

Table 1 Accuracy Analysis

Technique	**Accuracy**
Proposed Work	99.5
HIST-Otsu	98.5

The graph in figure 14 shows the comparison of proposed work and traditional work. The comparison is done in the terms of color strength. The color strength in proposed work is evaluated as follows:

$$color\ strength = \frac{1}{N}\sum_{i=1}^{i=n} x_i \ldots\ldots 1$$

Where, N refers to the size of rows and columns, x_i denotes the image.

On the basis of the comparison drawn in figure below, it is evaluated that the color strength of HIST-FCM-IT is 109 and for proposed work it is 130. Thus the color strength of proposed work is effective and strong than the traditional work.

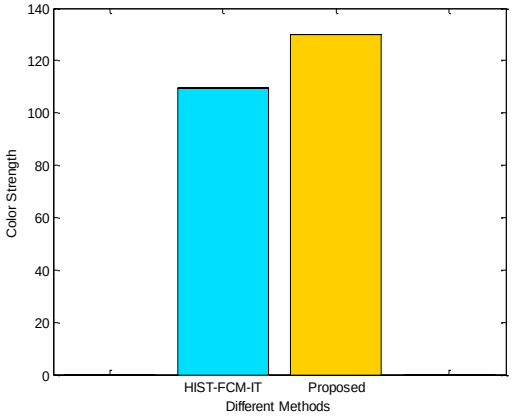

Figure 14 Color Strength Analysis

The graph in figure 15 depicts the comparison of proposed and traditional work in the terms of entropy. The value of the entropy should be high in order to get the qualitative results. The following formulation is used for measuring the entropy in proposed work.

$$E = -\sum_{i=0}^{n} p_i log_2\, p_i \ldots\ldots 2$$

The graph explains that the entropy of the proposed work is 7.28 and for traditional work is 6.63. Therefore the proposed work is proved to be better than the traditional work with highest value of the entropy.

The graph in figure 16 draws the comparison of proposed work and traditional work with respect to the edge strength. In order to measure the edge strength, the canny edge detection mechanism is applied. Canny edge detection detects the wider range of edges in the image by using multi stage algorithms. The canny edge detects employs the following equation to measure the gradient approximations:

$$|G| = \sqrt{Gx^2 + Gy^2} \approx |Gx| + |Gy| \ldots.3$$

Then the edge directions are evaluated using equation 5.3 as follows:

$$\theta = tan^{-1}\left(\frac{Gy}{Gx}\right) \ldots..4$$

The graph explains that the edge strength of proposed work is 0.729 whereas for traditional work it is 0.52.

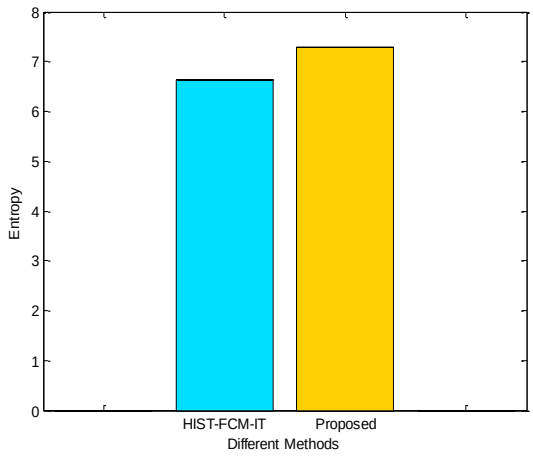

Figure 15 Entropy Analysis

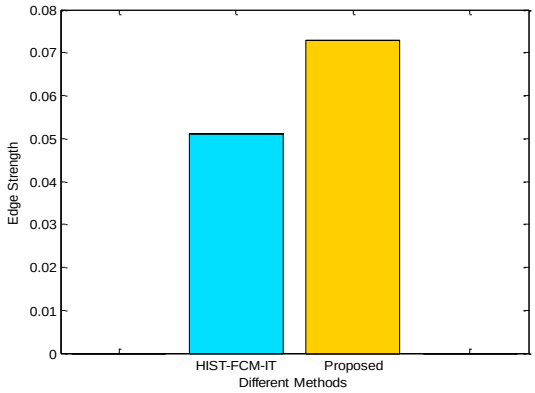

Figure 16 Edge Strength Analyses

5. CONCLUSION

This study develops a novel approach for image segmentation by using the concept of image contrast enhancement. In this work, firstly the image preprocessing is applied to the original image, then the adaptive histogram equalization technique is applied for equalizing the signals of the image. Along with this the Kuwahara filter is applied for filtering the image. After this the fuzzy C-mean technique is used for segmentation. The obtained accuracy off the proposed work is higher than the traditional segmentation techniques such as FCM, HIST-Otsu, Morphology edge Detection, 2D entropy Hist FCM IT and K-Mean.

After observing the results it is observed that the HIST-Otsu has the second highest accuracy rate after proposed work. Thus in future more enhancement in the present work can be done by hybridizing the proposed mechanism with HIST-Otsu technique.

REFERENCES

[1] Alban Ngatchou, Laurent Bitjoka, “Robust and Fast Segmentation Based on Fuzzy Clustering Combined with Unsupervised Histogram Analysis”, IEEE, 2017.

[2] Akshay Girdhar, Savita Gupta and Jaskaran Bhullar, “Region Based Adaptive Contrast Enhancement of Medical Ultrasound Images”, Computational Intelligence & Communication Technology (CICT), 2015 IEEE International Conference on, February 2015.

[3] A. Djerouni, H. Hamada, and N. Berrached, “MR imaging contrast enhancement and segmentation using fuzzy clustering”, International Journal of Computer Science Issues, Vol. 8, No 2, Pp. 392-401, July 2011.

[4] Makandar, A., & Halalli, B, “Image enhancement techniques using highpass and low pass filters”, International Journal of Computer Applications, Vol 109, Issue 14, 2015.

[5] Chin Yeow Wong, Shilong Liu, San Chi Liu, Md Arifur Rahman, Stephen Ching-Feng Lin, Guannan Jiang, Ngaiming Kwok and Haiyan Shi, “Image contrast enhancement using histogram equalization with maximum intensity coverage”, Journal of Modern Optics, Vol. 63, No. 16, Pp. 1618-1629, March 2016.

[6] Cao, G., Huang, L., Tian, H., Huang, X., Wang, Y., & Zhi, R., “Contrast enhancement of brightness-distorted images by improved adaptive gamma correction”. Computers & Electrical Engineering, 2017.

[7] Navdeep Kanwal, Akshay Girdhar and Savita Gupta, “Region Based Adaptive Contrast Enhancement of Medical X-Ray Images”, Bioinformatics and Biomedical Engineering, (iCBBE) 2011 5th International Conference on, May 2011.

[8] Namita Naik,, “Low Contrast Image Enhancement using Wavelet Transform based Algorithms: A Literature Review” International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Vol.-3, No.6, Pp 123-128, June 2015.

[9] Ritika and Sandeep Kaur, “Contrast Enhancement Techniques for Images– A Visual Analysis”, International Journal of Computer Applications, Vol. 64, No. 1, Pp. 20-25, February 2013.

[10] Kaur, R., & Kaur, S. “Comparison of contrast enhancement techniques for a medical image”. In Emerging Devices and Smart Systems (ICEDSS), IEEE, Pp 155-159, 2016.

[11] Vijay A. Kotkar and Sanjay S. Gharde, “Review Of Various Image Contrast Enhancement Techniques”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, No. 7, Pp. 2786-2793, July 2013 .

[12] Anu Namdeo , Sandeep Singh Bhadoriya, “A Review on Image Enhancement Techniques with its Advantages and Disadvantages”, IJSART, Volume 2, Issue 5,Pp 2395-1052 , 2016.

[13] K S Sandeepa, Basavaraj N Jagadale, J S Bhat, R Naveen Kumar, Mukund N Naagund, Panchaxri, “Image contrast enhancement using DWT-SVD based masking technique”, ICCES, Pp 581 – 585, 2017.

[14] Byeong Hak Kim, Min Young Kim, “Anti-saturation and contrast enhancement technique using interlaced histogram equalization (IHE) for improving target detection performance of EO/IR images”, ICCAS, Pp 1692 – 1695, 2017.

[15] Shubhi Kansal, Shikha Purwar, Rajiv Kumar Tripathi, “Trade-off between mean brightness and contrast in histogram equalization technique for image enhancement”, ICSIPA, Pp 195 – 198, 2017.

[16] Sunil Kumar Meena, Anjali Potnis, Madhuram Mishra, Prashant Dwivedy, Shahbaz Soofi, “Review and application of different contrast enhancement technique on various images”, IEMENTech, Pp 1-6, 2017.

[17] Reji Thankachan, Varsha PS, “Improved Kuwahara Filter for Bipolar Impulse Noise Removal and Edge Preservation in Color Images and Videos”, IJERT, Vol 3, Issue 11, Pp 265-270, 2014.