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Medical Image Analysis based on Global Contrast Enhancement using Bilateral Filtering

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Abstract: ***In the field of medical imaging the scanning technology is advancing day by day. With the help of various technologies like X-ray imaging, Computed Tomography and Magnetic Resonance Imaging it becomes very easy to diagnose the patient diseases. Now there are various limitations which can degrade the performance of the generated images from the hardware scanning machines. So to detect the various types of diseases the output digital images should be enhanced and processed fairly well. The main reason of not detecting the depth of the disease is the generation of low contrast medical images. Also in various internal surgeries of the human body the live camera feed is used to get the insight of various interested human parts and for that the images received should be processed and enhanced immediately by the used algorithms. The sizes of the detected objects and their shape and their periphery should be properly visible so that surgery could be successful. In the present research the global contrast enhancement of the medical images is done with the help of bilateral filtering. Further medical images are enhanced to get good and refined edges and for achieving it also various types of filters are used to get the refined medical images. The output of the proposed algorithm is compared with other medical image enhancement techniques. Various objective performance evaluation parameters like mean square error, peak signal to noise ratio are used for providing worthiness of proposed algorithm for contras enhancement of medical images.***

Keywords: Contrast enhancement, medical image processing, histogram equalization, peak signal to noise ratio, bilateral filtering.

I. INTRODUCTION

In the present decade the technology is advancing with high pace and this rhythm is very beneficial for the community. In case of medical technologies this advancement is boon for the patients as it could provide better services. With the advancement in this field various new diseases could be detected and their origin and other information about these could be easily fetched. All the medical instruments after capturing the data of the human body convert it into a medical image so that physicians could diagnose the disease. The main problem that generally arises in the medical images is their low contrast. As a result of it the diagnosis of the disease is not easy as it could lead to some misunderstanding as well. Sometimes the physician suggests the patients to scan one more time to get the good medical image which may have enough details of the disease. Now it will add more burdens to the patient and also the loss of time. For finding the information inside the medical images the contrast as well as illumination should be proper inside the image. In image processing various authors has used various types of techniques to improve the edges as well as the contrast enhancement of the images. Actually both of these features are important for getting the hidden details of the disease. This research paper is also a step towards the improvement of the contrast and refining the medical digital images so that one could get the improved medical image for diagnosis purposes.

II. LITERATURE REVIEW

S. M. Islam et al. [1] in 2019 presented a digital image enhancement technique for improvement of medical images. The benefit of this technique was that it could find the saved information in the digital images which were hidden. Here authors provided more stress towards the edge of the objects present in the medical images. Authors tried to explore the edges with use of various known methods like Laplacian, Sobel operators with addition and product operation and power law transform. Authors got two images out of which one image is sharpened and other was smoothed image. In the final stage authors had combined both the images and then increased the dynamic range of the digital images. Results were quite impressive and also the contrast of the medical images was improved significantly.

K. B. Singh et al. in 2017 [2] had combined the both local as well as global contrast enhancement of the digital image. Authors had first converted the image into hue saturation and vue channel image. After that authors received two matrices one was for the luminance and other was for the chrominance. Authors performed local enhancement first on the luminance matrices and then global enhancement. The result of this operation was merged with the chrominance matrices.

Finally hue saturation vue was merged and converted into red green blue channel image. Here the global enhancement improved the overall brightness of the digital image. Authors used the Matlab simulation software for the evaluation purposes. Authors showed the worthiness of the proposed algorithm with the help of various objective parameters.

W. Rui et al. in 2017 [3] proposed a novel method for improving the brightness and contrast of the medical images. Authors created a new homomorphic filter for this purpose. Authors first applied homomorphic filter so that there would be reduction in the illumination with sharpened edges of the objects. After it total variation model was applied so that image could be restored and noise could be removed. Authors compared the proposed method with the CLAHE, Retinex and Total variation methods. Authors applied the methods on the various X-ray images. Further the results were compared on the basis of various objective parameters like mean, entropy, gradient and the average Laplacian. Results obtained by the proposed method were better than other compared methods.

R. Rajendran et al. in 2016 [4] proposed a method to improve the medical image contrast. Authors first applied the guided filter on the input digital image. It was used to improve the edges of the images and also smoothed it. After it edges were enhanced with the help of various kernels. After it morphological operator were applied to enhance the digital image. After it contrast stretching was performed and increased the dynamic range of the medical image. In the end authors used the fusion process. Authors used the computed tomography digital images set for the testing purposes. The proposed algorithm showed good results by removing the noise as well as improving the overall brightness of the medical image.

III.PROBLEM FORMULATION AND METHODOLOGY

After having a deep literature review, the different research gaps that were identified are described below

1) Various techniques have not shown edge improvement in all the medical images significantly.
2) The overall improvement of the medical image has sometimes over enhancement and sometimes has under enhancement.
3) Some algorithm takes long time for the improvement of the medical images.
4) Some techniques have improved the one object fairly well but in case of other object which is present in the same medical image fails badly.

A. Objectives

This research work will be targeted to achieve the below mentioned objectives

1) To design, study and implement a global contrast enhancement of medical image.
2) The algorithm should be based on the bilateral filtering and homomorphic filtering.
3) Prime target is on improving the edge refinement as well as contrast in the low illumination region.
4) The algorithm should be fast and reliable for all the medical images.

B. Methodology

Below are the steps which will be performed to complete this research work

1) Enhance the low contrast region of the medical image significantly so that all the objects are visible.
2) Create an edge detection methodology which refines the edges of the digital medical images significantly.
3) Now improve the overall contrast of the image so that all of the objects have similar illumination.
4) Detect the various parts of the medical image.

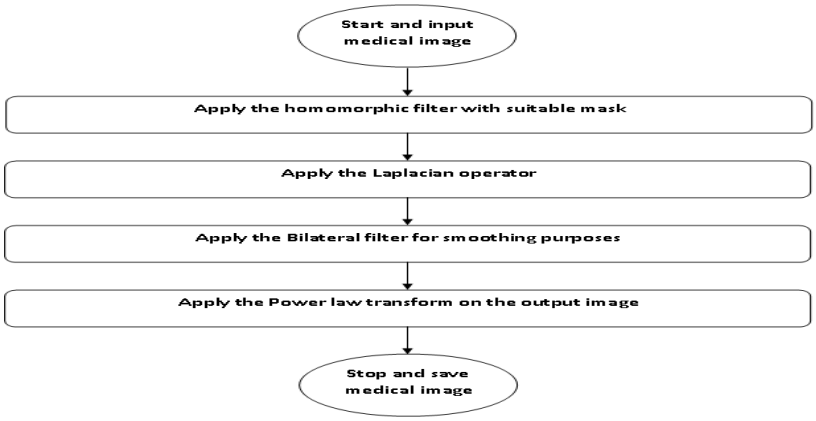

Fig. 1 Flowchart of proposed algorithm

C. Proposed Algorithm

The proposed algorithm includes specific steps which are as follows:

1) Apply the homomorphic filter with suitable mask to improve the illumination.
2) Apply the Laplacian operator.
3) Apply the bilateral filter for smoothing purposes.
4) Apply the power law transform to improve the overall contrast of the image.
5) Perform testing on various medical images with different illumination.

IV. RESULTS

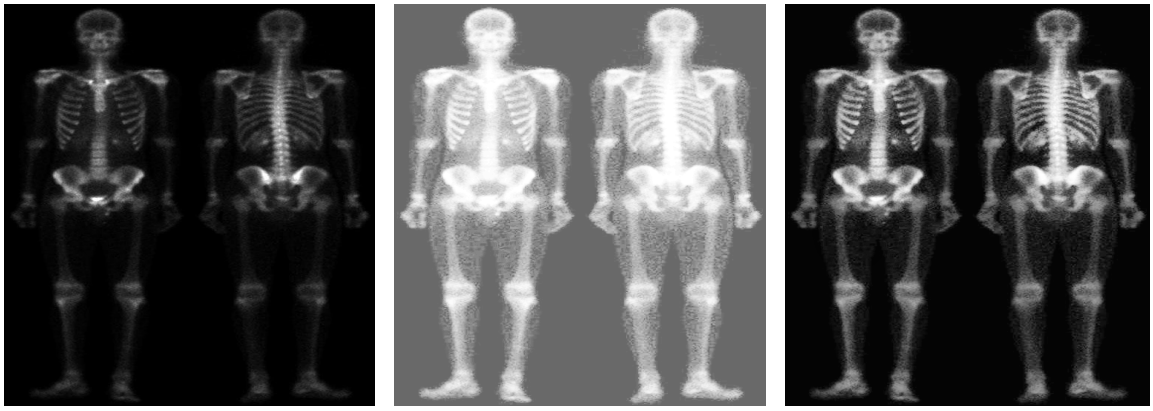

Fig. 2 (a, b, c) Original image, Histogram equalized image and Proposed image of Skeleton image

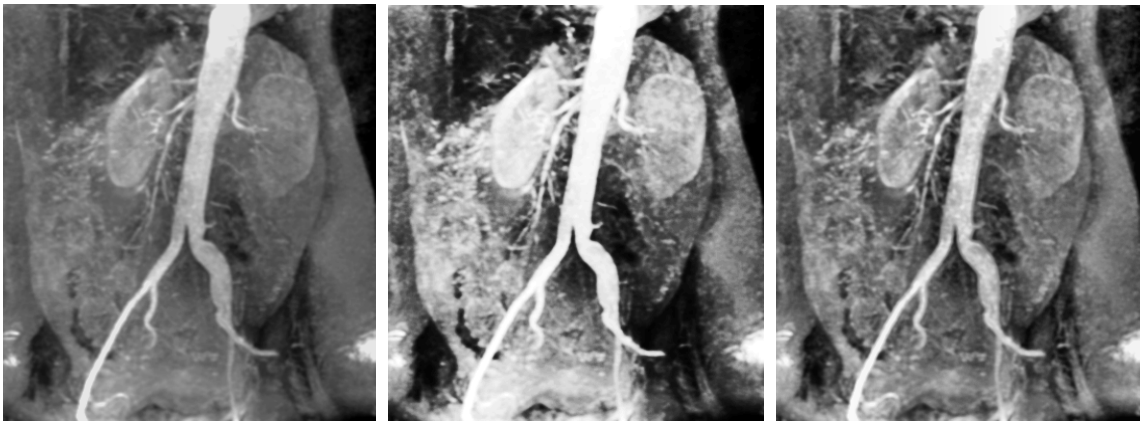

Fig. 3 (a, b, c) Original image, Histogram equalized image and Proposed image of Kidney image

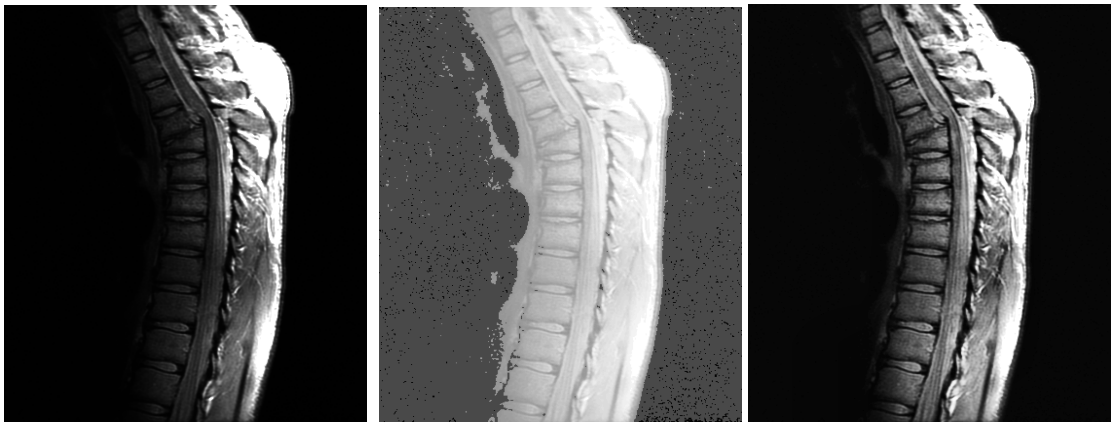

Fig. 4 (a, b, c) Original image, Histogram equalized image and Proposed image of Fractured Spine image

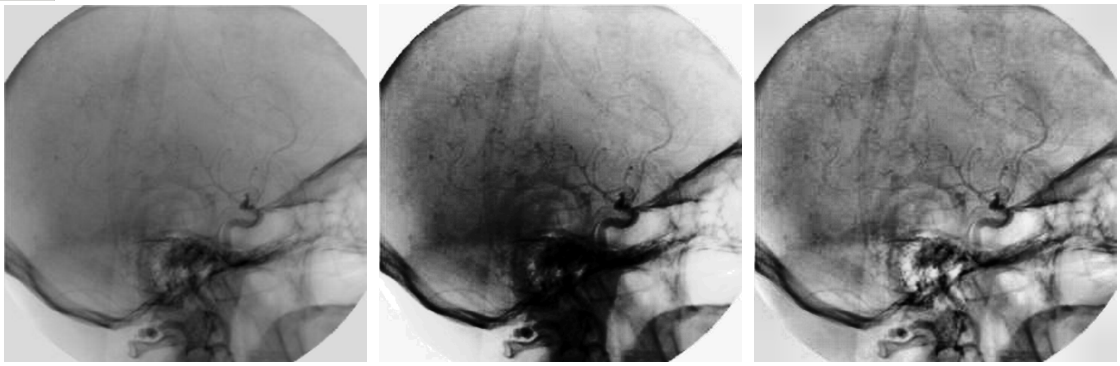

Fig. 5 (a, b, c) Original image, Histogram equalized image and Proposed image of Angiography image

Table I: Result Obtained From The Medical Image Processing

Image No	PSNR (HE METHOD)	PSNR (PROPOSED METHOD)	MSE (HE METHOD)	MSE (PROPOSED METHOD)
2	5.9326	13.7148	6.6042e+03	2.7644e+03
3	15.1009	21.5584	2.0090e+03	454.1901
4	7.7030	19.2026	1.1035e+04	781.2975
5	17.2962	19.6925	1.2119E+03	697

V. CONCLUSIONS

From the outcomes of the research it can be concluded that the proposed technique performed better in comparison to standard histogram equalization technique for contrast enhancement. The peak signal to noise ratio of the proposed algorithm is better than histogram equalization technique. Also the mean square error of the proposed technique is lower than the histogram equalization technique. The proposed system is able to detect the binary information present in the low contrast images and can be handful to detect tumour and also other information in the medical digital images.

In the future work various other techniques can be compared with the proposed technique. Also other objective parameters like entropy, correlation also can be used to get more microscopic information so that more information of the medical images could be evaluated.

VI. ACKNOWLEDGMENT

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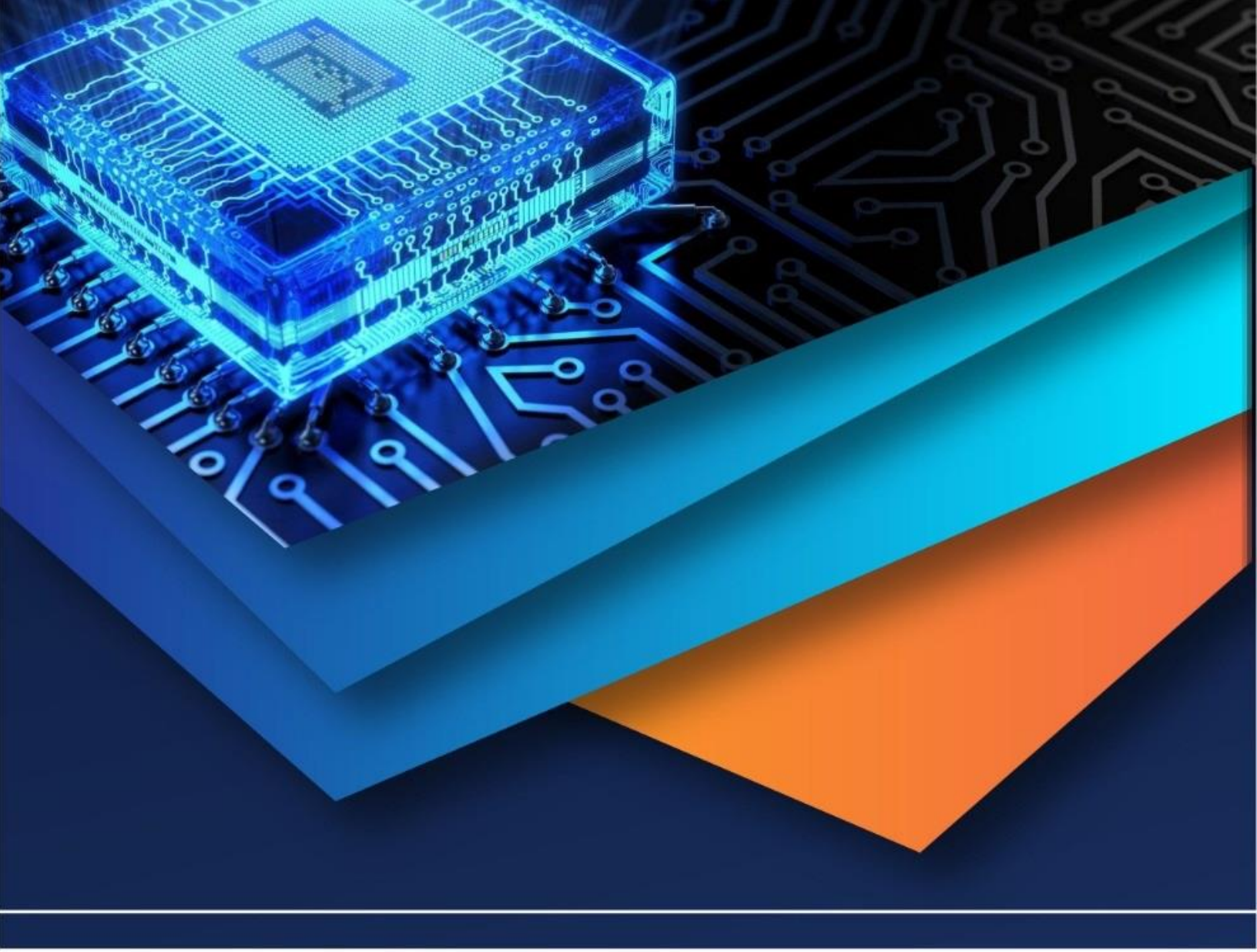

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