Contrast Enhancement of Medical Images: A Review

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Abstract:

This paper studies various research contributions in the field of contrast enhancement of medical images. Medical images such as X-rays, ultrasound and others are used in the analysis and diagnosis process by physicians and radiologists. If the image quality is not good and contrast is poor then the diagnosis result is badly affected. Therefore, this paper attempts to review the research papers on contrast enhancement and recommend some viable solution to the challenges in existing research works.

Keywords: Medical image, contrast, enhancement.

Introduction:

Recent advances in digital medical imaging techniques have led to increased applications of digital image processing. Existing methods present attention on enhancement of contrast is of particular interest in the areas of chest radiography, mammography and computer tomography and other modalities of medical image diagnosis and CAD (computer-aided diagnosis) system. Various enhancement techniques are subjective and problem oriented processing techniques wherein a particular algorithm is applied to design for a specific application [1-2]. Generally, X-Ray images can be used to image the human internal body structure, which is used to recognize the internal problems. It is a mostly used imaging modality to check the bone fractures and other related problems [2-4].

CT images are used to image the internal structure of human body and also important diagnostic tool in the field of medicine. It provides good contrast between the different soft tissues of the body which make it especially useful in imaging the brain, muscles and cancers compared with other medical imaging techniques increased on software and hardware level. With advancement of technology some CT machines have also been introduced which can increase the contrast at their own with the help of software and hardware. As the CT images are being used for diagnostic purposes, some software may also be designed to perform auto diagnosis. In general, the elucidation of CT image is being done manually by experienced interpreters of the medicine field [3-6]. The medical image can be easily analyzed with the help of contrast enhancement. There are different techniques are already available for analyzing medical images based on contrast enhancement.

Related Research and Discussion:

Patel and Sinha (2014 & 2015) presented mammographic image analysis and abnormality detection that employed image enhancement method which mainly used contrast enhancement. The approaches were assessed well using performance evaluation parameters but robustness was the main issue. Secondly, color image was not dealt directly [3-4]. Hao-Tian Wua et al. (2015) developed a reversible data hiding method with contrast enhancement for medical images. Firstly, image background segmentation is performed and the principal gray-scale values in the segmented background are identified. By excluding the corresponding histogram bins from being expanded for data hiding, the contrast of region of interest (ROI) in medical images can be selectively enhanced. Considering the characteristics of pixel distribution, we develop a new pre-processing strategy to reduce the visual distortions that may be caused. With the proposed method, an original image can be exactly recovered from the corresponding enhanced image by hiding the side information within it. The experimental results on a set of medical images show that the visibility of ROI can be improved. However, visual quality was affected [5].

Seungjong Kim et al. (2013) suggested a medical image enhancement in terms of production of medical images, noise reduction and contrast enhancement are important methods to increase qualities of processing results. Wavelet transforms produced promising results for localization in both time and frequency, and hence have been used for image processing applications including noise removal. By using the edge-based denoising and adaptive nonlinear histogram stretching, a novel medical image enhancement algorithm is proposed. The proposed adaptive nonlinear histogram stretching method is applied to increase the contrast of resultant image. Experimental results show that the proposed algorithm can enhance a low contrast medical image while preserving edges effectively without blurring the details [6]. Preeti et al. (2010) and Patel et al. (2015) presented how different image enhancement techniques like range compression, contrast stretching, histogram equalization with gamma correction and noise smoothing can be used to enhance the quality of medical images. Simulation results show that the techniques produce visually good results which make the diagnosis easy [7-8].

Bedi et al. (2013) and Zeyuti et al. (2004) also implemented contrast enhancement methods but the methods suffered with poor image recovery and visual quality [9-10]. Xuli et al. (1998) presented an algorithm for speckle reduction and contrast enhancement of echocardiographic images. Shrinkage of wavelet coefficients via soft thresholding within finer levels of scale is carried out on coefficients of logarithmically transformed echocardiograms. Enhancement of echocardiographic features is accomplished via nonlinear stretching followed by hard thresholding of wavelet coefficients within selected (midrange) spatial-frequency levels of analysis.A study using a database of clinical echocardiographic images suggests that such denoising and enhancement may improve the overall consistency of expert observers to manually defined borders [11].

Jiang et al. (2012) and Patel et al. (2012) presented contrast enhancement for medical images but the performance could be further improved [12-13]. Rao et al (2015) and Dippel et al. (2002) developed a novel image enhancement technique based on M band wavelets. The conventional image enhancement algorithms opt for contrast enhancement using equalization techniques. Contrast enhancement is one of the most important issues in image enhancement techniques. High difference in luminance reflected from two adjacent surfaces results in a good contrast image which makes the object more distinguishable from other objects in the background. The

proposed algorithm not only denoises the image by retaining the high frequency edges, but also increases the contrast and generates a high resolution image. Various parameters like MSE and PSNR are been taken into account for comparison of enhanced images generated from the proposed algorithm with that of the conventional techniques.

An example of contrast enhancement is shown in Fig. 1 by using standard histogram equalization method.

(a) Orginal image (b) Enhanced image

Fig. 1: An example of contrast enhancement using histogram equalization.

Conclusions and Recommendation:

Based on the extensive literature survey, it sis concluded that in most of the existing research papers on contrast enhancement robustness is the biggest issue. A research plan suggests to overcome the major challenges: by using soft computing techniques to reduce processing time in biometric applications and to make the testing process more efficient and simple; implementing parallelization and find optimal level of parallelization to achieve faster retrieval of the image; developing an efficient and robust image enhancement tool including fuzzy logic, neural network and optimize the performance of existing image enhancement techniques; designing a number of segmentation and clustering techniques in medical image processing to improve diagnosis accuracy. By these recommendations, one can think of achieving optimal value of robustness.

References

1. G R Sinha and Bhagwati Patel, Medical Image Processing: Concepts and Applications, ISBN: 978-81-203-4902-5, Prentice Hall of India, 2014.
2. R C Gonzalez and R E Woods, Digital Image Processing, Prentice Hall of India, 2013.
3. Bhagwati Charan Patel and G R Sinha, “Gray level clustering and contrast enhancement (GLC–CE) of mammographic breast cancer images”, CSI Transactions of Springer, 2(4), p. 279–286, January 2015.

4. Bhagwati Charan Patel and G.R.Sinha, "Abnormality Detection and Classification in Computer-aided Diagnosis (CAD) of Breast Cancer Images", Journal of Medical Imaging and Health Informatics, Vol. 4, No. 6, pp. 881-885, 2014.
5. Hao-Tian Wua, Jiwu Huang and Yun-Qing Shi, "A reversible data hiding method with contrast enhancement for medical images", J. Vis. Commun. Image R. 31 (2015) 146–153.
6. Seungjong Kim, Byongseok Min, Wongeun Oh and Jooheung Lee, " Medical Image Enhancement Algorithm Using Edge-Based Denoising and Adaptive Histogram Stretching", International Journal of Bio-Science and Bio-Technology Vol.5, No.5 (2013), pp.25-38.
7. Preethi S.J and K. Rajeswari, "Image Enhancement Techniques for Improving the Quality of Colour and Gray scale Medical Images", International Journal on Computer Science and Engineering NCICT 2010 Special Issue 18-23.
8. Bhagwati Charan Patel and G R Sinha, "Efficient Detection of Suspected areas in Mammographic Breast Cancer Images", i-manager's Journal on Pattern Recognition, 01(04), pp. 01-10, December 2014- February 2015.
9. S. S. Bedi and Rati Khandelwal, "Contrast Enhancement For PCA Fusion Of Medical Images", Journal Of Global Research In Computer Science, Volume 4, No. 3, pp. 25-29, March 2013.
10. Zeyuti YLI atd Clznridrnjit Bajiij, "A Fast And Adaptive Method For Image Contrast Enhancement", International Conference on Image Processing (ICIP), pp. 1001-1004, 2004.
11. Xuli Zong, Andrew F. Laine, and Edward A., "Speckle Reduction and Contrast Enhancement of Echocardiograms via Multiscale Nonlinear Processing", IEEE Transactions on Medical Imaging", Vol. 17, No. 4, pp. 534-542, AUGUST 1998.
12. Huiyan Jiang, Binbin Lou and Shiyang Liao, "Medical Image Enhancement Method Based on Mode Decomposition", Advances in Multimedia Technology (AMT), pp. 21-31, Volume1, Number1, December 2012.
13. Bhagwati Charan Patel and G R Sinha, "Energy and Region based Detection and Segmentation of Breast Cancer Mammographic Images", International Journal of Image, Graphics and Signal Processing, 6, pp. 44-51, 2012.
14. Yogesh Rao, Nisha Sarwade and Roshan Makkar, "Denoising and Enhancement of Medical Images Using Wavelets in LabVIEW", I.J. Image, Graphics and Signal Processing, 2015, 11, 42-47.
15. Sabine Dippel, Martin Stahl, Rafael Wiemker and Thomas Blaffert, "Multiscale Contrast Enhancement for Radiographies: Laplacian Pyramid versus Fast Wavelet Transform", IEEE Transactions on Medical Imaging, VOL. 21, NO. 4, pp. 343-353, APRIL 2002.