Grenze International Journal of Computer Theory and Engineering , Special issue

Automatic Fracture Detection in Bone Images

G Narayanaswamy[1] and Bindu A Thomas[2]
[1-2]Vidya Vikas Institute of Engineering and Technology, Mysuru, Karnataka, India
nswamy1979@gmail.com, binduvviet@gmail.com

***Abstract*—Automatic fracture detection in a bone image of any modalities is considered as an important process in medical image analysis by both orthopedic and radiologic point of view. The proposed research work use an algorithm can detect the fracture automatically in long bones (Tibia bones) images of any modalities and the detection process is carried out in three steps, namely preprocessing, segmentation and bone fracture detection. Based on the algorithm result it is possible to distinguish between fractured and non fractured bone images. The research work is carried out using Matlab 13.0 as the programming tool; the result obtained from algorithm shows approximately 80% accuracy in the fracture detection in bone image.**

***Index Terms*— Bone fracture, Tibia bone, Medical images, Hough transform and segmentation.**

I. INTRODUCTION

The advancement in the technology, medical image processing field is gaining wide acceptance in healthcare industry. The proper treatment is decided by the medical practioner is based on the accuracy of the disease diagnosis. The imaging of the human body can be produced by using several equipments such as X-ray-based devices, computed tomography (CT), Magnetic Resonance Imaging(MRI),Ultrasound(US) all these equipments helps in keeping the human organs in digital form. The human body is mainly supported by the bone structure which is a solid organs and it protecting many important organs such as brain, heart, lungs and other internal organs. The human body has 206bones with various shapes, size and structures. The femur bone is considered to be the long one whereas auditory osscles is the smallest one. Bone fracture is a common problem in human beings. The main reasons for bone fracture are pressure applied on bone or simple accident and also due to osteoporosis and bone cancer. The types of bone fracture may be oblique, compound, comminuted, spiral, greenstick and transverse. In modern hospitals, medical images are stored in the standard DICOM (Digital Imaging and Communications in Medicine) format which includes text into the images. Any attempt to retrieve and display these images must go through PACS (Picture Archives and Communication System) hardware. The main aim of this research work is to automatically detect the bone fracture especially in the long bone; later it is referred as a tibia bone.

II. LITERATURE SURVEY

There is a tremendous advancement in the medical imaging due to the discovery of both X-Ray and CT imaging techniques and these two becomes the fundamental diagnostic tool in modern healthcare. This section reviews some works that has focused on the various steps during fracture detection.

Grenze ID: 01.GIJCTE.3.4.1

A. Preprocessing

The X-Ray image is degraded in quality mainly due to the presence of Poisson noise, which leads to degradation in the visual quality of the image and obscures important information required for accurate diagnosis. Including denoising step in automatic fracture detection process is used by several researchers [7] for this purpose, a Weiner filter is recommended by Tsukahara et al (1998).Edge preservation is the main advantage from this filter but the result is blurred. Nijima[8]used wavelet method to identify the noise dominant regions and different shrinkage thresholding techniques are used to reduce the noise. Several proposals for denoising use wavelets [2].significant improvement in the result they got in the presence of Gaussian noise but the performance slightly degrades when used with Poisson noise. The method proposed by Lusier[3] i.e. fast interscale wavelet denoising method for Poisson- corrupted images is the answer for the problem with the poisons noise. In this work Gaussian filter is used to remove the noise in a bone image. The result is an image with less blur. It is intended to obtain the real edges of the image. If the Gaussian Filter is not applied before, sometimes the noise itself will be detected as an edge.

B. Segmentation

The bone image segmentation can be categorized in two ways namely, gray level feature- based methods and texture- based methods [9].the analysis of gray level or color features are analyzed by the gray level feature – based methods for segmenting an image. Histogram based methods, Edge based methods and region based method are belong to this category. Whereas in texture based segmentation divide the images into regions with similar texture properties. All these methods use random patterns/ textures but work well for segmenting medical images. All these methods work on a common objective, that is, to provide solution for efficient automatic medical image segmentation. Usage of the morphological and wavelet transformation gained more attention for bone image segmentation.

C. Fracture Detection

[2]Outline fracture can be detected in X-ray images of fractured bones presented by Y JIA and Y JIANG and display the alignment between the fractured bones. The author used geodesic active contour model to find the fracture with global constraints for the bone region. With X-ray images the method will give good result, to get this result a prior shape is collected and used as a global constraint of the model. The JIAN LIANG proposed a method to find the fracture in long bone such as tibia. The methods have proposed morphological method to identify fractures in tibia bones. The result obtained from the method will work efficiently but it takes lot of time to detect the fracture in an image.

[10]For automatic fracture detecting in a long bone was developed by MARTIN DONNELLEY et al. the non linear anisotropic diffusion method is used to for the edge extraction in an the X-ray image. The method helps to smooth the image without the losing critical information about boundary locations within the images. For the edge detection of the long bones can be done by using modified Hough transform with automatic peak detection to determine parameters for the straight lines. The parameters used to approximate the long bone edges are then used for centerline approximation, diaphysis segmentation and fracture detection in the segmented region.

The Hough transform is the heart of the proposed research work for the detection of the fracture in a bone image.

III. METHODOLOGY

During the process of identifying or detecting the fracture in a long bone i.e. tibia in a bone images, the following steps are to be considered.

A. Preprocessing

Procedure that contains steps that enhances the bone images so that it helps in detection of fracture in an image. The procedures adopted during this phase will enhance the features of a bone image so that output image should improve the performance of the subsequent stages. There are different types of noise. Salt and pepper noise is one of the most common types of noise that can be found in X-ray images. This type of noise is generally caused by a failure in capture or transmission that is appearing in the image as light and black dots. The salt and pepper noise is handled by applying a mathematical transformation T on the X-ray image as follow

g (x, y) = T [f (x, y)]
Where f (x, y) is the original X-ray image having salt and pepper noise and g (x, y) is the output image after applying T on it. Proposed research work chose to use the Gaussian filter as T to reduce the salt and pepper noise while preserving the edges and sharpness of the image.

B. Segmentation

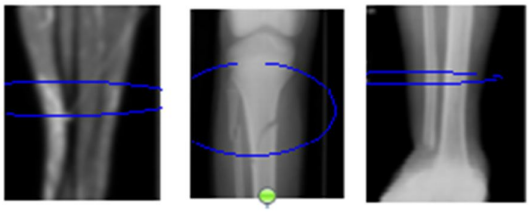
Tthe process that has two steps. The first step separates the bone structure from the bone image and the second step, identifies the diaphysis region from the segmented bone structure. Edge detection is one of the most widely used operations in applications that require determining objects' boundaries in an image. It is based on analyzing the changes in the intensity in the image. However, the quality of edge detection is highly de-pendent on lighting conditions, the presence of objects of similar intensities, density of edges in the scene and noise. There are different algorithms for edge detections such as Canny, Laplacian and Sobel. In this research work for the detection of the edges canny edge detector is used because canny can result in a good result compare to any other edge detector. The usage of these canny edge detection in the segmentation process narrows down the search region during fracture detection and thus aids in accurate detection of fractures in a time efficient manner.

C. Fracture Detection

A Hough Transform is used to detect the fracture in a bone image. Followed by the edge detection, it's necessary to identify the fracture region in an image that can be accomplished by the usage of the Hough transform, the process of the fracture detection is explained as follows.
The process of fracture detection is get started by reading the fractured bone images of different sizes, followed by the initialization of the various parameters such as areas, edges and pixel values are done. It is necessary to carry the denoising process to enhance the features of an image by nullifying the noises present in an bone image, the edge detection process is carried out after denoising, which will improve the fracture detection rate. Followed by fracture detection, ellipse is placed on the site of the break.

IV. RESULTS

To analyze the performance of the proposed system, it has been tested on 10 fractured bone images. Out of these, fracture was identified in 8 images in the diaphysis region of bone.i.e the accuracy of the proposed algorithm is about 80%.The figure.1 shows the result of proposed work to identify the fracture in an fractured bone images.



a. b c

Figure.1: Fracture detected in a bone Image

TABLE I.THRESHOLD VALUES FOR DIFFERENT IMAGES

Sl no	Figure Number	Hough Transform Threshold value
1	a	35
2	b	45
3	c	45

Threshold value calculated for different images as tabulated in Table I.The method used to calculate the threshold value for an image is by taking the maximum and minimum value of Hough Transform. The necessity of finding the threshold in the diaphysis region is to locate the fracture in the region.

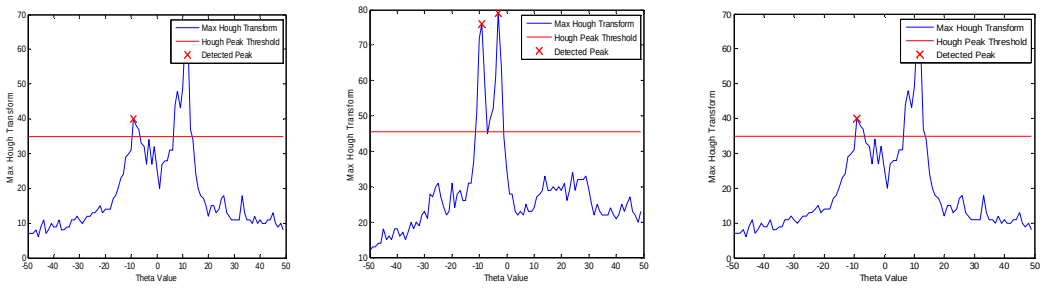


Figure 2: Analysis of threshold value of fractured bone images

The analysis of threshold value of a bone image in terms of variation between Max Hough transform versus theta value is as shown in Figure 2. The identification of the fracture is done only when there are two peaks above the threshold value. If there is only one peak or multiple peaks are identified, the fracture is not detected in an image. The Figure (a),(b) and (c) has the threshold value of 35,45 and 45 respectively.

V. CONCLUSION

The result of the research work is focused on identifying the region in which bone is fractured. This can be accomplished by using Hough Transform, which helps in accurate fracture detection. The limitation of this method is, in CT and some cases of X-ray images very difficult to find the area of fracture, In future work, it is fully implemented to CT images with multiple fractures in a bone and also classifies the type of fracture in a bone images.

ACKNOWLEDGEMENT

I would like to acknowledge Dr.Ravikiran, Assistant Professor Dept of orthopedic, JSS Hospital, Mysuru for his guidance, I thank Dr.Subramanya B M and Mr. Sagar Deshpande, Assistant Professors, Dept of ECE VVIET for their support to carry out this work.

REFERENCES

[1] S.K.Mahendran, S.Santhosh Baboo “An Enhanced Tibia Fracture Detection Tool Using ImageProcessing and Classification Fusion Techniques in X-RayImages“Globale Journal of Computer Science and Technology, Volume11, Issue14, Version 1.0, August 2011.

[2] Sharma, N. and Aggarwal, L.M. “ Automated medical image segmentation techniques”, J Med Phys,Vol.35, Pp.3-14,2010

[3] Zain, M. L. M., Elamvazuthi, I., Begam, M. “Enhancement of bone fracture image using filtering Input image Edge detected image K -MEAN CLUSTERING”, International Journal of Computer Applications (0975 – 8887). The International Journal of Video and Image Processing and Network Security, 2009.

[4] Sakata, M. and Ogawa, K.“Noise reduction and contrast enhancement for small-dose X-Ray images in wavelet domain”, IEEE Nuclear Science Symposium Conference Record (NSS/MIC), Orlando, FL, Pp. 2924-3654, 2009.

[5] Donnelley, Martin William. “Computer aided long-bone segmentation and fracture detection”. Diss. Flinders University, Faculty of Science and Engineering. 2008.

[6] Jia,Y.,and Y.Jiang. "Active contour model with shape constraints for bone fracture detection." Computer Graphics, Imaging and Visualisation,International Conference on. IEEE, 2006.

[7] Lim, S. E., Xing, Y., Chen, Y., Leow, W. K., Howe, T. S., Png, M. A.“Detection of femur and radius fractures in x-ray images”. In: Proc. 2nd Int. Conf. on Advances in Medical Signal and Info,2004.

[8] Donnelley, Martin. and Knowles, Greg. “Computer Aided Long Bone Fracture Detection”, IEEE, pp. 175

[9] Tian, T. “Detection of femur fractures in x-ray images”. Master’s thesis, National University of Singapore, Singapore,2002.

[10] Niijima, M.”Wavelet image analysis”. Kagaku Gijutsu Publishing (in Japanese), 2000.