An Audit of Computer Aided Fracture Detection System

C M A K Zeelan Basha, T. Maruthi Padmaja, G.N. Balaji

Abstract: ***X-Ray images are the most widely recognized methods for medical imaging accessibility for individuals during the wounds and mishaps. X-rays are most frequent and the oldest form of medical imaging. Yet, the minute fracture identification using the X-Ray image is beyond the realm of imagination,because of the complication of bone organisation and the dissimilarity in visual attributes of fracture upon their location. This is the reason why it it is hard to detect the fractures and furthermore decide the seriousness of the damage. The major challenges of X-Ray imaging are the presence of noise, intensity ambiguity, and overlapping tissues. This creates a hurdle in correct diagnosis and delays treatment. The various rates require the human services experts to analyze countless x-ray images. computerized detection of fractures in X-Ray images can be a huge commitment for helping the doctors in settling on quicker and increasingly precise diagnostic decisions and speeds up the plan for the treatment. This research compares the existing fracture detection techniques.From various fractures, programmed identification is viewed as challenging since they are unique and variable in presentation and their results are quite un predictable.The major challenges for computer-aided fracture detection can be accurate segmentation process, automatic identification of the region of interest (bone fracture), evaluation and suggestive course of action.***

Keywords: **Ray,Segmentation,Filtering,Fracture,Detection**

I. INTRODUCTION

Today in the healthcare domain, medical images play a vital role. Medical imaging is of significant use in the process of diagnosis and further surgical procedures and follow up studies. Medical imaging can be defined as the process of representing visually the interior parts of body, tissues or organs for clinical analysis, treatment, and disease monitoring.

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Table 1 Different Types of Medical mages and its Purpose

Sr No	Medical Imaging Type	Purpose
1	Ultra-Sonography (USG)	To record images within the body ultrasound is used
2	X-Ray	Uses the X-ray beam to extract and record images of internal bone structure of the body.
3	Echocardiography	It is used to know the heart state.
4	Computer Axial Tomography Scan	To know the state of the interior organs in slices.
5	Magnetic Resonance Imaging	It is used to get more clear images than CT Scan.
6	Linear Accelerator	It is used for radiotherapy in cancer.

The research focuses on finding the Region of Interest in the bones of X-Ray images. So the further explanation would be concentrating on X-Ray images.

II. X-RAY IMAGE METHOD

X-Ray imaging is the most seasoned and the most usually utilized type of medical imaging. X-Ray imaging utilizes X-Ray beams that are projected on various parts of the body. The X-Ray beams are caught up in various amounts relying upon the density of the organs while going through the body. On the opposite side of the body, the X-Rays are detected resulting in an image. The following figure shows a sample Chest X-Ray image.

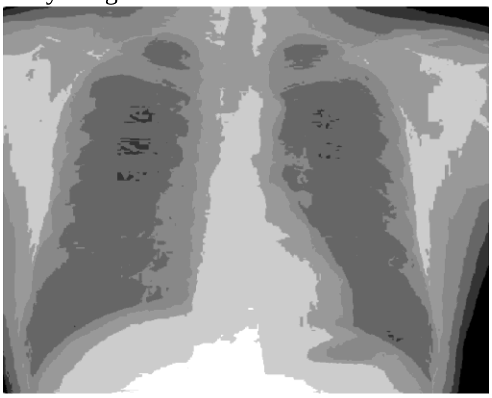

Figure 1 Chest X-Ray

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Table 2. 2 Parts of Chest X-Ray

Fat	Appears Dark Grey
Air and gas	Appears Black
Soft tissue and water	Appears Light Grey
Contrast Material and Metal	Appears Bright White
Bone	Appears Light White

- Ray images are typically used to treat:
- Broken Bones
- Cavities
- Breast Cancer
- Swallowed objects
- Lung diseases
- Identification of stones in the urinary system
- Problems in abdominal organs

The research focusses on different types of bone fractures. Significantly for our work,X-Rays are the images used for analysis.

III. BONE FRACTURE TYPES

Bones in the human body are naturally rigid and normally it cannot bend. An outside force can cause a bend in the bones, and when the force is too high, the bone will break or will get fractured/cracked. Bone fractures are of several types and the classification depends on the injuries caused by the breakage of the bone.

Regardless of the cause, generally bone fracture can be of following two types:

A. Simple fractures

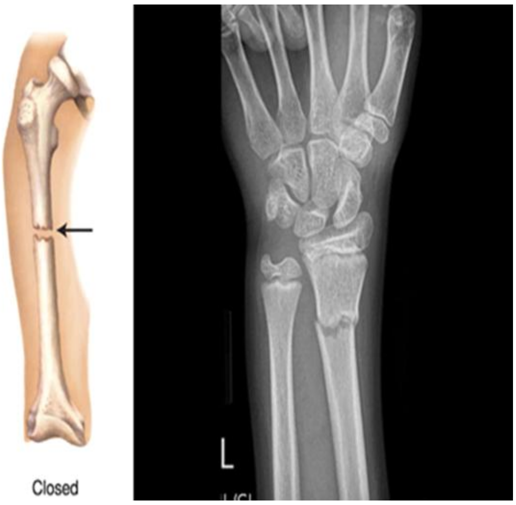


Figure 2 Simple Fracture

Simple fractures are the closed fractures, as the broken bones stick inside the skin. It may be just a crack rather than the break.

B. Compound fractures

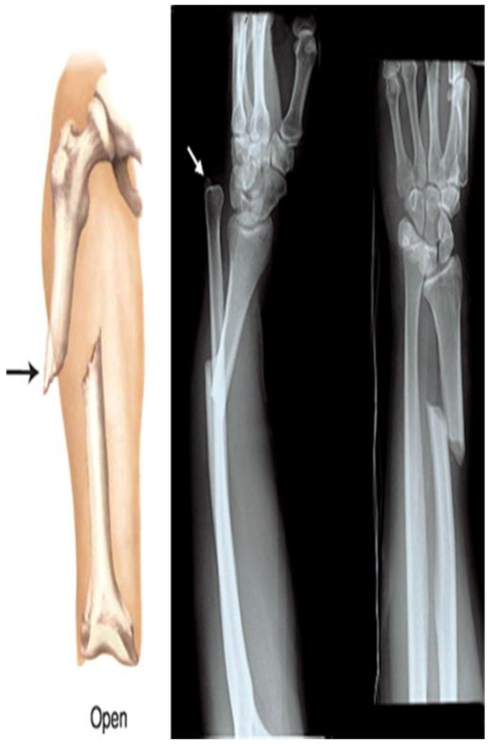
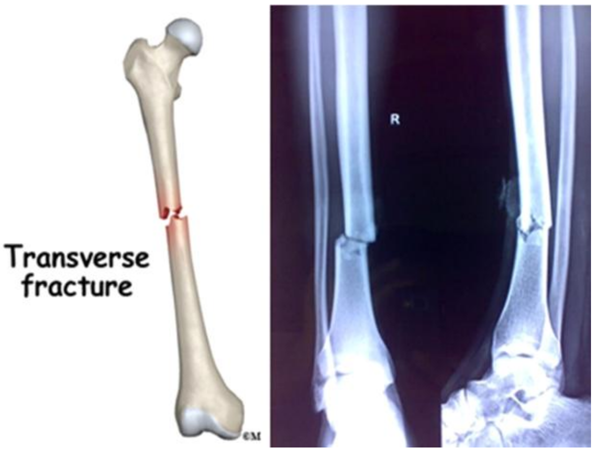


Figure 3 Compound Fracture

Compound fractures are highly critical as the broken bones penetrate out through the skin. They are also known as Open fractures. Compound fractures are highly prone to infection as the skin is cut. There is a possibility of infection in the place of wound and bone.

C. Other types of fractures also can be classified as follows

a. Transverse fractures



Bone Crack/break from the right angle to the bone's long axis.

b. Spiral fractures

Figure 5 Spiral Fracture

c. Comminuted fractures

Figure 6 Comminuted Fracture

Comminuted fractures are severe fractures in which bone is broken apart into several small pieces.

d. Impacted fractures

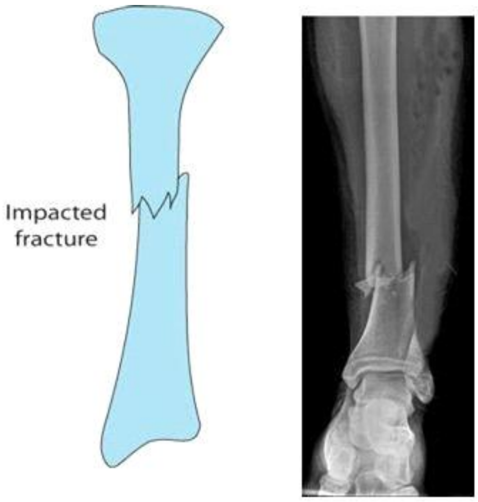


Figure 7 Impacted Fracture

In impacted fractures, broken bone fragments are collapsed with each other. The external force is too extreme that bone fragments submerge into each other.

e.Greenstick fractures

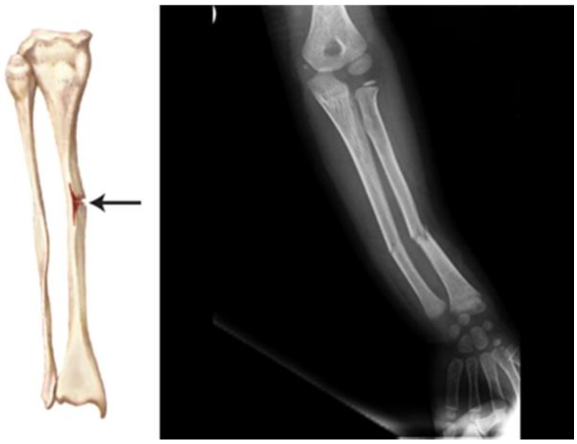


Figure 8 Green Stick Fracture

f. Oblique fractures

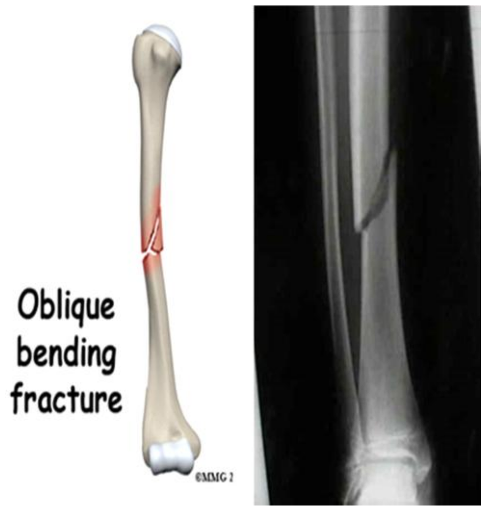


Figure 9 Oblique Fracture

This type of fracture is Diagonal to a bone's long axis. The external or accidental force is applied to the bone other than the right angle and it will cause the oblique fracture.

IV. MEDICAL IMAGE SEGMENTATION

This procedure can be either a minute part of any decision support system or can be some other quantitative analysis to be done. This has pulled in a lot of consideration resulting an immense literature of published surveys and computational procedures

A. General Approaches to Segmentation

There are different approaches to Segmentation but it can be categorized mainly into three different types. Automatic segmentation, semi-automatic segmentation, manual segmentation.In manual segmentation generally it is done by human and most of the time it is accurate but it will consume a lot of time.In semi-automatic segmentation user inputs will be required in a certain degree and then based on user inputs segmentation will be performed.For an example, specifying parameters for clustering algorithms..Computerized segmentation is the toughest of all the 3 types of segmentations, because it does not involve any user input. But it has the biggest advantage that it will be less time to consume as it can process a large number of images without user inputs. The only major thing would be to provide automatic segmentation algorithm for which it can be quite efficient.[5]Which divides the medical images segmentation into the 3 generations in which each adds additional level of algorithmic complexity.[6]

One of the generation techniques which are of the first generation works on a low level like finding pixel intensity values or on bimodal thresholding using Otsu's method[7], the edge detection , and the region growing based on the adjacent pixels. Here the approaches used do not use any earlier data and so they are of less use.Some methods which fall under the second generation uses statistical analysis. Here pixels in the image can belong to the known class of a predefined set. Here methods like active contour or snakes can be used which can either expand or contract towards the specific features, in the image[8].The latest generation calls for the third generation works with the prior information supplied to it and are faster.

B. Segmentation of bone from X-ray Images and its literature survey

As seen in the past literature X-Ray has got relatively less attention. This can be owed to the fact that X-Ray images are very difficult to analyze. Also, there are huge variations in the X- Ray images that are taken due to the changes in the photon density of the X-Ray beam. Also, noise is generated which results in intensity variation and contrast which does not keep the quality of the image same always for the same organs X-Ray also[10].There is difficulty in identifying the organ, skin and bone part in the X-Ray image because of absorption rate by different tissues and also it leads to blurred edges in the image. Also for two different persons or patients, the same X-Ray taken of the same organ of the body has different intensity characteristics which make it challenging for the researcher to do the research on the same part of the bone.

A patient with osteoporosis may have diminish bone thickness, and the bone matter in the influenced region will thusly seems thicker than the typical X-Ray images. Thus, however, the general arrangement continues as before, the exact state of bones that may differs with the one patient to the next.In instance to the traumatic injury, it might not be advisable to the patient to move here and there to get into the exact position when taking an X-Ray image,especially in the event that he/she is in an unsteady condition or has managed the various injury.The area and introduction of particular structures may hence shift starting with one X-Ray picture then onto the next, notwithstanding when gathered from a similar patient. According to the studies for radiograph segmentation by Manos[11] has gone with region- growing and merging method as stated by to its size, resemblance and then was assigning label equivalent to different regions according to their obtained intensity characteristics. Limitation of the approach by him was neither he has considered spatial information. Also, regions were not clearly demarcated according to those studies for different images of X-Ray.

Some early studies also focused on identifying lung regions in chest X-Rays and they applied Markov Random field models[12], rule-based heuristics[13], and classifiers based on local features [14] with a different rate of success.

One study has applied ASM for automatic segmentation of the patella in knee joint[15] with the help of a genetic algorithm. But as patella is very simple structure to identify with clearly defined edges it might be difficult to obtain good results in the case when there are overlapping structures. Tragically, this admonition applies to this admonition applies to countless the audits that use ASM or AAM to perceive objects of enthusiasm for pelvic X-Ray images. Be that as it may, as of late deformable models have gained importance in automatic as well as semi- automatic segmentation methods. Model applications incorporate recognizing vertebrae fracture[16]and also isolating lung fields in chest radiographs[17], [18]. For instance, the modernized division strategy proposed by Boukala[19] considers the to be as a single structure and can't see specific bones, additionally, the shape setting descriptors it uses to display the models are frail against false edges in the information images.

Region Growing (RG) technique is a region-based segmentation method which is applied locally to an image[20]. RG analyzes pixels in a neighbor of physically or consequently set seed points and combines them if a homogeneity condition in intensity similarity is met. which is applied locally to an image[20]. This examines pixels in a neighbor of physically it sets the seed focuses and consolidates them if a homogeneity condition in power similitude is met. RG procedures are used fundamentally to fragment the knee bone[21] as a result of its greater estimation in the joint and they are more dominant than thresholding strategies[23] Some of the advanced segmentation method based on strategies is a combination of less advanced methods with the latest one[25]. Atlas methods which are based on intensity, shape, and texture are hybrid segmentation methods[26][27]. Here source image is converted to the target image using non-linear geometrical transformations giving reliable results.Ding [28] use of an atlas-based approach in mechanically segmenting the femurs from the pelvic X-Ray images .The obtained Images with multiple overlapping bones always present a greater technical challenge to segment the bone part from the image. Thus by studying the above literature, it is difficult for the machine to automatically segment the part of the bone from the X-Ray image.

V. AUTOMATIC IDENTIFICATION OF REGION OF INTEREST (BONE BREAKAGE)

The most troublesome piece of medical image analysis is the computerized localization and delineation of region of interests.Computerized data assessment is one method for upgrading the clinical utility of estimations. A vital job for mechanized data extraction in medicinal imaging normally includes the segmentation of regions of the image so as to measure volumes and regions of interests of biological tissues for further analysis and confinement of pathologies. An x-ray beam makes image of any bone in the body, including the hand, wrist, arm, elbow, shoulder, foot, lower leg, leg (shin), knee, thigh, hip, pelvis or spine. Acknowledgment and right treatment of breaks are seen as noteworthy, as an off-base analysis regularly prompts unable patient organization, extended frustration, and exorbitant treatment.

During literature study, we didn't get any such research paper tending to computerized identification of the bone fractures from the X-ray images. In any case, just a couple of creations have guaranteed robotized division of the bone part from the X-beam image. Patent No: US9275469 US claims compositions and methods that allow for the analysis of bone mineral density and/or bone structure from x-ray images, wherein the bone structure includes trabecular bone structure. Patent No: US 8715187 B2 claims at automatically identifying and segmenting different tissue types in ultrasound images. Patent No: US 8135200 B2 relates to an imaging system using uto-shutter, a method for finding a region of interest in a digital image.

VI. CONCLUSION

The significance of computerized none fracture detection comes from the fact that in clinical practice when an orthopedic doctor is not available, it becomes very difficult in providing timely treatment.Mostly in the places where the density of population is more and less number of hospitals are present.This can lead to fatal consequences for the computer detection of fractures which can assist in identifying the type of fracture and the decision support system can give the primary course of treatment and thus improve the timeliness and fasten the healthcare for the patient.

REFERENCES

1. M. L. Giger, Computer-aided diagnosis in medical imaging-A new era in image interpretation, World Markets Research Centre, Tech. Rep. (2000).
2. S. Thammasitboon and W. B. Cutrer, “Diagnostic decision-making and strategies to improve diagnosis,” Curr. Probl. Pediatr. Adolesc. Health Care, vol. 43, no. 9, pp. 232–241, Oct. 2013.
3. Arun Baran Singha Mahapatra., Essentials of medical physiology. ISBN 81-86793-56- 9.
4. P. Chakraborty; G. Chakraborty., Practical Pathology. ISBN 81-7381-332-9.
5. Robbins and Cotran, Review of Pathology. ISBN 0-7216-0194-4.
6. David Sutton, Radiology and imaging for med. students (7th ed.). ISBN 81-7867-100- X.
7. “Automated medical image segmentation techniques Sharma N, Aggarwal LM - J Med Phys.” [Online]. Available: http://www.jmp.org.in/article.asp?issn=0971-203;year=2010;volume=35;issue=1;spage=3;epage=14;aulast=Sharma.
8. D. J. Withey and Z. J. Koles, “Medical Image Segmentation: Methods and Software,” in 2007 Joint Meeting of the 6th International Symposium on Noninvasive Functional Source Imaging of the Brain and Heart and the International Conference on Functional Biomedical Imaging, 2007, pp. 140–143.
9. N. Otsu, “A Threshold Selection Method from Gray-Level Histograms,” IEEE Trans. Syst. Man Cybern., vol. 9, no. 1, pp. 62–66, Jan. 1979.
10. T. McInerney and D. Terzopoulos, “Deformable models in medical image analysis,” in Mathematical methods in biomedical image analysis, 1996., Proceedings of the workshop on, 1996, pp. 171–180.
11. T. F. Cootes and C. J. Taylor, “Statistical models of appearance for medical image analysis and computer vision,” in Medical Imaging 2001, 2001, pp. 236–248.
12. N. Umadevi and S. N. Geethalakshmi, “Multiple classification systems for fracture detection in human bone x-ray images,” in 2012 Third International Conference on Computing Communication Networking Technologies (ICCCNT), 2012, pp. 1–8.
13. G. K. Manos, A. Y. Cairns, I. W. Rickets, and D. Sinclair, “Segmenting radiographs of the hand and wrist,” Comput. Methods Programs Biomed., vol. 43, no. 3, pp. 227–237, Jun. 1994.
14. N. F. Vittitoe, R. Vargas-Voracek, and C. F. Floyd, “Identification of lung regions
15. in chest radiographs using Markov random field modeling,” Med. Phys., vol. 25, no. 6, pp. 976–985, Jun. 1998.
16. “Lung segmentation in digital radiographs | SpringerLink.” [Online]. Available: https://link.springer.com/article/10.1007/BF03168427.
17. “A fully automated algorithm for the segmentation of lung fields on digital chest radiographic images. - PubMed - NCBI.” [Online]. Available: https://www.ncbi.nlm.nih.gov/pubmed/7565349.
18. H. C. Chen, C. H. Wu, C. J. Lin, Y. H. Liu, and Y. N. Sun, “Automated segmentation for patella from lateral knee X-ray images,” Conf. Proc. Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. IEEE Eng. Med. Biol. Soc. Annu. Conf., vol. 2009, pp. 3553–3556, 2009.
19. M. G. Roberts, T. Oh, E. M. B. Pacheco, R. Mohankumar, T. F. Cootes, and J. E. Adams, “Semi-automatic determination of detailed vertebral shape from lumbar radiographs using active appearance models,” Osteoporos. Int. J. Establ. Result Coop. Eur. Found. Osteoporos. Natl. Osteoporos. Found. USA, vol. 23, no. 2, pp. 655–664, Feb. 2012.
20. T. Xu, M. Mandal, R. Long, and A. Basu, “Gradient vector flow based active shape model for lung field segmentation in chest radiographs,” in 2009 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2009, pp. 3561– 3564.
21. B. van Ginneken, M. B. Stegmann, and M. Loog, “Segmentation of anatomical structures in chest radiographs using supervised methods: a comparative study on a public database,” Med. Image Anal., vol. 10, no. 1, pp. 19–40, Feb. 2006.
22. N. Boukala, E. Favier, B. Laget, and P. Radeva, “Active shape model-based segmentation of bone structures in hip radiographs,” in 2004 IEEE International Conference on Industrial Technology, 2004. IEEE ICIT ’04, 2004, vol. 3, p. 1682– 1687 Vol. 3.
23. D. L. Pham, C. Xu, and J. L. Prince, “Current methods in medical image segmentation 1,” Annu. Rev. Biomed. Eng., vol. 2, no. 1, pp. 315–337, 2000.
24. A. Aprovitola and L. Gallo, “Knee bone segmentation from MRI: A classification and literature review,” Biocybern. Biomed. Eng., vol. 36, no. 2, pp. 437–449, 2016.
25. T. Kapur, P. Beardsley, S. Gibson, W. Grimson, and W. Wells, “Model-based segmentation of clinical knee MRI,” in Proc. IEEE Int’l Workshop on Model-Based 3D Image Analysis, 1998, pp. 97–106.
26. Y. Sun, E. C. Teo, and Q. H. Zhang, “Discussions of Knee joint segmentation,” in Biomedical and Pharmaceutical Engineering, 2006. ICBPE 2006. International Conference on, 2006.
27. C. Xu and J. L. Prince, “Snakes, shapes, and gradient vector flow,” IEEE Trans. Image Process., vol. 7, no. 3, pp. 359–369, Mar. 1998.
28. B. Fischer and J. Modersitzki, “A unified approach to fast image registration and a new curvature based registration technique,” Linear Algebra Its Appl., vol. 380, pp. 107–124, Mar. 2004.