Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 7, July 2021: 7849 - 7853

Research Article

Automatic Joint detection Hand Radiographs in Rheumatoid Arthritis

Prof G.S. Mate[1], Dr. A.K. Kureshi[2] ,

JSPM's Rajarshi Shahu College of Engineering, Tathawade Pune

Abstract

Although radiographic evaluation of joint space measurement is essential in characterizing disease progression and prediction in patients with rheumatoid arthritis (RA), it is often difficult even for trained radiologists to find radiographic changes on hand radiographs because lesion changes are often subtle. Therefore, an effective system analysis is necessary for the identification and detection of rheumatoid arthritis by hand, especially during its development or pre-diagnostic stages. First symptom of this disease is seen in joints of hand finger and wrist joints thus making hand radiograph analysis extremely important. Lately Reading hand X-ray radiographic image to measure joint space width is very tedious and time consuming task for the radiologist since there are 14 joints in hand and also the structure of hand is complicated to carry out joint space width measurement and analysis. In this paper a quantitative method is proposed for automatically detection of hand joints of RA patients. The proposed system is designed to develop an intelligent system to detect rheumatoid arthritis of the hand using image processing techniques and a neural network of convolution.The system comprises of two main phases. The image processing phase is the first stage in which images are processed using image processing. These techniques include pre-processing, image segmentation and feature extraction using gabor filter. We have experimented 21 digital hand X-ray radiograph of resolution 2000 pixels×2000 pixels and automatically detected all finger joints successfully.

Keyword-Rheumatoid Arthritis, Hand X-ray Gabor filter

I. Introduction

Rheumatoid arthritis (RA) can be defined as a complex autoimmune inflammatory disease associated with significant disability, morbidity and death. For prognostic and rapeutic reasons, early identification of patients with aggressive and destructive disease is importantA chronic inflammatory disorder that can affect the joints of the fingers, knees and hands causes swelling, stiffness and pain is another definition for rheumatoid arthritis. The actuators for the onset of RA are only theoretical, but it is expected that a genetic responsibility for the disorder, several viruses and bacteria can play a major role in disrupting immunological tolerance and psychological conditions by further weakening the immune system of the persons concerned. Since the main causes of RA remain unknown, cures or treatments have not yet been found. Today all treatments and therapies are only available to reduce symptoms and delay the progression of the disease (Newman, 1995).

RA has many signs and symptoms that can be detected in an image, including:

• tender, warm, swollen joints
• hours of morning stiffness
• firm bumps of rheumatoid nodules in the skin (tissue)

Rheumatoid arthritis (RA) or joint inflammation can be characterized as a complex autoimmune incendiary infection that is linked to impressive disability, horror and death .Early distinguishing evidence of patients with severe dangerous infection is essential for predictive reasons. An alternative definition for rheumatoid joint pain is an ongoing fire problem that can affect the joints of the fingers, knees and hands, leading to swelling, firmness and agony.The close distance between the femoral and tibial bones, the loss of cartilage and the spurs of the bone are the basic signs of this disease. In our identification system, we focus on extracting these features using certain image processing techniques to be fed into a neural network that has the ability to classify with many normal and arthritic hand images after learning convergence.

The paper is organized as follows. In Section II, related work is discussed. Section III describe the automatic joint position detection and the accurate contour detection of bone is described. In Section III experimental results are explained in detail. Section IV describes validation of result and the paper ends with conclusion in Section V.

II. Related work

Rheumatoid Arthritis (RA) is a disease where the joints of knees, fingers get affected . RA results in joint stiffness, pain, swelling of the joints which showsdeformity in the late stages of the disease. So its detection is of at most important in early stages, Various researchers has proposed methods like MRI, X-Ray, Radiography, Thermograph etc. for the detection of RA. For supporting research in RA

GorgLangs et al[1] The application was proposed where the quantification of radiographic changes in RA was done by measuring two indicators for disease progression. Hand radiograph was used to determine bone positions and contour delineations are determined. Van't Klooster developed semi-automated method to measure all joint margin , JSW measurement was applied to both hands, joints of thumb are not considered for analysis[2]. Manual hand X-ray photo analysis is very difficult and time consuming task for the radiologist. Since bones in little finger are thinner than other fingers, it is difficult to separate bones from the X-ray photo background [3]. Syaiful Anam et al. have proposed automatic bone boundary detection in hand radiographs by using modified level set method and diffusion filter [4]. Automatic joint location estimation are obtained by local linear mapping based on texture features. Bone contours are delineated by active shape model comprised of statistical model of bone shape and local texture [5] In previous studies, many methods for identifying lesions using classifiers such as an artificial neural network (ANN), support vector machine (SVM), and genetic algorithm (GA). Recently, deep learning has gained interest in the general imaging field. Particularly, many studies have reported a better performance of the deep convolutional neural network (DCNN) than conventional classifiers in image identification [6]. Yinghe Huo et al. have proposed automatic joint detection in rheumatoid arthritis hand radiographs

[8]. This method has focused on both joint location and joint margin detection. An automatic unsupervised joint location and joint margin detection method with a high detection rate was proposed. Secondly, the margin span is anatomically defined

III. Joint Location Detection

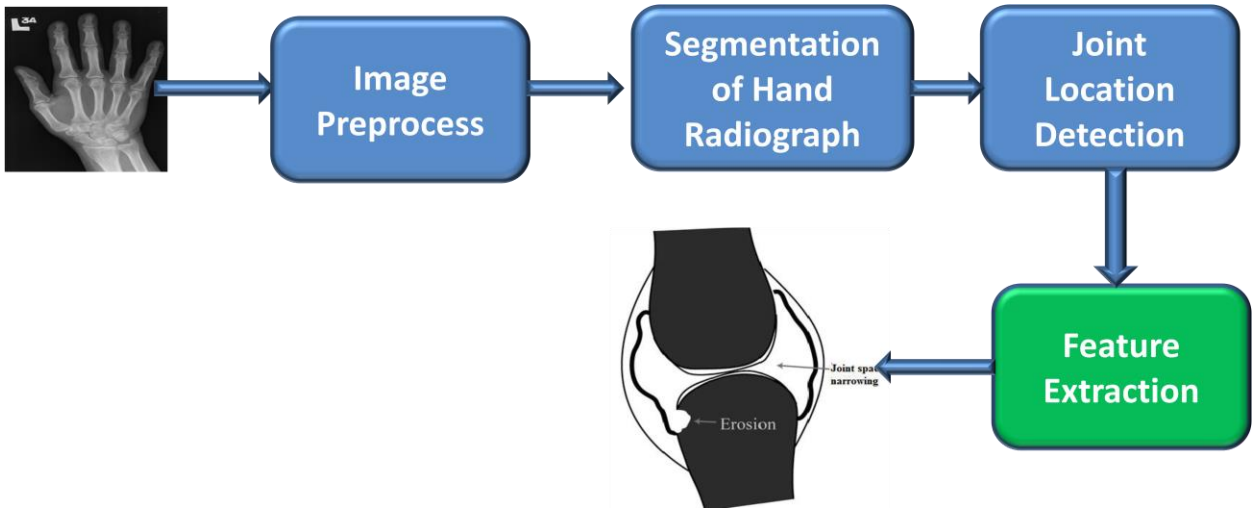
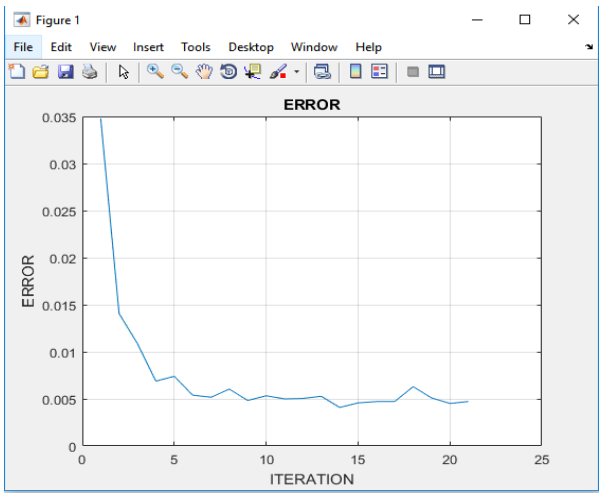


Fig 1.Block diagram for to detect Joint in Hand radiograph

3.1 Preprocessing-Pre-processing is the main step in image analysis that performs image enhancement and noise reduction techniques to improve image quality. The image is enhanced by improving fine details and removing noise from the image. In the rheumatoid arthritis system, Enhancement and noise reduction techniques are implemented, which can produce the best possible results. Enhancement will lead to more prominent edges and a sharp image such as the tumor noise is obtained will reduce the blurring effect of the image. The original image is resized with 100X100. Error for processing the hand x ray image is detected and same is removed .



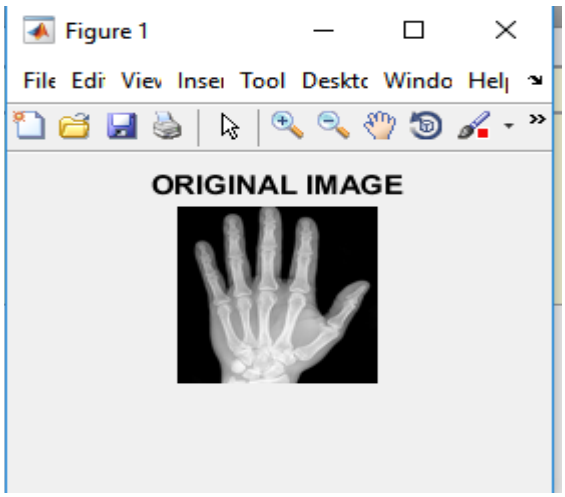
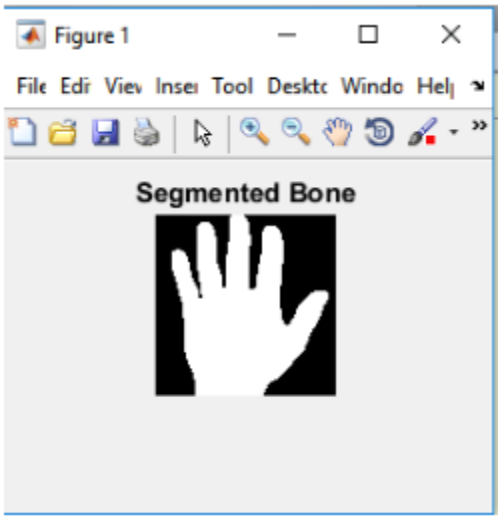


Fig 2 Error **Fig 3 Original Image**

3.2 Segmentation-Image segmentation is a process of dividing the image into homogeneous regions that correspond to different objects in the image. The image is divided into meaningful regions. The image is segmented using fundamental image features such as intensity, edge or texture.



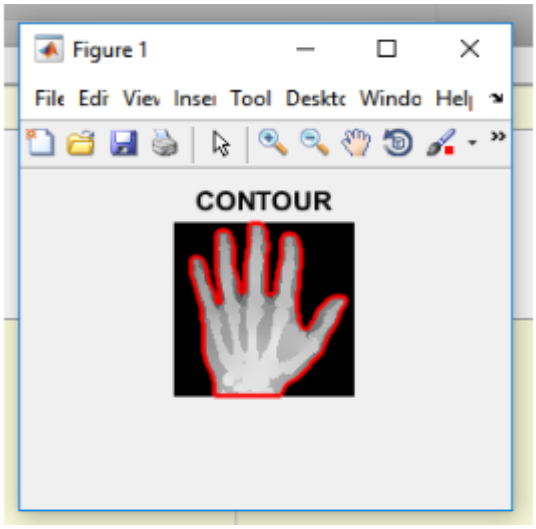


Fig 4 Segmentation **Fig 5 Contour**

3.3 Feature extraction-The extraction of features is the technique used to extract specific features from pre- processed images of various abnormal categories. This technique extracts the high level of features required to classify the targets. Features are the items that are unique in size, shape, composition, location, etc. The extraction of features is an important step in building any classification of patterns and aims to extract the relevant information that characterizes every class. Gabor filter [7] is used to locate the joint position. For 2D signals such as images is the standard deviation of the Gaussian kernel depends upon the spatial frequency to be measured. Φ is the orientation. (x,y) is the position of filter relative to the input signal Gabor filter can be viewed in following Equation

$$g(x,y,\theta,\emptyset) = exp\frac{(-x^2+y^2)}{\sigma^2}.\exp\left(2\pi\theta\sqrt{-1}(x\cos\emptyset + y\sin\emptyset)\right)$$

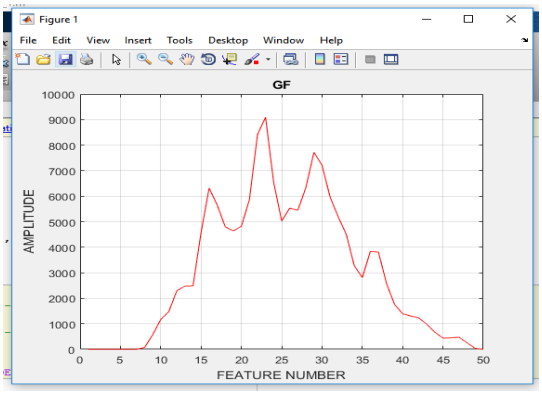


Fig 6 Gabor Features

V. Conclusion

The method introduced in this paper is a fully automated system to detect the joint. The results are satisfying and reliable. We have experimented 21 digital hand X-ray radiograph of resolution 2000 pixels×2000 pixels and automatically detected all finger joints successfully

References

1. Gorg Langs et al- "Automatic Quantification of Joint Space Narrowing and Erosions in RA"
2. IEEE Transaction on Medical Imaging Vol28,No 1 Jan2009.
3. Van't Klooster R, Hendricks EA, Watt I, Kloppenburg M., Reiber JH, Stoel BC, "Automatic
4. quantification of Osteoarthritis: validation of a new method to measure joint space width,
5. Osteoarthritis, Cartilage, Elsevier 16(1), pp 18-25, 2008.
6. Andrzej Bieleckia,, Mariusz Korkoszb, Bartosz Zielin,"Hand radiographs preprocessing,
7. image representation in the finger regions and joint space width measurements for image
8. interpretation" ,Elsevier publication, Pattern recognition 41, May 2008.
9. Syaiful Anam, Eiji Uchino, Hideaki Misawa, and Noriaki Suetake, ―Automatic bone
10. boundary detection in hand radiographs by using modified level set method and diffusion
11. filter, In IEEE 6th International Workshop on Computational Intelligence and Applications,
12. Hiroshima, Japan, July 13, 2013.
13. Kelvin Leung, Mark Holden, Nadeem Saeed, Keith Books, J. Buckton, A.A. Williams,
14. S.Campbell, K.Changani,D.reid, Y.Zhao, M.Wilde, D.Rueckert, J.Hajanal, Derek L.G.Hill,
15. "Automatic Quantification of changes in bone in serial MR images of joints", IEEE
16. transaction on medical imaging,vol 25,no.12,Dec 2006
17. Krizhevsky A, Sutskever I, Hinton GE (2012) Imagenet classification with deep
18. convolutional neural networks. Advances in neural information processing systems, pp:1097–
19. 1105
20. Simona E. Grigorescu, Nicolai Petkov, Peter Kruizinga, "Comparison of texture features
21. based on Gabor filters", IEEE transaction on image processing, vol 11, no.10, Oct 2012.
22. Yinghe Huo, Koen L. Vincken, Max A. Viergever, Floris P. Lafeber, ―Automatic joint
23. detection in rheumatoid arthritis hand radiograph‖, In IEEE 10th International Symposium on
24. Biomedical Imaging: From Nano to Macro San Francisco, CA, USA, April 7-11, 2013.
25. Bhayashree et al , ―Determination and analysis of Arthritis using Digital imaging
26. techniques, IJEEDC, ISSN 2320-2084, vol 2 Issue 9,2014.
27. Murakami et al , "Automatic identification of bone erosions in rheumatoid arthritis from
28. hand radiographs based on deep convolutional neural network "Multimed Tools Appl (2018)
29. 77:10921–10937