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AUTOMATIC QUANTIFICATION OF JOINT SPACE NARROWING AND EROSIONS IN RHEUMATOID ARTHIRITIS

J.Jayavarshini [#1],S.Sandhya [#2],S.Gayathri [#3],S.Nivethini [#4],R.Nivya Shri [#5]

[1,2,3,4,5]*Electronics And Communication Engineering , Velammal Engineering College, (India)*

ABSTRACT

Rheumatoid arthritis is a chronic disease which destroys the joints of our body. This leads to erosion in bones which intern may cause aberration in body and also leads to ankylosis in the final stage of the disease. Periodic analysis of the disease is necessary as it is chronic and is done by measuring JSW(Joint Space Width). At the beginning of this disease mainly the joints of hand and wrist are affected which is analyzed using a hand radiography. The manual JSW is measured in hand by X-ray digital radiograph of Arthritis but it has disadvantages like inaccuracy, inter-reader variability. Also, these analysis are difficult for radiologist since there are 14 number of hand joints. Hence to find this disease and to measure the severity of the disease computer-aided analysis is required. Thus, the image processing technique using MATLAB is required for automatic analysis of joint space narrowing. In this process bone boundaries are predicted using Active contour which describes the shape of the bone and local texture. GLCM(Gray Level Coherence Matrix) is used for the feature extraction (that is differentiating bone and non-bone features).At last LLM(Local Linear Mapping) is used for joint space detection. In this paper, we have examined 30 radiograph images in which ten are affected by rheumatoid arthritis and the remaining are normal. Here joint location is estimated with an accuracy of 92% in which speed of image interpretation is higher. By this automated analysis there is no need of any skilled person and remote analysis is also possible.

Keywords: Active contour, Gray Level Coherence Matrix, Joint Space Width, Local Linear Mapping, Rheumatoid arthritis.

I.INTRODUCTION

Rheumatoid arthritis is a disease in which the body's immune system attacks its own tissue, including joints. In severe cases, it attacks internal organs. Rheumatoid arthritis affects joint linings, causing painful swelling. Over long periods of time, the inflammation associated with rheumatoid arthritis can cause bone erosion and joint deformity . Rheumatoid Arthritis (RA) is a inflammatory disease that mainly affects the joints in the body especially the fingers, hands, wrist and knees. RA causes bone erosion and disability along with pain, swelling, stiffness and loss of function in the joints. Ratio of female to male RA patients is about 3:1 .Rheumatoid arthritis affects 1.5 million Americans and causes for 22% of all deaths from 808arthritis and other rheumatic conditions. RA affects 0.75% of the population The life expectancy of an RA patient is reduced by 4 to 10 years.

Till today there is no proven cure of the disease, hence close monitoring of disease is important in medical treatment and diagnosis to slow down the progression of the disease. Hence Conventional radiographs have been considered to be a commonly used method for evaluating the progression of bone and joint damage in RA. Hand radiograph analysis in RA is the time consuming for radiologists. Hand radiograph is very much essential in order to show the accurate analysis. In diagnostic process the importance of joint space width requires the distribution of narrowed hand joints. There are three joints in each finger. Thumb has two joints.Those three hand joints are MCP,PIP and DIP. The metacarpophalangeal (MCP) is located between metacarpal phalangeal bone and proximal phalange bone. The proximal interphalangeal is the joint located between proximal and intermediate phalanx and the joint between intermediate and distal phalanx is called as distal interphalangeal (DIP) joint. Image processing is a physical process which converts the input image signal into a physical image. The image signal can be either digital or analog. The actual output itself can be an actual physical image or the characteristics of an image.To implement the image processing MATLAB is used.The MATLAB ® high-performance language for technical computing integrates computation, visualization, and programming in an environment which is user friendly. MATLAB represents every problems and solutions in familiar mathematical notation that is via matrix.

II.EXISTING METHOD

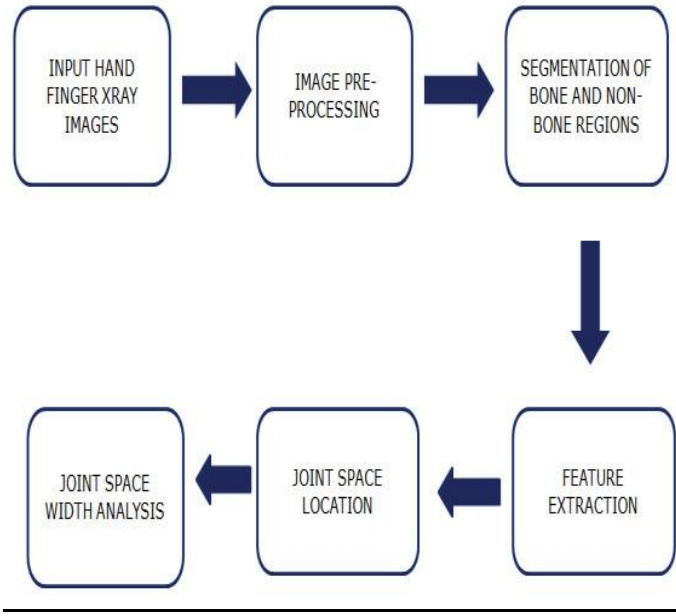
Rheumatoid arthritis is an autoimmune disease which affects the lining of our joints .It can affect more than our joints resulting in bone erosion and joint deformity. At the beginning, for monitoring the disease manual JSW measurement in hand X-ray digital radiograph of Arthritis patients were in use but it has disadvantages like inaccuracy, inter-reader variability. RA affects 0.75% of the population in India every year and even the life expectancy of an RA patient is reduced by 4 to 10 years. Till today there is no perfect method for curing, hence periodic analyses of the disease is necessary to avoid them worsen. Later, joint space widths are automatically localized and segmented using hierarchical inferences and statistical models came into existence. In this, a number of shape descriptors are obtained from the segmented bone contour to quantify skeletal growth. These descriptors are particularly selected to reflect growth-related shape variations in the metaphysic epiphysis junction. CAJSA detects joint space width of JSD-MCP and JSD-PIP. The segmentation technique used here is Active Shape Model (ASM) and the valley points are detected using LLM algorithm. This segmentation technique which gives better performance than the classical contour but this requires the bone boundary to be a closed loop.

III.PROPOSED METHOD

In our proposed system, phalanx bones are being automatically localized and it is segmented using hierarchical inferences and statistical models. To quantify skeletal growth, many shape descriptors are used which is segmented using active contour. Active contour, which helps us to differentiate bone and non-bone boundaries. From these, the above feature vector has been selected for the regression model and a Bayesian estimator. These descriptors are mainly selected to show any growth-related shape variations in the metaphysic epiphysis

junction. Thus for proposed method of Skeletal maturity or bone age of children, CAJSA will help us to find the joint space width of JSD-MCP and JSD-PIP. Therefore, a sharp JSN score will be performed. This segmentation technique which gives you a better performance than the classical contour models. It can also be applied to various kind of noisy images. But we require a bone boundary which must be a closed loop .Hence we have introduced our method of detecting a contour using various active shape models .But here we use Active Shape Model (ASM) method for detecting the edge. An iterative optimization process using ASM segmentation, this may require an appropriate indication of starting point to converge in order to arrive at proper solutions . Using GLCM, the various features of the descriptors are obtained. As a result, peak and valley points on the skeleton are detected. Then the key point is the exact joint location which is being traced by STP -IP algorithm. STP-IP algorithm which is used to detect the joint space location automatically.

3.1 BLOCK DIAGRAM



3.1 PREPROCESSING

In preprocessing stage, the input X-ray image is resampled to low resolution using Laplacian filter. Laplacian filters are used to find the sharp changes in the input image.It is commonly used to smooth the image .As it is a derivative filter it is very sensitive to noise and is smooth the image using laplacian it is common to smooth the image (e.g., using a Gaussian filter) before applying the Laplacian. Image filtering is useful for many applications, including smoothing, sharpening, removing noise, and edge detection. The grey scale is enhanced and morphological operations are performed

3.2 BINARIZATION

Binarization is done to create a binary image from the filtered image.This is done by replacing all values above determined threshold to 1s and setting all other values to 0s. By default, binarization uses Otsu's algorithm. This algorithm chooses the threshold value to minimize the intraclass variance of the thresholded black and white pixels. Binarization uses a 256-bin image histogram to compute Otsu's threshold. The output image will be a black and white image. Binarization is to differentiate bone and non bone features

3.3 BONE SEGMENTATION

The bone contours are detected with shape and texture approach using ASM and active contour .Therefore ASM are kept in the bone boundaries which segments bone from non-bone boundaries. Active contour model is used for delineating an object outline from a possibly noisy 2D input image and is also called as snakes.It is used for object tracking, shape recognition, segmentation, edge detection and stereo matching. segments the image A into foreground (object) and background regions using active contour segmentation. Active contour evolves the segmentation using an iterative process. By default, activecontour performs 100 iterations but here it performs about 1000 iterations for accuracy. mask is a binary image that specifies the initial state of the active contour. The boundaries of the object regions (white) in mask define the initial contour position used for contour evolution to segment the image

3.4 FEATURE EXTRACTION

GLCM is used to extract various kinds of features which enable us to detect the boundaries.The Grey Level Coherence Matrix characterize the texture of an image by calculating the repeating frequency of pixel with specific values. From the specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix

3.5 JOINT LOCATION DETECTION

STP-IP are used to detect the location and position of 12 joints .The relation is established between local image and located landmark positions which may result in orientation of hand.To locate joints in hand radiograph image ,STP-IPs are used and joint space width is detected.

3.6 JSW MEASUREMENT

To locate the joint features, STP-IP are applied to the local image texture which is extracted and detected. Minimum JSW, mean JSW, joint space area, and JSW at fixed locations are included in Joint space width measurements. Mainly JSW measurement is used to measure the joint space narrowing.

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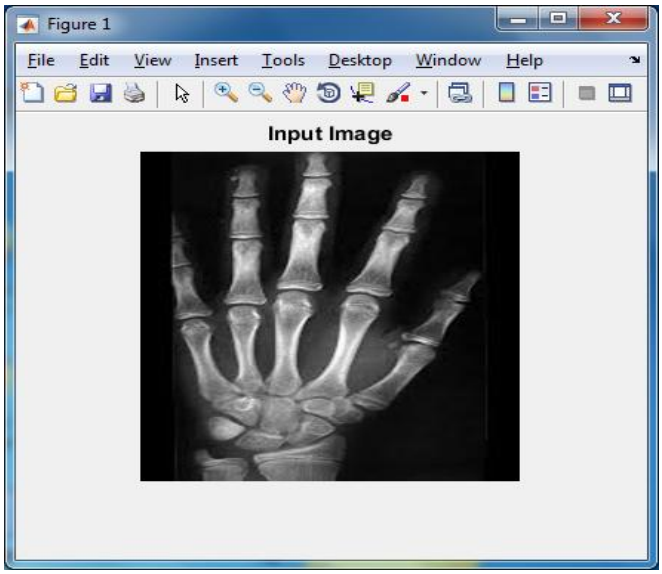
IV. RESULTS

4.1 INPUT IMAGE

Fig.1 Input Image



Since the bones are clearly visible in X-rays it is considered to be a standard way of identifying JSW(joint space width). At the start of disease 90% of the symptoms of Arthritis is seen in hands, hence about 30 hand X-ray images are taken for analysis out of which 10 hand X-ray images are normal and 20 hand X-ray images are with various joints affected by RA. These hand X-ray images are collected from hospital. The Input hand X-ray image used here is of 1000×2000 pixels.

4.2 FILTERED IMAGE

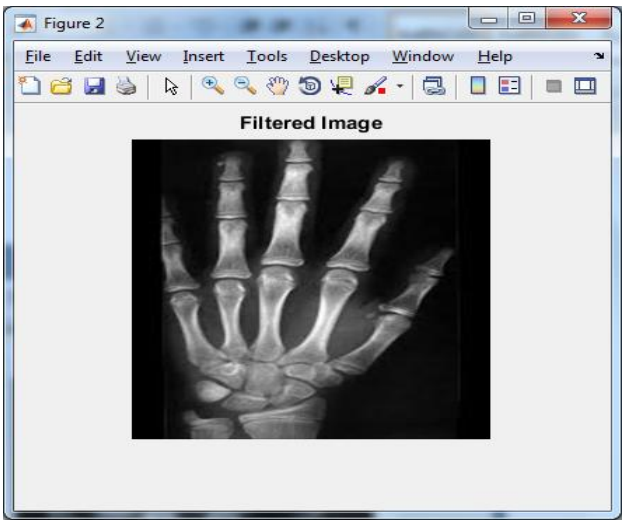


Fig2.Filtered image

This image is resized in preprocessing step to a resolution of 500×500 pixels. In this method Laplacian filter is used to remove noises in the input image. Laplacian filter is also for the purpose of finding the rapid changes that is edges in the input images.

4.3.BINARIZED IMAGE

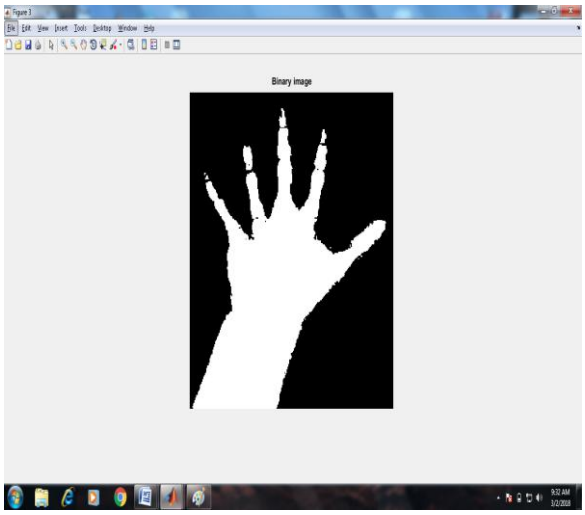


Fig.3 Binarized image

Fig.3 shows image after binarization. Binarization isfor the reduction of grayscale image to binary image. This is also for differentiation between bone and non bone features where background represents non bone and the foreground represents represents bone. Skeletonization

Of binary image is a thinning process where the peak and the valley points are detected.

4.4 SEGMENTED IMAGE

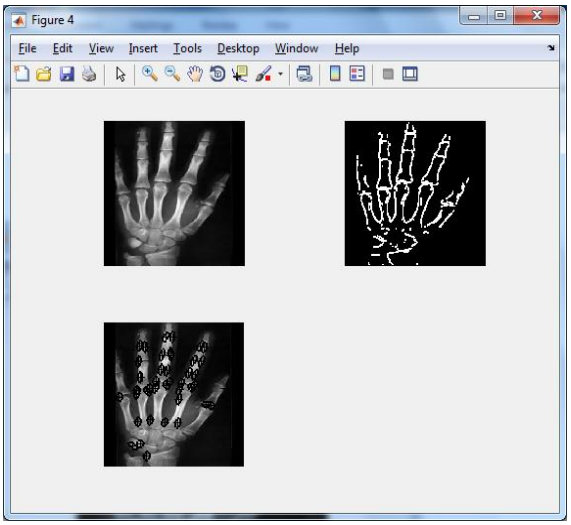


Fig4.segmented image

Fig.4 shows the image segmented using Active contour. For individual bone contours detection with a statistical shape and texture model ASMs are used. The resulting contour is refined by snake. An ASM will be fitted to the bone contours. Because of the ASM there will be delineation in the image which can be refined by Active Contour. The active contour is used to extract the texture information from the gray value profiles in the ASM. Active contour is used because this allows for a more flexible segmentation of the bone. The shape of hand is traced perfectly after the 1000 iteration which has more accuracy.

4.5 JOINT LOCATION IDENTIFICATION

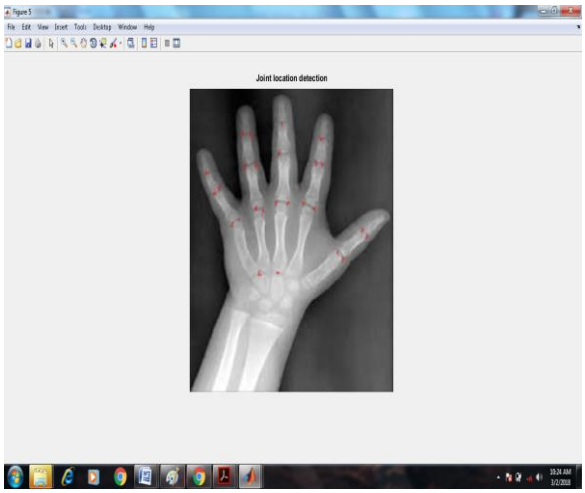


Fig.5Joint location identification

Fig.5 shows image of joint location identification for arthritis patient. Using this, the various statistical features are calculated like mean, median, variance which is used for the analysis of severity of the disease. Joint location accuracy is calculated by considering the number of accurate joints identified divided by the total number of joints that is 14.

V.CONCLUSION

All the images are tested and the calculated mean joint location accuracy is found to be 95%. The bone segmentation process accuracy was found to be 80%. Reproducibility error percentage is 1% to 3%. The database image and the result found is validated by a team of medical experts. The proposed model of detection of Rheumatoid arthritis is fully automated. It provides increased accuracy, reproducibility and speed of image interpretation. This model provides integration of the status of multiple joints, thus reducing time as well as intra and inter-reader variations. In future this work can be extended to diagnose the severity of the disease and the research will also include applying the computerized approach to large-scale cohorts, so as to examine whether the approach has an increased responsiveness to changes compared with the conventional Svdh scoring method.

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