Segmentation of Bones Using MRI

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Abstract:- Segmenting bone tissue automatically in Magnetic Resonance Imaging(MRI) scans is difficult for low signal-to-noise ratios, lack of consistency in lighting conditions is very high, and variability within bone cells in the scanned images. Current methods available are either it is partially automatic system or depends on databases of prior manually segmentation result. Fast and accurate segmentation of knee structures from MRI is essential for clinical feasibility of these techniques. However, manually segmenting bone tissue is time consuming. The main objective is to first design a system for automatic segmentation of bone structures for MRI data with a bilateral filtering and clustering based methods.

Keywords:- *Segmentation, Bilateral filtering, K-means, Fuzzy C-means, MRI.*

I. INTRODUCTION

Magnetic Resonance Imaging (MRI) helps a doctor diagnose an injury or disease, and it can monitor how well you're doing with a treatment. MRIs can be done on different parts of your body. MRI scan is useful for looking at soft tissues and the nervous system and also to examine bones, joints, and soft tissues, structural abnormalities such as tumors, inflammatory disease. Musculoskeletal models created by MRI scanning can be used to in the field of education to teach students, clinics and hospitals. To obtaining musculoskeletal models, manually segmenting bones and muscles is required and also manually segmenting bone structure is too much time consuming process; segmenting single bone structure takes an hour. Automatic segmentation could allow clinical experts and doctors to quickly identify segmented region of bones. Completely automatic segmentation is difficult for following reasons. First, identifying different tissues in bone is difficult even for human labelers and medical experts due to difference in signal intensity between the background and the area of interest. Second, making global image processing difficult because lack of consistency in lightning conditions is very high during MRI scanning causes background in other regions to be lighter than the white cancellous bone tissue in some region. Third, different bone tissues and blood vessels tend to vary largely in appearance with each other than with the surrounding blood vessels and muscle tissue. Methods in segmentation procedure must yield good result to inconsistencies.

II. PROBLEM STATEMENT

MRI is a specific radiology method for generating functional and structural image of the body, and particularly useful for neurological, muscular, oncological and skeletal imaging. Structural images of the body can be obtained in any position, specifically, rapidly, and without uncovering to ionizing radiation. MRI uses a strong magnetic field and radio waves to create detailed images of the organs and tissues within the body. Radio waves is used to produce an effect detectable by the scanner and to alter the alignment of the magnetization. We can observe optimization problem in MR imaging techniques due to in more pulse sequences. Based on the structure of bone, the optimal pulse sequence must be chosen in order to optimally differentiate the cells or organs of interest and to carry out the segmentation procedure [2].

III. METHODOLOGY

Segmentation is always delayed due to noise present in the image and difficulty in understanding structure of bones because of streaks. Therefore, the bilateral filter which returns structural edge information by reducing noise present in the image. Bilateral filtering algorithm is a nonlinear, edge preserving algorithm.

A. Bilateral Filtering

Bilateral filtering algorithm works based on the idea of a combination of domain and range filtering. A bilateral filter is a noise reducing and smooths images while preserving edges, by means of a nonlinear combination of nearby pixel values in the image. From Gaussian distribution weights are calculated. Crucially, the weights on the radiometric differences, not only on Euclidean distance of pixels. Bilateral filter in image has a significant noise reduction and also edges are well preserved [6]. The bilateral filter is a specially varying filter that better preserves edges than the Gaussian filter [1].

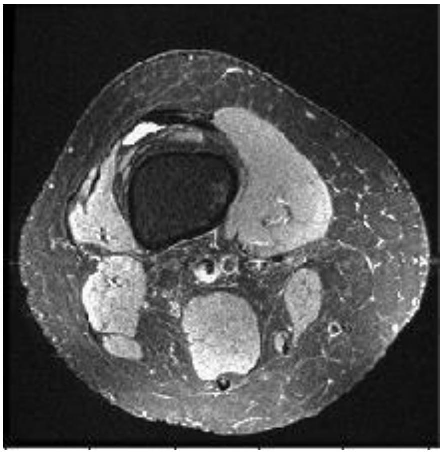

Fig 1:- Original Image

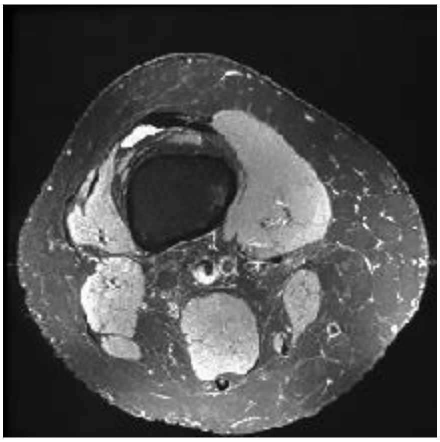

Fig 2:- Image after applying Bilateral Filtering algorithm.

B. K-Means clustering

K-Means clustering algorithm is an unsupervised algorithm. K-means algorithm is used to segment the required area from the background. It clusters, or partitions the given data into K-clusters or parts based on the K-centroids and gives us a primary segmentation [4]. In the primary segmentation, coarse areas of the images are smoothened. K-means clustering is simple and has relatively low computational complexity, it partitions a collection of data into a k number group of data. K means clustering classifies a given set of data into k number of disjoint clusters. K-means algorithm consists of two separate phases. In the first phase it k centroids are calculated and in the second phase, it takes each point to the cluster which has the nearest centroid from the respective data point. There are different methods to define the distance of the nearest centroid and one of the most used methods is Euclidean distance. Once the grouping is done, new centroid of each cluster is calculated and a new Euclidean distance is calculated based on that centroid between each center and each data point and the points that having minimum Euclidean distance in the cluster is assigned to the centroid. Each cluster in the partition is outlined by its member objects and by its centroid. The centroid for each cluster is the point to that the sum of the squared distance between the data points and centroid would be minimum. K -means is iterative in which it minimizes the sum of distances from each object to its cluster centroid, over all clusters.

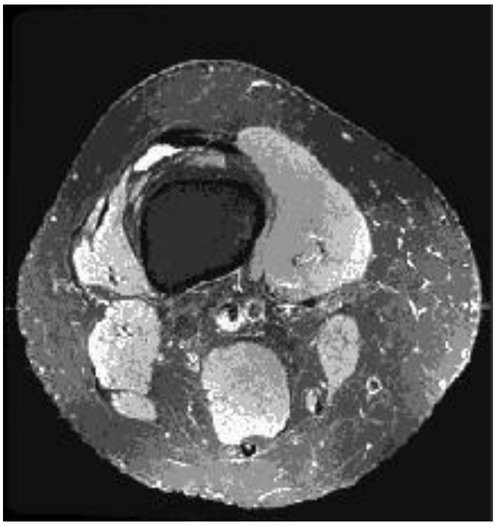

Fig 3:- After applying K-Means algorithm

C. Fuzzy C-means clustering (FCM)

The FCM algorithm which is used for segmentation of MR image and is observed to gives improved segmentation results [4] [7]. Further the incorporation of spatial information in to the objective function of standard FCM yields successful results for robust and effective image segmentation of noisy images and some techniques of FCM can be applied to segment colored images. This algorithm is used for analysis based on distance between various input data points. This algorithm works by assigning membership to each data point corresponding to each cluster center on the basis of distance between the data point and the cluster center. Membership of data is more when the data is more nearer to the cluster center. Clearly, summation of membership of each data point should be equal to one.

The main objective of fuzzy clustering algorithm is to partition the data points in the image into clusters. The similarity of data items in different clusters is minimized and the similarity of data items within each cluster is maximized.

$$\sum_{j=1}^{k} \sum_{x_i \in C_j} u_{ij}^{m} (x_i - \mu_j)^2$$

Where,

- uij is the degree to which an observation xi belongs to a cluster cj
- µj is the center of the cluster j
- uij is the degree to which an observation xi belongs to a cluster cj
- m is the fuzzifier

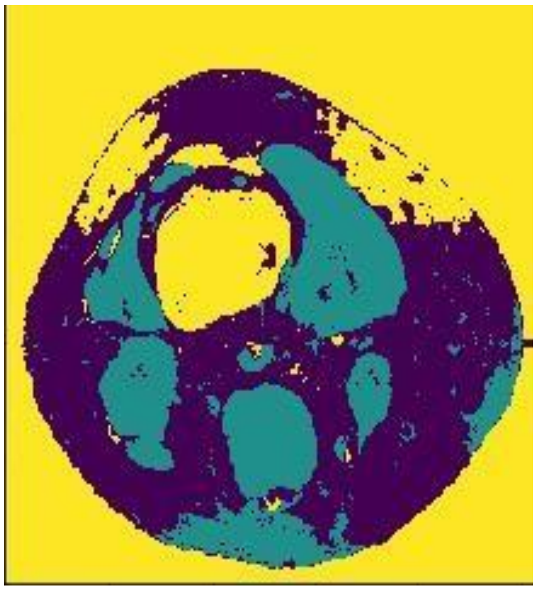

Fig 4:- After applying Fuzzy C-Means algorithm for axial MRI

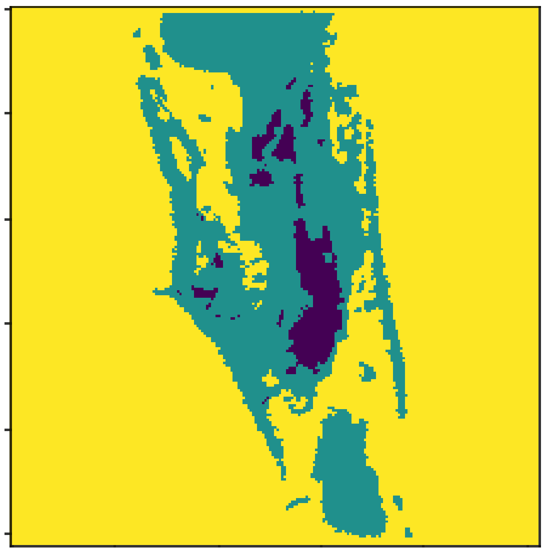

Fig 5:- After applying Fuzzy C-Means algorithm for Sagittal MRI

IV. PROPOSED SYSTEM

For pre-processing of image, we are using bilateral filtering in order to mitigate noise in the images. Two models were used to segment the bones: Fuzzy C-means and K-means clustering [4] [7]. Though several different variations of K-means were implemented, the resulting segmentations were infrequently better than moderate [5]. Fuzzy C-means clustering is implemented. Where a musculoskeletal researcher would spend several hours to segment a single bone, C-means performed the segmentation to a reasonable degree of accuracy.

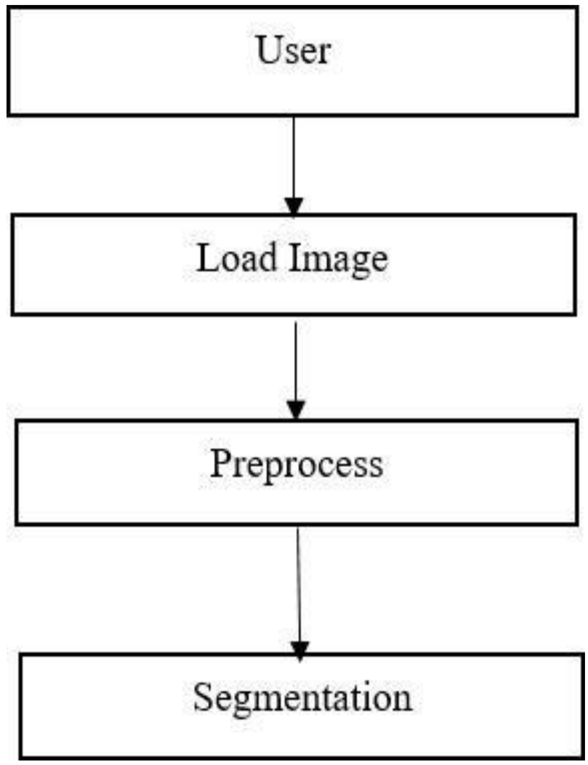

Fig 6:- System Architecture of Segmentation of Bones using MRI

V. CONCLUSION

The developed system will help us to find the segmented region of bones for three different planes i.e. for sagittal, coronal, axial plane of knee MRI. This system further can be implemented to recognize tumors in bones and by using advanced Convolutional neural network (CNN) with highest degree of accuracy.

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