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MULTI CLASS SEGMENTATION OF SPINAL VERTEBRAE USING IMPROVED REGION EXTRACTION TECHNIQUE IN IMAGE PROCESSING

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ABSTRACT

Image Segmentation is generally used to separate the objects from the background, and it has proved to be a powerful tool in Bio-medical imaging for the diagnosis of various images. Generally, Segmentation involves dividing the image into various constituent parts or objects by performing various algorithms to segment the desired part from the image. The Magnetic Resonance (MR) Image is used for representing the soft tissue, organs, and also three-dimensional visualization inside of the human body. The proposed system involves the multi-class segmentation of spinal vertebrae where with magnetic resonance (MR) image plays a significant role in various spinal disease diagnoses and treatments of spine disorders. The Existing fully convolutional network-based methods has a disadvantage that it fails to work for the different spinal structures. Hence, the proposed model includes the Fuzzy C- means Clustering for the Cluster Formation Algorithm to increase the efficiency of the system and the optimized image is obtained for the diagnosis. The cluster formed will be extracted by the Mean GGN Growing Properties which helps to get the other data points for the evaluation, and finally, the Fractional Ridge Edge Detection Technique detects the edges from the extracted cluster image. The Proposed model uses the Weiner Filter to remove the noise in the 2D input MR Image and the Region Based Segmentation will extract only the affected cells from the input image even when the cells are scattered. The Simulation is done in MATLAB and performs around 400 iterations for the Edge Detection Technique and the Area, Perimeter , Centroid and Diameter are calculator for the cluster in order to get the accuracy is increased to 95%.

Keywords: Region Extraction, Wiener Filter, Fuzzy C-Means Clustering, Cluster Formation, Edge Detection.

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INTRODUCTION

Intervertebral disc disease is a characteristic condition that occurs by the breakdown of one or more discs in the spinal vertebrae where it separates the bones of the spine, causing the pain in the backbone or neck and also resulting side effects in the legs and arms. The intervertebral discs has internal links between vertebrae and absorb pressure on the spine. While the discs in the lower region are affected in common in intervertebral disc disease, and also any part of the spine may result in disc degeneration. Depending on the location of the affected area, the intervertebral disc disease may result in periodic or chronic pain in the back or neck side. Pain is worse when straining on these bones. Degenerated discs are subjected to out-pouching where the protruding disc can stress against any of the spinal nerves that run from the spinal cord to the rest of the body. This pressure may cause pain, weakness, and numbness in the back and legs. Sciatica, which means the herniated discs will cause nerve pain that travels along the sciatic nerve, runs from the lower back to each leg of the body. When the disc degenerates, small bony outgrowths are formed at the edges of the affected vertebrae.

Computed Tomography (CT) image is mostly used to detect the edges of the lumbar RFA to the correct location due to its pixel variations of the vertebra in the CT image. Visualization of the IVDs is absolutely necessary for the surgeon to accurately find the dislocated tissue during the lumbar RFA. However, the CT image is incapable of finding the IVDs in all sorts of images. Comparing the CT image and magnetic resonance (MR) image to find a solution for this issue/ because MR image has high contrast for IVDs. The globally rigid or non-rigid images includes the spinal vertebra with a rigid structure where the remainder is non-rigid part of the image. MRI provides better soft tissue contrast than CT and highly adept to capture the images. Hence it is useful for the physicians to diagnose and analyze the results from the image easily.

Automated spine parsing of MR images, achieves the multi-class segmentation of the vertebrae and IVDs. Spine parsing (i.e., multi-class segmentation of vertebrae and intervertebral discs (IVDs)) for volumetric magnetic resonance (MR) image plays an important role for the analysis of spinal diseases and its treatments as Diagnosing the Spinal vertebrae is a challenge in the inter-class similarity and intra-class variation of spine images.

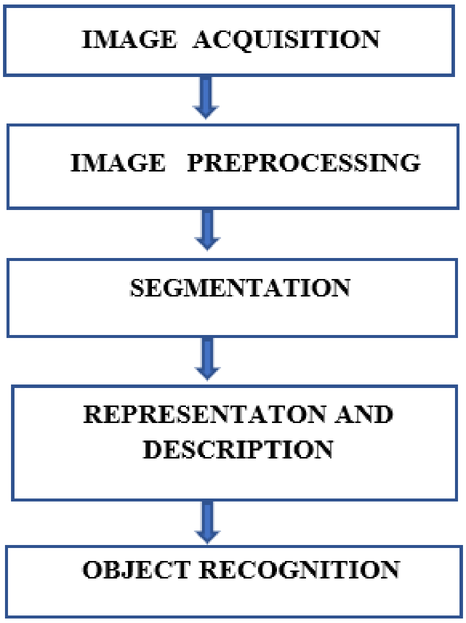
1. The Inter-class similarity is when objects belonging to various classes have the similar appearance due to non-visible variations in the morphological features.

2. Intra-class variation is when objects belonging to the same class had identical variation in appearances. The Multi-class segmentation of spinal vertebrae is a non-trivial task for the high correlated samples that differs in the appearance of adjacent vertebrae. The second stage is comprised of a fully convolutional deep spinal network, the exploits the local context in the lumbar region and labelling the lumbar vertebrae.

Image segmentation is a technique used in digital image processing and where it partitions an image into multiple parts or regions based on the characteristics of the pixels in the image. This technique involves separating foreground noise from the background, and clustering regions based on similarities in color or shape or the pixel values. It reduces the complexity of the image and thus become ease for the processing or analysis of each image segment.

Thus, segmentation refers as the assignment of labels with respect to pixels in identifying the various elements in the image.

A main use of image segmentation is in object detection. Instead of processing the entire image for the analysis, it will be better to have a common practice with an image segmentation algorithm to find objects of interest in the image. Then, the object detector can operate on a certain algorithm defined by the segmentation process. This prevents the detector from processing the entire image, improving the accuracy, and reducing inference time.



Flow of the Segmentation process

After defining the image regions or the super-pixels values, the feature is extracted based on appearance (color and texture), geometry or location-based features in the image. If the feature is directly as same as input to the logistic/CRF multi-class segmentation model, then a bias term called constant feature can be appended which helps in classification based on model of the image. At the same time, compare the groundtruth label value for each super-pixel for the high accuracy. The over-segmented image contains about 200 super-pixels using some specific methods or randomly split in the images for the 296 training and 295 tests. The Extracted feature plays an important role in the area of image processing. Feature extraction process in the image processing algorithm is done after the preprocessing phase. This process can be divided into two stages as Feature selection and Classification/Extraction.

Feature selection is critical to the in the entire process of segmentation where the classifier cannot divide the region or extract without any comparison. Henceforth it involves the various thresholding techniques to find-out the differed pixel in the image. The extracted features should contain the information required to distinguish between classes, for an insensitive to irrelevant pixels in the input, and also bringing out the smaller number of output values compared to the actual input and to permit efficient computation of various functions and limit the number of iterations required.

Feature extraction is also an important step for extracting the specific pattern or information from the image. As a result of this process, the relevant features are extracted from object sets to form feature vectors. These feature vectors are then used classify the input unit with target output unit.

When the pre-processing and the other stages of segmentation are done, some feature extraction technique is applied to the segments to obtain features, which is followed by application of classification and post processing techniques. It is essential to focus on the feature extraction phase as it has an observable impact on the efficiency of the recognition system. Feature selection of a feature extraction method is the single most important factor in achieving high recognition performance. Feature extraction has been given as “extracting from the raw data information that is most suitable for classification purposes, while minimizing the within class pattern variability and enhancing the between class pattern variability”. Thus, selection of a suitable feature extraction technique according to the input to be applied needs to be done with utmost care. Taking into consideration all these factors, it becomes essential to look at the various available techniques for feature extraction in a given domain, covering vast possibilities of cases.

RELATED WORKS

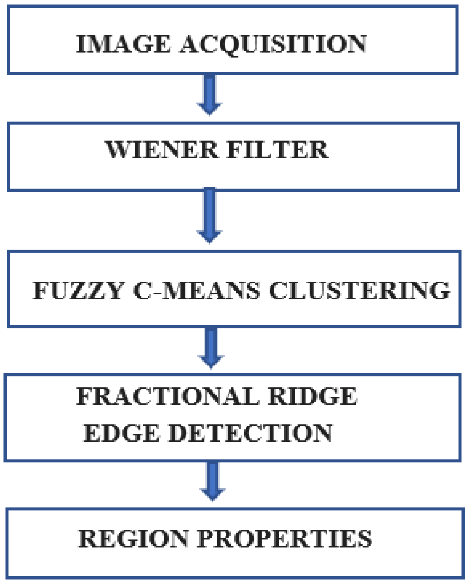
Segmentation of the vertebrae in the spine is of very important diagnosis to many medical applications. The atlas-based segmentation uses a number of atlases of the spine to get the target data set. The labels of the deformed atlases are combined using label fusion to get the segmentation of the target data set. An average DICE score of 0.94±0.030.94±0.03 of this method achieved on the training data set[1]. The vertebral bodies are detected and labeled using integral channel features from the graphical parts model and a set of image volumes with the labelled intervertebral disc atlases that are registered to the target volume using the output from the initialization process continued by the registered atlases that can be combined using label fusion to derive the final segmentation. The output was evaluated using a set of \(15+10\) T2-weighted image volumes provided as training and test data respectively for the segmentation process[2]. Segmentation of spinal vertebrae in 3-D space has the complexity in vertebrae shapes, as the gaps in the cortical bone and boundaries and the noise, inhomogeneity, and missing information in the images introduced the accurate spinal vertebrae segmentation method that will deal with the noisy images with missing information. This method uses an edge-mounted Willmore flow, as well as a prior shape kernel density estimator, to the level set segmentation framework. The shape model of the extracted image provides more information that cannot be found from the original image, and the level set function with the threshold value towards prior shape and the edge-mounted Willmore flow captures the local geometry and smoothens the level set surface of the image. Evaluation of this segmentation results with ground-truth validation in the effectiveness with the overall accuracy as 89.32±1.70% and 14.03±1.40 mm based on the Dice similarity coefficient and Hausdorff distance, respectively[3]. The recent advances in the high resolution magnetic resonance (MR) imaging of the spinal vertebrae provide process for the automated assessment of intervertebral disc (IVD) and vertebral body (VB) anatomy. Similarly, the high resolution three-dimensional (3D) morphological information contained in these images are used for the detection spine disorders from the image. The automated work proposed to extract the 3D segmentations of lumbar and thoracic intervertebral disc’s(IVD) and vertebral body’s(VB) from the MR images using statistical shape analysis and grey level intensity profiles. This method results in the IVDs being automatically segmented from 3D volumetric scans and shape the parameters obtained which can be used in preliminary analyses which results in the 100% sensitivity, 98.3% specificity of the disc abnormalities associated with early degenerative changes[4]. In the Spine Segmentation methods, there may be a nonlinear low-dimensional sub-forms are created from a set of mesh models in the input image. The Inference from the various forms and the shape parameters are performed using the higher-order Markov random field (HOMRF).

Singleton and pairwise possibilities are a measure to derive from the global data and shape coherence space respectively, while higher-order values from the range can be encoded from the geometrical modes of variation to segment in each localized vertebra models. The Quantitative analysis with the method yields an accuracy of 1.6 ± 0.6 mm for CT imaging and of 2.0 ± 0.8 mm for MR imaging, with the localization of anatomical landmarks [5]. The variational level set method with a signed distance function is used to compare the watershed segmentation method which have been already implemented with the various datasets. To check the efficiency of this method on the sagittal T2-weighted MR images of the spine, both the methods are compared with different images with the golden standard using dice and Jaccard coefficients . The later method can become very much useful for the radiologists with the timely segmentation of the vertebral bodies as well as of the intervertebral disks[6]. Computerized segmentation for the medical images mainly plays a role to unclear the image boundaries, artifacts, and traces of surgical activities, the shape of the segmented structures may differ from the shape of normal structures. Even with the insufficient information, landmarking is effective in analyzing the structures but sometimes results in lack of robustness. Hence, the multi-energy segmentation framework[7] can be used to segment the structures with pathological shape. It uses the theory of Laplacian shape editing and results in a Dice coefficient of 84.7 ± 5.0%, 85.3 ± 4.8% and 78.3 ± 5.1%, and boundary distance of 1.14 ± 0.49mm, 1.42 ± 0.45mm and 2.27 ± 0.52mm. The method defined in [8] involves two steps where one to localize the center of each IVD, and the other to classify image pixels around each disc center as foreground (disc) or background. Accurate localization and segmentation of intervertebral discs from the volumetric data[9] finds to be a major pre-condition for the diagnosis and treatment of the spinal disorders. Along with the methods of deep learning, the 2D fully convolutional networks (FCN) have done the state-of-the-art performance on the 2D image segmentation methods. The Cascaded 3D Fully Convolutional Networks[10] which involves the localization FCN and the segmentation FCN plays a major role in finding the bounding box of the lumbar region from the input image. The resulted image is sent as an input to the 3D U-net like FCN called as "Segmentation-Net” is received, which will be a pixel-wise multi-class segmented image to with the volume-wise labels. The output image with this methos has an average Dice coefficient of 95.77 ± 0.81% and an average symmetric surface distance of 0.37 ± 0.06 mm. The manual annotation of the segmentation may results consuming more time and prone to error with the limited images, hence an automatic and accurate method[11] for segmentation based on the fully convolutional networks (FCN) with multi-modality 3D MR data is developed to effectively integrate which results in generating accurate segmentation results. Voxel-level segmentation[12] creates masks for the image to be obtained with a human-machine hybrid algorithm and anatomical ratings, This methos will improve the robustness and accuracy of the segmentation algorithms. Precise segmentation and anatomical identification of the vertebrae provides the basis for automatic analysis of the spine, such as detection of vertebral compression fractures or other abnormalities. Most dedicated spine CT and MR scans as well as scans of the chest, abdomen, or neck cover only part of the spine. An iterative instance segmentation approach [13] uses a fully convolutional neural network to divide and label the vertebrae sequentially, and independent of the number of visible vertebrae levels. This instance-by-instance segmentation is enabled by combining the network with a memory component which holds the information that is already a segmented vertebra. The network continuously analyzes the image patches, using information from both image and memory to search for the next vertebra. This method was evaluated with five different datasets, thus including the multiple modalities for the CT and MR, where various fields of view and coverages of different sections of the spinal vertebrae is observed.

As a result, the average Dice score of 94.9 ± 2.1% with an average absolute symmetric surface distance of 0.2 ± 10.1mm is observed and the anatomical identification has an accuracy of 93% with mislabeled vertebrae. And the vertebrae were divided into completely or incompletely visible classes with an accuracy of 97%. Thus, the iterative segmentation method compares the result with state-of-the-art methods and which is fast, flexible and generalizable. A network and training strategy[14] completely depends on the data augmentation to use the available annotated samples more efficiently. The design consists of a narrow path to find the context and symmetric expanding path that enables absolute localization. Using the same network trained on transmitted light microscopy images. Segmentation of a 512x512 image using the network and training strategy takes less than a second on a recent GPU. To efficiently handle a large number of points and incorporate values of each point, a pointwise attention-based convolutional neural network architecture[15] is implemented where a salient 3D feature points among all feature in the mapped image is considered as outstanding contextual information in the channel-wise attention modules. This method model has been evaluated on the two most important 3D point cloud datasets for the 3D semantic segmentation task. It achieves a reasonable performance compared to state-of-the-art models in terms of accuracy, with a much smaller number of parameters. To perform the automated segmentation and classification of the intervertebral discs, vertebrae, and neural foramen in MRIs in one process is semantic segmentation[16] reduces the task of Multiple tasks where multiple semantic segmentation of various spinal images occur at the same time and reduces the multiple targets where an average of 21 spinal structures per MRI is used in automated analysis with more variety and variability and reduces the weak spatial correlations and subtle differences between normal and abnormal structures in the digital image. In this paper, convolution with holes. This experimental method results on MRIs of 253 patients with the high pixel accuracy of 96.2% and Dice coefficient of 87.1%, Sensitivity of 89.1% and Specificity of 86.0%, That has more effectiveness and potential for diagnosis tools. The U-Net methodology [17] proposed using the Deep Learning in 2015 gives the accurate segmentation of small targets and its measurable in the network architecture. The medical image segmentation technologies based on the U-Net structure works for different variants concentrating on their structure, innovation, efficiency, etc. and founds to be 2500 times more effective than the older methods with its reviews and categorizes which calculates the loss functions, evaluation parameters, and modules that are commonly applied to the segmentation process in medical imaging.

OVERVIEW OF PROPOSED METHOD:

Multi-class image segmentation which is also known as pixel labeling focus to label every pixel of the image with a finite class. But classifying every pixel will be difficult and expensive where many methods for segmenting the image into super pixels exists and classifying each region based on the class value also takes more time. Every Segmentation process involves multiple methods for the analysis. Image Acquisition is the first and foremost of the Segmentation process which involves the creation of digital images for the medical analysis followed by the Image preprocessing where the data images will be removed from the low-frequency background noise. The next process is Image segmentation in which the partitioning the digital image into multiple segments is performed. Finally, the segmented image will give the simplified image that is meaningful and easier to analyze for the diagnosis of medical disorder.



Flow of the Proposed methodology

a) IMAGE PREPROCESSING: Image pre-processing technique is implemented on the input images which results in the lowest level of abstraction. This technique do not increase the image information but decrease the pixel content if entropy is an information measure. The aim of pre-processing is to improve the image data and get the enhanced image features that will be relevant to the analysis task. During image pre-processing, the input image will be further classified or sub-divided based on the feature analysis. The Proposed method uses the Wiener filter which is the MSE-optimal stationary linear filter for the images that are degraded by the additive noise and blurring. Calculation of the Wiener filter includes the signal and noise processes that are second-order stationary to be removed. Wiener filters play an important role in the Linear prediction, Echo cancellation, Signal restoration, Channel equalization and System identification. The noise reduction process with zero mean will be considered as major value where loss of generality should occur. During the image pre-processing, the data in the images should be corrected as it is the prior process for the feature measurement and analysis. Few functionalities that are considered in pre-processing are Sensor corrections to remove the dead pixel correction, Lighting corrections to make the local texture and structure even throughout the image. Geometric corrections – correcting the image for the invalid perspective in the geometry prior to feature description. Some features will be more robust to geometric variation in the image and the Color corrections which in which the color saturation to maintain the intensity channel is taken care.

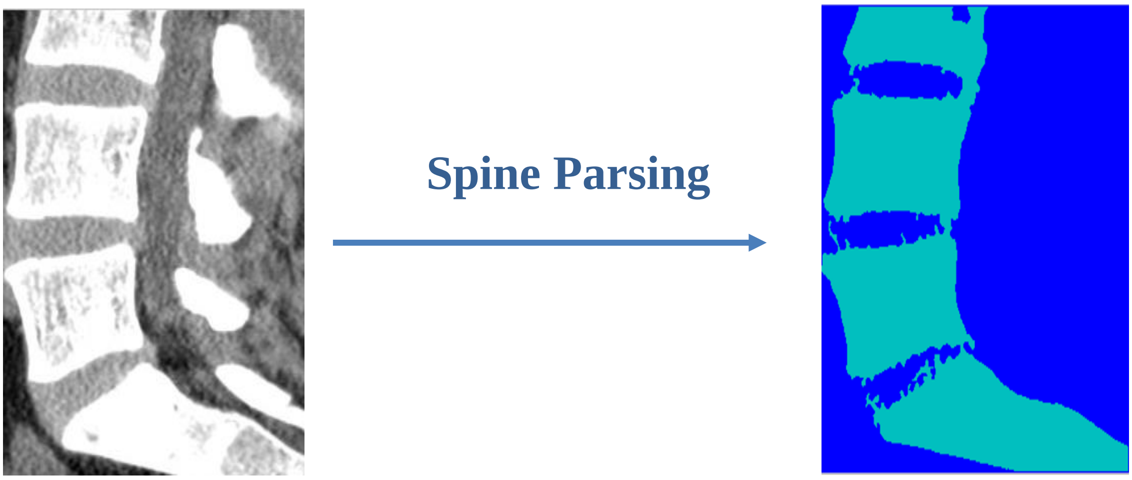
Wiener filters are used in the frequency domain calculation in which a noisy image of x(n, m) is taken and is performed with the Discrete Fourier Transform (DFT) to for the output image of $X(u, v)$. Wiener filters will be comparatively slow as it applies the frequency domain. And finally, to speed up the filtering process, the inverse Fast Fourier Transform (FFT) of the Wiener filter $G(u, v)$ is done to obtain an impulse response $g(n, m)$ of the input image. The impulse image can be truncated spatially to produce a convolution mask. The Wiener filter coefficients are calculated to reduce the average square distance between a desired signal and the filter output. The Wiener filter is selected in this process because it removes the added noise and inverts the blurring of the input image at the same time. The resulted image will have the effective mean square error from the input image.

b) CLUSTER FORMATION: Thresholding is a process in image segmentation in which the pixels of the image is made further more easier to analyze. In thresholding, the digital image will be converted from color or grayscale into a binary image, which will be a typical black and white image. The main purpose of thresholding is to extract the pixels from a specific image in which the object is present for analysis. The information is of binary values in which the pixels represent a range of intensities. There are different types of Thresholding in which the Histogram shape-based methods helps in thresholding the natural images where the Clustering-based methods in which the gray-level data values are clustered in two parts as background and foreground. The Entropy-based method will result in entropy of the foreground and background regions and the cross-entropy of the original and binary image. Object Attribute-method gives the measure of similarity between the gray-level image and the binary images. The Spatial methods and Local methods will work for the higher-order probability distribution of the data values by adapting to the threshold value on each pixel to the input image characteristics.

Clustering is a thresholding technique that plays a major part in the image segmentation. The cluster analysis is to partition an image data set into a number of classes based on the distinct values in the image. There are four different clustering methods used to retrieve the desired cluster model such as k means, improved k mean, fuzzy c mean (FCM) and improved fuzzy c mean algorithm (IFCM). The proposed method uses the Fuzzy C-Means clustering. The Fuzzy logic principles will group the multidimensional data in the image by assigning a point called *membership* for cluster center from 0 to 100. This will be compared to the traditional hard-threshold clustering where every point in the image will be labelled. This algorithm works by assigning label or value to each data point in the cluster center based on the distance among the cluster center and the data points in the image. The data value will be more for the cluster that are near to the cluster center and comparatively less when the data points lie apart from the center. Clearly, summation of all the label values for each data point will be equal to one. This clustering algorithm will finally create a fuzzy partition from input data. The algorithm depends on a parameter named m which indicates the degree of fuzziness in the output image. Large values of m may tend to blur the classes and other elements that belongs to all clusters. The optimized solution will depend on the parameter m, where selecting the value of m result in different partitions. The main advantage of the using the fuzzy c-means clustering is that the degree of members of the data set value will be in range of [0,1] and the result is flexible such that the data points can belong more than one cluster in the image. The mean GGN growing properties method includes the ground glass nodule (GGN) with adaptive intensity models with the Markov random field (MRF) based modeling. As a result, a high clarity clustered image is receives as an output of the clustering process

c) EDGE DETECTION: Edge detection is a technique to identify the points in the digital image where the image brightness changes sharply or has discontinuities in the pixel values. The points where the image brightness changes sharply will be formed into a set of curved line segments which will be called as edges. This edge detection technique will also find the location and the presence of edges by making changes in the intensity of an image. There are various operations used in the image processing to detect edges where it can detect the variation of grey levels and easily removes the noise that is detected in the filtering process. In image processing, the edge detection plays a major role and may result in pattern recognition, image segmentation and scene analysis. It may use some filtering technique to extract the edge points in the image. The sudden change in the image occurs when the edge of an image reaches high in the brightness of the image. Thus, in image processing, edges are considered as a single class of singularity and this singularity is characterized as discontinuities where the gradient approaches are infinity. Generally, the image data will be the discrete form in which the edges of the image are considered as the local maxima of the gradient.

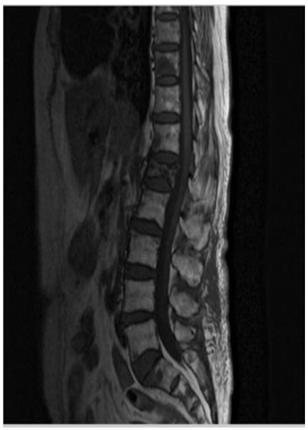
Most of the edges exits between objects and objects, primitives and primitive and may also between objects and background. Edge detection is used for measuring the intensity of the image, detecting, and locating the changes in the digital image. The main aim of using the edge detection in the proposed system is that to intimate the local edge operator using the edge enhancement operator and thus defining the the edge strength and set the edge points. There may three types of edges found in the image: as Horizontal edges, Vertical edges and Diagonal edges The output of the edge detection technique will be useful in Pattern recognition, Image morphology and Feature extraction from the image .To extract the feature , the Ridge Edge Detection Method is used in the proposed algorithm. The purpose of ridge detection is usually to capture the major axis of symmetry of an elongated object, whereas the purpose of edge detection is usually to capture the boundary of the object. The Region growing technique in image segmentation works by assembling pixels into larger groups based on predefined seed pixels, growing criteria and stop conditions based on the image taken for the analysis. This feature extraction will be a dimensionality reduction process, in which, the initial set of the raw data break down into n number manageable groups to be processing it in an easier way, where incase of large data sets of data with a large number of variables, takes a lot of computing resources to process them. This technique of extracting the features is useful when you have a large data set and need to reduce the number of resources without losing any important or relevant information. Feature extraction helps to reduce the large number of redundant data from the data sets. As a result, the reduction in the number of data helps to build a model with less machine's efforts and also increases the speed processing thus improving the accuracy in the result. The Region Growing methods will help in separating the regions that have the similar properties and gives the original images that have clear edges and good segmentation results.



RESULT AND DISCUSSION

a) **INPUT IMAGE**

The input images are the 2D MR Image of spinal vertebrae thar has some displacements and noises in the structure that are required to be diagnosed.



b) **IMAGE PREPROCESSING**

The MR image which is a 2-D digital image is first converted to a gray scale image by rgb2gray conversion mechanism. The `rgb2gray(RGB)` converts the input image to the grayscale image by eliminating the hue and saturation data from the image while retaining the luminance of the image. The Gray image will be then given to Wiener filter to remove the Gaussian white Noise power.

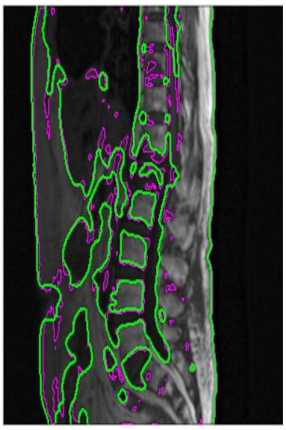
c) **CLUSTER FORMATION**

The clustered cells are formed using the Fuzzy C-Means clustering that have the same pixel values among the data points in the noise removed image and the region is high-lighted with the . The data set is grouped into *N* clusters that have similar data point each cluster with a certain degree. The data point that is close to the center of cluster will have a high degree of membership and the others will have a low degree of membership comparatively.

The process starts with a random initial guess the cluster centers and then the mean location of each cluster. Now the fcm algorithm assigns the data point with a random membership grade for each cluster based on the mean. With the comparison of the means value, the cluster centers and the membership grades for each data point varies accordingly. This iteration mechanism minimizes an objective function that represents the distance from any data point to a cluster center by the membership of that data point in the cluster.

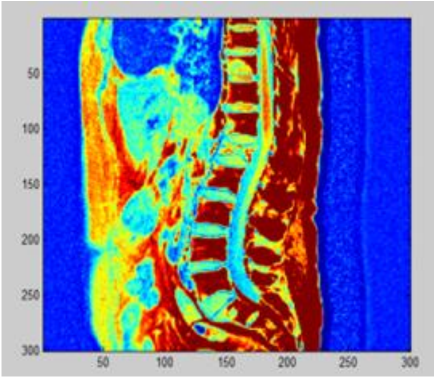
d) **EDGE DETECTION**

The edge detection process calculates a global threshold value from grayscale image, using Otsu's method. The Otsu's method minimizes the intraclass variance of the black and white pixels of the image. The threshold process finally converts a grayscale image to a binary image where the edges will have high intensity than the other pixel values.



e) **REGION PROPERTIES**

The region is repeated grown by comparing all the neighboring pixels from the center value. The difference between a pixel's intensity value and the region's mean, is used for consideration. The pixel with the smallest difference is allocated to the region and stops when the intensity difference between region mean and the new pixel value becomes larger than the threshold value.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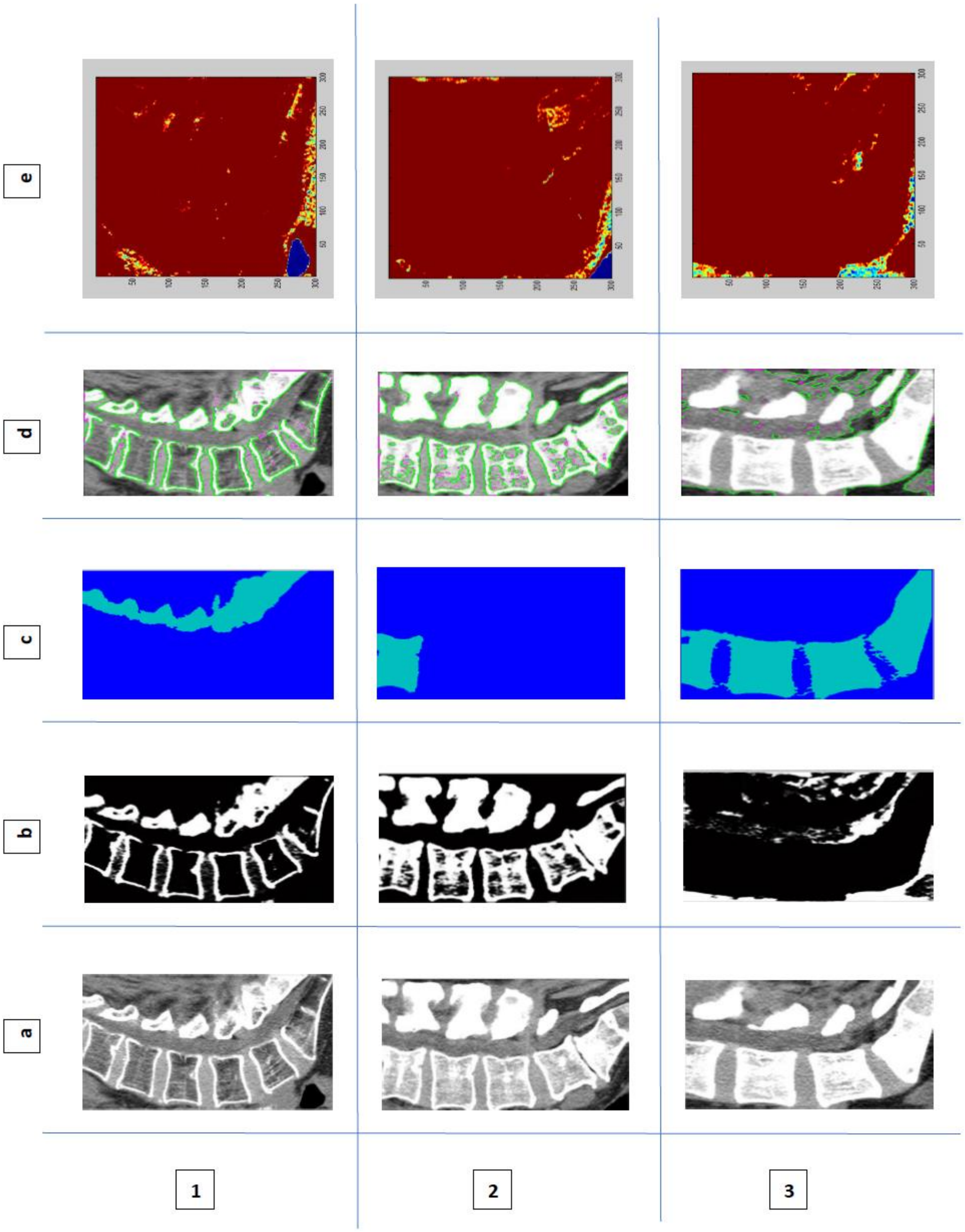
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The above images are three different sets of 2-D MR Images where all the three images are being processes with the proposed segmentation mechanism and analyzed with the outputs for efficiency. The images under the column a are the input images , b are the preprocessed images that are applied with the Wiener filter to remove the noises. The c and d column are the cluster separation images and the threshold images from the preprocessed images. The last e column shows the comparison chart of the output image based on the intensity, fitness, and time parameters. The Intensity depends on the Fitness of the output image.

Sample Number	Region Number	Area	Perimeter	Centroid	Diameter	Region Growing Opening	Region Growing Ending
1	2835.0	591.2	22.6	51.9	60.1	Initial position (174|158|1) with 225 as initial pixel value	Found 13731 pixels within the threshold range (937 polygon vertices)
	10.0	8.8	60.8	225.0	3.6		
	3.0	3.4	114.3	25.3	2.0		
	1451.0	271.0	262.7	275.9	43.0		
2	206.0	218.4	2.3	64.6	16.2	Initial position (47|129|1) with 254 as initial pixel value	Found 5800 pixels within the threshold range (346 polygon vertices)
	1.0	0.0	153.0	140.0	1.1		
	1.0	0.0	253.0	5.0	1.1		
3	8541.0	416.2	74.4	190.6	104.3	Initial position (8|122|1) with 243 as initial pixel value	Found 35021 pixels within the threshold range (1967 polygon vertices)!

The above table gives the analysis of the three different images that are segmented using the proposed method. Each image has undergone n number of iterations throughout all the pixels to be compared with the pixel value and form the clusters. The values of the area, perimeter, centroid and diameter of the displaced cells from the cluster center that can be used for the analysis. Some samples may have more than one displacement cells, hence the number of regions will be more than one in the region analysis. The Region number is the pixel number that is labelled during the preprocessing method and will be carried throughout the process for the easy analysis. The Opening and Closing of the Region Growing values gives the initial position of the cluster starting as a pixel value with the number of pixels involved with the threshold range.

CONCLUSION

We have presented an improved algorithm for the feature extraction mechanism with the combination of cluster separation and the thresholding technique together for attaining the high efficiency of the output image. The pre-processing methods removes the noises effectively and the segmentation will effectively capture the scattered cells also. The output comparison with the intensity and the fitness will be more useful and accurate for the diagnosis and captures all the possibilities of the cluster cells throughout the input image. The Region Growing Opening and Ending will give the exact pixel values from where the deferred cells begin and the dimension of each cluster for the easy analysis. Hence, this method can be used in diagnosing the vertebral disorders in Medical Purposes with the improved accuracy.

REFERENCES

[1] D. Forsberg, "Atlas-based segmentation of the thoracic and lumbar vertebrae," in Recent Advances in Computational Methods and Clinical Applications for Spine Imaging. Springer, 2015, pp. 215–220.

[2] C. Wang and D. Forsberg, "Segmentation of intervertebral discs in 3d MRI data using multi-atlas based registration," in Lecture Notes in Computer Science. Springer International Publishing, 2016, pp. 107– 116.

[3] P. H. Lim, U. Bagci, and L. Bai, "Introducing willmore flow into level set segmentation of spinal vertebrae," IEEE Transactions on Biomedical Engineering, vol. 60, no. 1, pp. 115–122, 2012.

[4] A. Neubert, J. Fripp, C. Engstrom, R. Schwarz, L. Lauer, O. Salvado, and S. Crozier, "Automated detection, 3d segmentation and analysis of high resolution spine mr images using statistical shape models," Physics in Medicine & Biology, vol. 57, no. 24, p. 8357, 2012.

[5] S. Kadoury, H. Labelle, and N. Paragios, "Spine segmentation in medical images using manifold embeddings and higher-order mrfs," IEEE transactions on medical imaging, vol. 32, no. 7, pp. 1227–1238, 2013.

[6] M. W. Law, K. Tay, A. Leung, G. J. Garvin, and S. Li, "Intervertebral disc segmentation in mr images using anisotropic oriented flux," Medical image analysis, vol. 17, no. 1, pp. 43–61, 2013.

[7] B. Ibragimov, R. Korez, B. Likar, F. Pernus, L. Xing, and T. Vr- ˇ tovec, "Segmentation of pathological structures by landmark-assisted deformable models," IEEE transactions on medical imaging, vol. 36, no. 7, pp. 1457–1469, 2017.

[8] C. Chen, D. Belavy, W. Yu, C. Chu, G. Armbrecht, M. Bansmann, D. Felsenberg, and G. Zheng, "Localization and segmentation of 3d intervertebral discs in mr images by data driven estimation," IEEE transactions on medical imaging, vol. 34, no. 8, pp. 1719–1729, 2015.

[9] H. Chen, Q. Dou, X. Wang, J. Qin, J. C. Cheng, and P.-A. Heng, "3d fully convolutional networks for intervertebral disc localization and segmentation," in International Conference on Medical Imaging and Augmented Reality. Springer, 2016, pp. 375–382.

[10] R. Janssens, G. Zeng, and G. Zheng, "Fully automatic segmentation of lumbar vertebrae from ct images using cascaded 3d fully convolutional networks," in 2018 IEEE 15th International Symposium on Biomedical Imaging (ISBI 2018). IEEE, 2018, pp. 893–897.

[11] X. Li, Q. Dou, H. Chen, C.-W. Fu, X. Qi, D. L. Belavy, G. Armbrecht, ` D. Felsenberg, G. Zheng, and P.-A. Heng, "3d multi-scale fcn with random modality voxel dropout learning for intervertebral disc localization and segmentation from multi-modality mr images," Medical image analysis, vol. 45, pp. 41–54, 2018.

[12] A. Sekuboyina, A. Valentinitsch, J. S. Kirschke, and B. H. Menze, "A localisation-segmentation approach for multi-label annotation of lumbar vertebrae using deep nets," arXiv preprint arXiv:1703.04347, 2017.

[13] N. Lessmann, B. van Ginneken, P. A. de Jong, and I. Isgum, "Iterative fully convolutional neural networks for automatic vertebra segmentation," 2018.

[14] O. Ronneberger, P. Fischer, and T. Brox, "U-net: Convolutional networks for biomedical image segmentation," in International Conference on Medical image computing and computer-assisted intervention. Springer, 2015, pp. 234–241.

[15] L.-C. Chen, Y. Zhu, G. Papandreou, F. Schroff, and H. Adam, "Encoderdecoder with atrous separable convolution for semantic image segmentation," in Proceedings of the European conference on computer vision (ECCV), 2018, pp. 801–818.

[16] Z. Han, B. Wei, A. Mercado, S. Leung, and S. Li, "Spine-gan: Semantic segmentation of multiple spinal structures," Medical image analysis, vol. 50, pp. 23–35, 2018.

[17] O. C¸ ic¸ek, A. Abdulkadir, S. S. Lienkamp, T. Brox, and O. Ronneberger, ¨ "3d u-net: learning dense volumetric segmentation from sparse annotation," in International conference on medical image computing and computer-assisted intervention. Springer, 2016, pp. 424–432.

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