Spinal cord segmentation and classification of degenerative disease

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ABSTRACT

spinal cord plays an important role in human life. In our work, we are using digital image processing technique, the interior part of the human body can be analyzed using MRI, CT and X-RAY etc. Medical image processing technique is extensively used in medical field. In here we are using MRI image to perform our work In our proposed work, we are finding degenerative disease from spinal cord image. In our work first, we are preprocessing the MRI image and locate the degenerative part of the spinal cord, finding the degenerative part using various segmentation approach after that classifying degenerative disease or normal spinal cord using various classification algorithm. For segmentation, we are using an efficient semantic segmentation approach.

INTRODUCTION

Digital image processing is the way of processing digital image by using a computational algorithm. Digital image processing includes following steps image acquisition, image analysis, image preprocessing and finally digital image formation. An image can be represented as a two-dimensional array, specifically rows and columns. A digital image is collected of a finite number of elements. The medical image processing has various benefits over MRI processing. It allows a much extensive series of algorithms to be useful to the input data and can avoid difficulties such as the build-up of noise and indication alteration during processing.

Medical imaging is the method and process of generating internal parts of the human body. In computer science, image processing is one of the major application which helps in the analysis and handling of the digitized images in order to improve its features by doing some enhancements using algorithms. Image processing techniques are broadly used in medical field with respect to the classification and identification of various disorders, within that Degenerative disorders are one of the medical condition which causes a tissue or an organ to deteriorate rapidly. It is mainly classified into three groups and within that nervous system affecting degenerative disorders are occurred due to the mutations which happens to nervous tissues. Degenerative disc disease commonly seems problems in human beings. The disc are placed in between spinal cord vertebra. In spinal cord 31 nerves are there, in here we are mainly concentrating thoracic region of the spinal cord. “Spinal cords” plays a key role in the connection between peripheral nervous system to our brain, so in this work, we are making out the spinal cord segmentation using Region of interest in order to classify the degenerative disorders using naive, wise classification. Preprocessing of datasets are done with respect to the features and segmentation process are carried out. From the segmented inputs extraction of various features are done, and
from those inputs, we are making out the classification of normal as well as degenerative MRI. Degenerative disc disease is an age-related problem. It mainly seems in 40-60 years old people. The main symptoms of degenerative disc disease is back pain; the treatment of this disease is physical therapy, meditation and physical exercise. The degenerative disc disease is also influencing the structure of the SC (spinal cord). The diagnosis of SC (spinal cord) degenerative disc disease is medical image scanning. In medical image processing technique, we are mainly using in CT scanning and MRI scanning. The MRI scanning is more accurate compare to CT scanned images.

Leener et al. (2015) says that “automatic segmentation of spinal cord and spinal canal coupled with vertebral labeling” is about the segmentation and vertebral labeling of the spinal cord. In this method, they used propagated segmentation method (propseg). Propseg is a method to segment the MRI images automatically. This tool provides very fast and accurate segmentation. There are two modules in this project one is spinal cord segmentation and method to extract the position of inter vertebral disc. In this paper, results are interpreted in the form of graph and tables. The propseg method is a tool and a combination of some algorithm; the linear intensity method is used to preprocess the image, and the linear thresholding algorithm is used to segment the MRI images. The limitation of the work is, this tool is only taken T1 and T2 weighed MRI images, and if the spinal cord having any injury, it cannot labeling the vertebral. In this work, dataset are collected from center for translational developmental orthocenter, Yale university new Haven, CT, USA. (Chevrefois et al., 2007) says that “Watershed segmentation of intervertebral disk and the spinal canal from MRI images” is about the segmentation of SC (spinal cord) and spinal canal using a watershed algorithm. This paper specifies the shape and position in vertebral disk; the ultimate goal of the segmentation process is the final application will be used in a clinical context. The watershed segmentation is a region-based segmentation. The result shows that the method is robust to identify the shape and topology of MRI images of scoliotic patients. The scoliotics patients mean curvature of the spinal cord; this method is very accurate to specify the shape of a curved spinal cord. Histogram equalization method is used to preprocess the MRI images the project implementation using matlab. In this work, result are interpreted in the form of figure and graphs. The limitation of the work cannot specify the shape of the damaged spinal cord. The dataset is collected from Washington university central orthoimages. (Chen et al., 2015) says that “Localization and Segmentation of 3D Intervertebral Discs in MR Images” is about the automatic segmentation and localization of spinal cord inter vertebral disc (IVD) from MR images. This is a validation framework for evaluating the performance of segmentation and localization. For the segmentation, they used to propose MLD (Mean Localization Distance) with SD (Standard Deviation) and successful detection with various range of accuracy. The evaluation of segmentation performance they use two metrics, DOC (Dice overlap coefficient) and AAD (Average absolute distance). The dataset will be collected from Washington University of central ortho imaging. They are used two trained dataset. The first dataset shows the 90% of accuracy in segmentation and the second dataset shows 92% of segmentation accuracy. The limitation of the system is validated only 3D T2-weighted turbo spinal nerve MRI images. (Law et al., 2013) says that “Intervertebral disc segmentation in MR images using anisotropic oriented flux” deals with the unsupervised intervertebral disc segmentation based on middle sagittal spine MRI images. The anisotropic diffusion method is used to preprocessing the image. The anisotropic diffusion means removing the noise of images at the same time without removing the significant part of images. This system contains two steps, cross vertebral detection and disc segmentation. This is an unsupervised disc segmentation system based on sagittal spine MR scan. The disc segmentation based on the position and direction on the inter vertebral. They use two mechanisms to identify the disc, AGF (anisotropic gradient flux) and AGC (anisotropic gradient consistency) for disc detection. The database consisting of 455 intervertebral disc extracted from 69 patient. The final outcome of the work is secure and accurate over a large range of the parameter values. The limitation of the system is if any variation will happen in the disc boundary and adjacent structure of a disc, it can’t detect the disc. (Michopoulou et al., 2009) says that “Atlas-Based Segmentation of Degenerated Lumbar Intervertebral Discs from MR Images of the Spine” is about the 2D semi-automation segmentation of normal and degenerated intervertebral disc from T2 weighted MR images. The ARFCM (atlas robust fuzzy c-means) algorithm is used to segment the intervertebral disc. The dataset collected from international spinal cord injury (SCI). The method contains segmentation by atlas registration, in this stage using 2 steps construction of the probabilistic atlas and rigid landmark-based registration. The outcome of the system is stable and accurate segmentation on both degenerated and normal IVD (intervertebral...
Disc herniation is the formation of bulging in the intervertebral disc. It causes lower back pain due to herniated damage part of the intervertebral disc (IVD). The methodology used for this system is multiscale segmentation in bilateral scale and black and white images. The proposed system test on 32 MRI images and it shows 100% accuracy. The future work enlarges the dataset and focused on other problem related to disc herniation. (Suzani et al., 2015) says that “Deep learning for automatic localization, identification, and segmentation of vertebral bodies in volumetric MR images” is about the paper proposes an automatic method for vertebra localization, labeling, and segmentation in multi-slice Magnetic Resonance (MR) images. The methodology is used for this system is a deep learning approach is used for simultaneous localization and identification of vertebrae. The antistrophic diffusion method is used to preprocessing images. The threshold segmentation method is used to segment the MRI images Dr shuo li help to find the dataset of MR images of the spinal cord. The result shows the 100% stable and accurate of automatic spinal nerve identification and segmentation of the spinal cord vertebra. The future work will involve the advanced analysis of segmentation and identification using complex dataset. (Ünal et al., 2011) says that “Automatic Diagnosis of Intervertebral Degenerative Disk Disease Using Artificial Neural Network” is about the cause of intervertebral degenerative disk disease is the reduction of fluid that acts as shock absorber intervertebral in the discs. The methodology is used for this system is ANN (Artificial Neural Network ). ANN method is used to analyze the neuron part of the human body. The bias field correction method is used to preprocessing the image; the ANN method is used to localization and identifying the intervertebral disc. The canny edge detection method is used to identify the disc region in the spinal cord. The dataset will be collected from Konya Numune Hospital, Konya/Turkey. As a result of the classification process, IVDDD (intervertebral degenerative disc disease) is diagnosed. The training performance of the IVDDD (intervertebral degenerative disc disease diagnosing) system is 99.79%. The performance of the proposed system can be improved with more images in the future. (Lim et al., 2013) says that “Image Segmentation Using Level Set Method With Willmore Flow” is about the segmentation of the spinal cord using a new method.
Willmore Flow. This model will detect the object in images based on the technique of curve evolution level sets. This model of introducing Willmore flow to the level set framework, can segment the images with accurate border so, this can be used in the 3-D segmentation. We have presented a new model for the segmentation by incorporating the Willmore flow and kernel density functions to the level sets framework in MATLAB and by this it has obtained the accurate segmentation of the spine even with missing data. The methodology used for this system for segmentation is masking and level set method. The dataset consisting of 20 CT images of normal spinal vertebrae images of the patient for visualization. The CT images are getting from various places. The experimental results of this model of level sets framework has obtained high accurate segmentation on the CT images. The novelty of the system is Manual selection of the spinal cord region the accuracy may be reduced; hence by applying this Willmore level set a framework for that selection accuracy of obtaining correct result will be more. (Wang et al, 2015) says that “Regression Segmentation for Spinal Images” is about the segmentation of spinal cord image using regression method. It is a segmentation framework model. The framework is based on novel regression segmentation and boundary regression problem. The methodology for the system is the Unified regression segmentation framework. This includes normalization and segmentation. The MRI image will be collected from 113 clinical subjects. The result reaches a high (dice similarity index) DSI 0.912 and agrees (boundary distance) BD 0.928mm. With our unified and expendable framework, this is an efficient tool for diagnosis and identifying the spinal cord region. Provides a novel way to solve the segmentation problem from a totally new perspective; it is willing to take more complex challenges. (Štern et al, 2011) says that “Parametric modelling and segmentation of vertebral bodies in 3D CT and MR spine images” This paper introduce a difference between image-enhancing functionality using #D CT and MRI spine image. The methodology used for the system is modeling the shape and pose of the vertebral body and deformation and alignment of the 3D model to the vertebral body in the image. The dataset will be collected from NIDILR (National Institute for Disability, Independent Living, and Rehabilitation Research). The proposed methodology is very stable and accurate for segmentation of spinal cord vertebral body and also introduce the new parametric model for segmenting the inter vertebral bodies. This work is helping to users to identify the problem of an internal body organ. This is an automatic segmentation tool and classification. The feature detection technique is implemented by PCA and classification done by the nearest neighbour classifier and artificial neural network. The dataset will be collected from IETU (Institute of Electronics, Technical University) of Lodz. The result of the model is 93% accuracy in performance. The advantage of the system is help to identify the human internal organ without consulting the clinical person or doctor. (Leener et al, 2016) says that “Segmentation of the human spinal cord” is about the segmentation of human spinal cord the goal of the system is to provide an overview of segmentation methods for the human spinal cord that have been published or presented in scientific meetings. Some pre-processing steps may be performed before segmentation. That is bias field correction, Gaussian or non-local mean filter and Field of view (FOV) cropping. The methodology introduces an accurate and stable spinal cord segmentation, they using two segmentation method to calculate the accuracy of the system, thresholding segmentation and ROI segmentation is used to locate the specific part human spinal cord, the ROI mechanism is shows the more accurate result of segmentation. The result shows the higher accurate segmentation of spinal cord MRI image from complex and more noise of MRI images.

PROBLEM DEFINITION

Spinal cord segmentation and classification of degenerative disc disease project contain preprocess segmentation and classification. Preprocess the spinal cord MRI image using Histogram equalization and median filter method. After preprocessing segment, the image using ROI segmentation method based on the segmented image classify the Spinal cord degenerative disc disease. The naïve bayes method can be used to classify the disease.

METHODOLOGY

In our proposed work, we are taking 500-600 data set of spinal cord MRI of degenerative disc disease. The degenerative disc disease is mainly caused in thoracic region of the spinal nerve. We take an only
Thoracic region of spinal cord MRI. Degenerative disc disease is an aging problem. It mainly seems in 40-60 years old people. The data set will be collected from MIMs hospital Calicut. The degenerative disc disease spinal cord MRI image collection is very difficult. Once the dataset is collected, perform the image preprocessing after that segment, the image and classified based on the features.

Figure 1: Flow diagram

Here we are used the preprocessing techniques are median filter and histogram equalization method. Median filtering is widely used in digital image preprocessing. This is a method to remove the noise of the image and make it clear. Histogram equalization is an image pre-processing technique. This technique is equalized the intensity value of the image. The outcome of this process is a good quality image. The ROI segmentation is used to segment the spinal cord. Finally, we get a selected region of interest and non-selected region of interest. The feature extraction is the major part of this work, depends on the feature extraction naive bayes classifier is used to classify the image. There is two groups of classification degenerative disease and normal.

The above Figure 1 state that the working of the proposed model

MATHEMATICAL MODEL

In our work, we are doing spinal cord MRI segmentation and classification of degenerative disease

Preprocessing

In the preprocessing technique, we are using a median filter and histogram equalization method. These two technique is help to reduce the noise of images. The outcome of the technique is good quality picture.

Median Filter

The median filter is a preprocessing method in which we are taking a median value to preprocess the MRI image. We have to substitute a pixel by the median, in its place of the regular intervals of all pixels in a region $v$.

$$A[p, q] = \text{median} \left\{ b[r, s] , (r, s) \in v \right\}$$

Everywhere $v$ characterizes area definite by the manipulator, positioned round place $[p, q]$ in the image.

Histogram Equalization

It is a method aimed at altering image intensities to improve contrast.

$$p = \frac{\text{number of pixel intensity}}{\text{total number of pixel}}$$

It is the process of equalizing the intensity or pixel of images.

Segmentation

It is a procedure of separating into many parts. The area of segmentation is the shorten, and alteration of illustration of an image into approximately that is additional expressive and cooler to investigate.

ROI Segmentation

It is a manual segmentation method, in this method, we selected only the region of interest.

Naive bayes classifier

The naïve bayes algorithm is completely based on bayes theorem.

$$\text{pro}(E/F) = \frac{e \cdot \text{pro}(E)}{\text{pro}(F)}$$

Here we are used boundary-based and ROI segmentation
Segmentation processing, we are used edge-based, ROI and thresholding techniques

Step 0: Preprocessed the MRI.

Step 1: The particular area segmented applied by ROI.

Step 2: Convert into Binary image using the threshold method.

Step 3: Using naïve Bayes classification.

Step 4: stop.

EXPERIMENTAL RESULTS

Figure 2 shows the preprocess and segmentation of the spinal cord MRI image. Our proposed work we are performing preprocessing through MATLAB environment after removes noise from the MRI. Then we are proceeding with segmentation process, and feature extraction, based on feature extraction classify the spinal cord MRI images. The preprocessing technique can be used in the median filter and histogram equalization. Preprocessing is the way to removing the noise of images; some MRI image have a lot of noise in the background; the preprocessing method also helps to get an accuracy of segmentation result. The ROI method can be used to separate the specific region of MRI images. Threshold segmentation is used to locate the degenerative part of the spinal cord image. Thresholding is the method to convert MRI image into a binary image. Using feature extraction and calculate the distance between inter vertebra and classify based on the distance result. The naïve bayes classifier is used to classify the degenerative disc disease.

CONCLUSIONS

In the present work, we are classifying the spinal cord degenerative disease. Degenerative disc disease is an aging problem. It will mainly effect the 40-60 years old people. We are classifying two types one is degenerative SC(spinal cord), and another is normal SC(spinal cord). The dataset collection of the degenerative spinal cord is very difficult.

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REFERENCES


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