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Extraction of Tumour Depending Cells in Brain from Rough Set Theory and Magnetic Resonance Images

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Abstract: Brain is the center of human Central nervous system. Radiologists perform the diagnosis of brain tumour manually on MRI images but it being time consuming and error prone as large no of image slices and the large variations between them. The MRI (Magnetic resonance Imaging) brain tumor segmentation is a complicated task due to the variance and intricacy of tumors. Segmentation of images holds an important position in the area of image processing. There are lots of methods for automatic and semi- automatic image classification, though most of them fail because of unknown noise, poor image contrast, inhomogeneity and boundaries that are usual in medical images. Image processing has become an area of boundless possibilities to explore as the advances in research field in this domain are gaining momentum. Brain tumour detection is a crucial task these days. The principle aim of the project is to perform the MRI Brain image classification of cancer, based on Rough Set Theory and Feed Forward Neural Network classifier.

Keywords: Brain Tumor; MRI; Segmentation; Rough Set Theory; FFNN Classifier.

I. INTRODUCTION

Detection of anatomical brain structures with their exact location is important for treatments like radiation therapy and surgery. The developments in the application of information technology have completely changed the world. The obvious reason for the introduction of computer systems is: reliability, accuracy, simplicity and ease of use. The techniques like MRI (Magnetic Resonance Imaging), NMRI (Nuclear Magnetic Resonance Imaging), MRT (Magnetic Resonance Tomography) and CT (Computed Tomography) Scan are being widely used to get the images for processing to detect the tumour, out of which MRI is widely used as it provides much greater contrast between the different soft tissues of the body compared to computed tomography (CT). In medical imaging, an image is captured, digitized and processed for doing segmentation and for extracting important information.

A tumour is an acronym for a neoplasm or a solid lesion formed by an abnormal growth of cells (termed neoplastic) which looks like a swelling. Malignant tumours are classified in to two types like Primary and Secondary tumours. Benign tumour is less harmful compared to malignant as in malignant tumour it spreads rapidly invading other tissues of brain, progressively worsening the condition causing death. Segmentation by experts is variable. Therefore, there is a strong need to have some efficient computer based system that accurately defines the boundaries of brain tissues along with minimizing the chances of user interaction with the system. Additionally, manual segmentation process requires at least three hours to complete. According to the traditional methods for measuring tumor volumes are not reliable and are error sensitive.

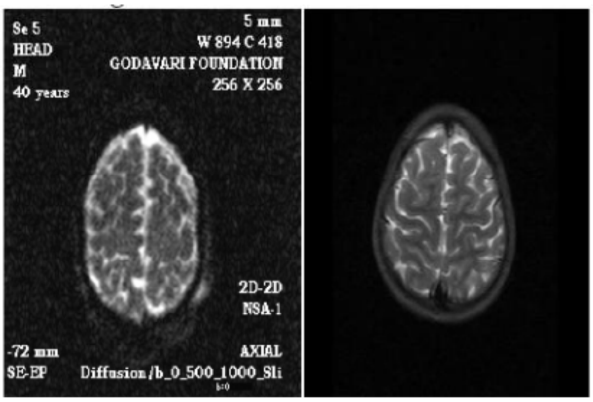
The MRI images can be of T1, T2 weighted type of which T2 weighted Images are being widely used in Medical Imaging as in this case of cerebral and spinal study, the CSF (cerebrospinal fluid) are lighter in T2 weighted images as they are acquired using fast echo spin sequence whereas the T1 weighted images are acquired using a spin echo sequence. Primary focus on exact brain tumours location and its extraction with parameters like area and time to yield faithful and error free output. So called non malignant(Benign) brain tumors can be just as life threatening as malignant tumors, as they squeeze out normal brain tissue and disrupt function. The glioma family of tumors comprises 44.4% of all brain tumors. Glioblastoma type of Astrocytoma is the most common glioma which comprises 51.9%, followed by other types of astrocytoma at 21.6% of all brain tumors. There are lots of methods for automatic and semi- automatic image classification, though; most of them fail because of unknown noise, poor image contrast, inhomogeneity and week boundaries that are usual in medical images. Medical images mostly contain complicated structures and their accurate classification is necessary for clinical diagnosis.

Rough sets theory was introduced by Polish Mathematician Pawlak in 1980s. It is regarded as a new mathematical tool to deal with vagueness and uncertainty. It was widely studied in many fields such as machine learning, data mining and pattern recognition etc. In the authors defined explicit and implicit regions based on the rough sets theory and introduced a new method for inducing decision trees in light of the principle of minimal rough fringe.

II. PRE PROCESSING

The first step is to get the MRI image and application of pre-processing steps. There are various methods which come under this step; we will be dealing with only grey scale and filters. Basically pre-processing is done to remove noise and blurring as well as ringing effect in order to get the enhanced and much clear image for our purpose. The filter which we have used is median filter but as we are working on image samples that are required for the medical purpose. The median filter has to be passed with mask for better image, to achieve this we are using sobel operator.

Pre-processing methods use a small neighborhood of a pixel in an input image to get a new brightness value in the output image.



Original Image Pre-Processed Image

Fig. 1 Pre-Processing of MRI image

The MRI image consist labels on the MRI such as patient name, age and marks and some other information which could interfere with the tumour detection is not of interest when detecting a tumour. At this time Pre-Processing is of vital importance as the intensity value, greater than that of the threshold value is removed from MRI right from the first row and column of the image. The high intensity values of film artifact are removed from MRI brain image.

III. AUTOMATED IMAGE SEGMENTATION

Within the segmentation process, each image region confined by a rectangular window is represented by a feature vector of length R. These vectors computed for Q selected regions are organized in the pattern matrix PR,Q and form clusters in the R-dimensional space. The Q pattern vectors in P are fed into the input NN layer, while the number C of the output layer elements represents the desired number of segmentation classes. Now for clustering we need to have basis for clustering like criterion function which defines the cluster classification on a stand, keeping in mind that the criterion function should be optimized. Suppose that we have a set D of n samples x1,x2,...xn that we want to partition into exactly into 'c' disjoint subsets D1,..,Dc.Some of the Criterion functions for clustering are as the sum of squared error criterion, Related minimum variance criterion ,Scattering criterion. In each epoch of the network training process, the network weights WC,R are recalculated by minimizing the distances between each input pattern vector and the corresponding weights of the winning neuron characterized by its coefficients closest to the current pattern. In case that the process is successfully completed, the network weights belonging to separate output elements represent typical class individuals. In this paper, the region segmentation process comprises of training the NN on all image regions extracted by a rectangular sliding window with half overlap, and subsequent exploitation of the trained network for region classification.

IV. Gaussian Filter

A Gaussian filter is a filter whose impulse response is a Gaussian function. Gaussian filters are created to shun overshoot of step function input while reducing the rise and fall time. Gaussian filter has the minimum possible group delay. In mathematical terms, a Gaussian filter changes the input signal by convolution with a Gaussian function and this change is also called as Weierstrass transform. The input image undergoes smoothing using Gaussian smoothing filter for elimination of noise. Gaussian filter is a linear spatial filter which is used for reducing the high frequency components of an image as a result it smooth's the edges of the input image.

Properties of Gaussian Filtering:

- Gaussian smoothing is very effective for removing Gaussian noise.
- The weights give higher significance to pixels near the edge (reduces edge blurring).
- They are linear low pass filters.
- Computationally efficient (large filters are implemented using small 1D filters).
- Rotationally symmetric (perform the same in all directions).
- The degree of smoothing is controlled by σ(larger σ more intensive smoothing).

So in general, you have many possibilities: try Gaussian filter, and compare it with other algorithms such as Wiener filter, Median filter (circular, rectangular, diagonal), Gabor Filter, Kalman filter. Gaussian Filter Advantages: reduces noise.

V. Rough Set Theory

Rough set theory deals with the classificatory analysis of data tables. The data can be acquired from measurements or from human experts. The main goal of the rough set analysis is to synthesize approximation of concepts from the acquired data. We show that first in the traditional approach and later how it evolves towards "information granules" under tolerance relation. The purpose of developing such definitions may be two fold. In some instances, the aim may be to gain insight into the problem at hand by analyzing the constructed model, i.e. the structure of the model is itself of interest. In other applications, the transparency and explain ability features of the model may be of secondary importance and the main objective is to construct a classifier that classifies unseen objects well. A logical calculus on approximate notions is equally important. It is based on the concept of "being a part to a degree" and is known as rough mereology.

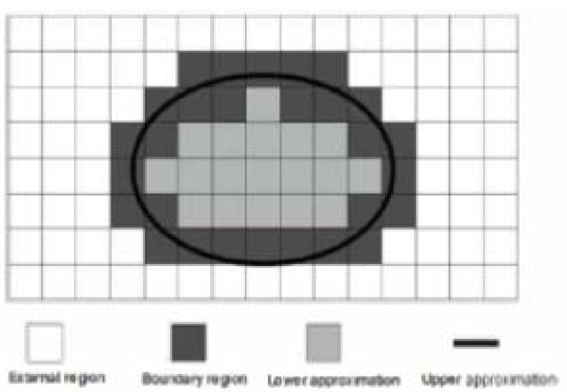


Fig. 2 Schematic view of the four regions of the class in RST

Various rough image processing methodologies have been applied to handle the different challenges posed by medical imaging. We can define rough image processing as the collection of all approaches and techniques that understand, represent, and process the images, and their segments and features as rough sets. In this section, we first describe the ability of rough sets to handle and represent images and color images, followed by the various rough-set-based approaches developed for handling the different functional aspects to solve medical imaging problems. In grayscale images boundaries between object regions are often ill-defined because of grayness or spatial ambiguities. This uncertainty can be effectively handled by describing the different objects as rough sets with upper (or outer) and lower (or inner) approximations. Here, the concepts of upper and lower approximation can be viewed, respectively, as outer and inner approximations of an image region in terms of granules. Definition 1 (Rough image): Let the universe U be an image consisting of a collection of pixels. Then, if we partition U into a collection of non overlapping windows of size $m \times n$, each window can be considered as a granule G. Given this granulation, object regions in the image can be approximated by rough sets.

A rough image is a collection of pixels along with the equivalence relation induced partition of an image into sets of pixels lying within each non overlapping window over the image. With this definition, the roughness of various transforms (or partitions) of an image can be computed using image granules for windows of different sizes. An ROI is a selected subset of samples within an image identified for a particular purpose. The concept of ROI is commonly used in medical imaging. For example, the boundaries of a tumor may be defined on an image or in a volume for the purpose of measuring its size. The endocardial border may be defined on an image, perhaps during different phases of the cardiac cycle, say end-systole and end-diastole, for the purpose of assessing cardiac function.

Hirano and Tsumoto introduced the rough direct representation of ROIs in medical images. The main advantage of this method is its ability to represent inconsistency between the knowledge-driven shape and image-driven shape of an ROI using rough approximations. The method consists of three steps. First, they derive discretized feature values that describe the characteristics of an ROI. Second, using all features, they build up the basic regions (categories) in the image so that each region contains voxels that are indiscernible on all features. Finally, according to the given knowledge about the ROI, they construct an ideal shape of the ROI and approximate it by the basic categories. Then, the image is split into three sets of voxels, which are:

1. Certainly included in the ROI (positive region);
2. Certainly excluded from the ROI (negative region);
3. Possibly included in the ROI (boundary region).

The ROI is consequently represented by the positive region associated with some boundary regions. Hirano and Tsumoto described procedures for rough representation of ROIs under single and multiple types of classification knowledge. Usually, the constant variables defined in the prior knowledge, e.g., some threshold values, do not meet the exact boundary of images due to inter image variances of the intensity. The approach tries to roughly represent the shape of the ROI by approximating the given shapes of the ROI by the primitive regions derived from feature of the image itself. It is reported that the simplest case occurs when we have information only about the intensity range of the ROI. Identification of anatomical features is a necessary step for medical image analysis. Automatic methods for feature identification using conventional pattern recognition techniques typically classify an object as a member of a predefined class of objects, but do not attempt to recover the exact or approximate shape of that object. For this reason, such techniques are usually not sufficient to identify the borders of organs when individual geometry varies in local detail, even though the general geometrical shape is similar.

VI. FFNN CLASSIFIER

Many researchers have endeavored to develop efficient and effective algorithms to compute useful feature extraction and reduction of information systems, and mutual information and discernibility matrix-based feature-reduction methods. Swiniarski and Hargis presented applications of rough set methods for feature selection in pattern recognition. They emphasize the role of the basic constructs of rough set approach in feature selection, namely reduces and their approximations, including dynamic redacts. Their algorithm for feature selection is based on an application of a rough set method to the result of principal components analysis (PCA) used for feature projection and reduction. They present various experiments including mammogram recognition.

Simon Haykin A neural network is a massively parallel distributed processor that has a natural propensity for storing experiential knowledge and making it available for use. It resembles the brain in two respects (Haykin 1998): 1. Knowledge is acquired by the network through a learning process. 2. Interconnection strengths known as synaptic weights are used to store the knowledge. Basically, learning is a process by which the free parameters (i.e., synaptic weights and bias levels) of a neural network are adapted through a continuing process of stimulation by the environment in which the network is embedded.

VII. CONCLUSION

This paper presents an automated system for classification of MRI brain images with different pathological condition. Many cancer forms can only be diagnosed after a sample of suspicious tissue has been removed and tested. Pathologists view pathologic tissues, typical1y with microscopes, to determine the degree of normalcy versus disease. This process is time consuming and fatiguing. The system described in this paper classifies the abnormality into benign or malignant in an automated fashion. This paper use conceptual1y simple classification method using Feed Forward Neural Network. Texture features are calculated using Rough set theory. The proposed system effectively classifies the abnormality of brain tumor.

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