Multi-Fractal Texture Estimation for Detection and Segmentation of Brain Tumors

J. Charitha Chowdhary1 Christeena Joseph2

Department of ECE, Saveetha School of Engineering, Saveetha Institute of Medical & Technical Sciences Chennai, India

Abstract
Automatic brain tumor segmentation is a sensitive stage in the medical field. The task of analyzing a large amount of MRI scans daily demanded by medical centers is common and radiologists should have some automatic tools to support it. In this work, the automatic image segmentation technique is improved and applied to MRI scan images in order to detect brain tumors. In MR images, the tumor part can be seen clearly by the accurate size and measurement for the treatment. The automatic image segmentation algorithm, exploit the information obtained from deducting tumor in brain MRI and the segmentation algorithm will segment brain MR images into white matter, gray matter and cerebrospinal fluid separately. The detection of the brain tumor by segmentation and extraction is done by pixel intensity. Detection of tumor source and tumor age is done by thresholding. Along with the tumor part, the tumor stage is also classified using SVM Classifier.

Key Words: MRI scan images, brain tumors, thresholding, SVM Classifier.

1 Introduction
When abnormal cells are formed inside the brain, the state of condition is called an Intra-cranial neoplasm or Brain tumor. Malignant or Cancerous tumor and Benign tumor are two main types of tumor. A Malignant tumor can be divided into two portions, the primary tumor that starts inside the brain, and the secondary tumor that has spread from somewhere else, known as brain metastasis tumor. All kinds of a brain tumor may produce symptoms that vary depending on the part of the brain involved. These may include headaches, seizures, the problem with vision, vomiting, and mental changes. There are many methods available for the detection but the aim of this project is to apply soft computing techniques for the detection. The aim to propose a prototype of a medical expert system which could help to detect the Brain tumor is done.[14] MRI scans have become very useful for assessing many brain-related disorders. MRI regarded as a superior tool for brain imaging because it does not use ionizing radiation (X-rays) and MRI provides detailed pictures of brain and nerve tissues in multiple planes without obstruction by overlying bones. The task of analyzing a large amount MRI scans daily demanded by medical centers is tiresome and radiologists should have some automatic tools to support it.[11][18]
The proposed automated method is to classify the Brain MRI images into two categories viz., normal and abnormal, where the abnormal images are further classified into five categories namely clot, bleed, tumor, trauma, and acute-infract.

Varying intensity of tumors in brain magnetic resonance images (MRIs) makes the automatic segmentation of such tumors extremely challenging. Brain tumor segmentation using MRI has been an intense research area. Both feature and atlas-based techniques, as well as their combinations, have been proposed for brain tumor segmentation. In addition, the elastic registration of template MRI with distorted patient images due to pathological processes is non-trivial. It may pose a further challenge in detecting tumor from post-operative patient MRI where deformation may be more extensive. Such problems with the segmentation of atlas tumor can be mitigated by devising complementary techniques to support tumor segmentation.[2][3] Duvatizikos et al. used systematic deformations due to tumor growth to match preoperative images of the patient with that of the postoperative. Menze et al. proposed a generative probabilistic model for segmentation by augmenting atlas of healthy tissue priors with a latent atlas of the tumor.

A self-organising Map (SOM) or self-arranging highlight outline is a kind of simulated neural system (ANN) that is prepared utilizing unsupervised figuring out how to create a low-dimensional (normally two-dimensional), discretized portrayal of the info space of the preparation tests, called a guide, and is along these lines a strategy to do dimensionality lessening. Self-organising Map contrast from other simulated neural systems as they apply focused learning rather than blunder redress adapting, (for example, back proliferation with angle plummet), and as in they utilize an area capacity to safeguard the topological properties of the information space.

The information was a table with a line for every individual from Congress, and segments for specific votes containing every part's yes/no/avoid the vote. The SOM calculation orchestrated these individuals in a two-dimensional framework putting comparable individuals nearer together. The main plot demonstrates the gathering when the information is part into two groups. The second plot demonstrates the normal separation from neighbors: bigger separations are darker. The third plot predicts Republican (red) or Democratic (blue) party participation. Alternate plots each overlay the subsequent guide with anticipated qualities on an information measurement: red means an anticipated 'yes' vote on that bill, blue means a 'no' vote. The plot was made in Synapse.[6] This makes SOMs helpful for picturing low-dimensional perspectives of high-dimensional information, much the same as multidimensional scaling. The counterfeit neural system presented by the Finnish teacher Teuvo Kohonen in the 1980s is now and again called a Kohonen guide or system. It is computationally helpful deliberation expanding on organic models of neural frameworks from the 1970s and morphogenesis models going back to Alan Turing in the 1950s.

Like most manufactured neural systems, SOMs work in two modes: preparing and mapping. "Preparing" assembles the guide utilizing input illustrations (an aggressive procedure, additionally called vector quantization), while "mapping" consequently orders another information vector. A self-organising map comprises of parts called hubs or neurons. Related with every hub are a weight vector of an indistinguishable measurement from the information vectors and a situation in the top space. The standard game plan of hubs is a two-dimensional general dispersing in a hexagonal or rectangular framework. The self-organising map guide portrays a mapping from a higher-dimensional information space to a lower-dimensional guide space.[4] The methodology for putting a vector from information space onto the guide is to discover the hub with the nearest (littlest separation metric) weight vector to the information space vector.

k-implies grouping is a technique for vector quantization, initially from flag preparing, that is prevalent for bunch examination in information mining.[10] k-implies bunching plans to parcel n perceptions into k groups in which every perception has a place with the group with the closest mean, filling in as a model of the group. These outcomes in an apportioning of the information space into Voronoi cells.[5]

The issue is computationally troublesome (NP-hard): in any case, there are effective heuristic calculations that are generally utilized and meet rapidly to a neighborhood ideal. These are typically like the desire augmentation calculation for blends of Gaussian disseminations by means of an iterative refinement approach utilized by the two calculations. Furthermore, they both utilize group focuses to demonstrate the information: be that as it may, k-implies bunching tends to discover groups of practically identical spatial degree, while the desire augmentation system enables bunches to have distinctive shapes.

The calculation has a free relationship to the k-closest neighbor classifier, a prominent machine learning method for an order that is frequently mistaken for k-
implies due to the k in the name. One can apply the 1-closest neighbor classifier on the bunch focuses got by k-intends to group new information into the current bunches. This is known as closest centroid classifier or Rocchio calculation.\[1\]

2 Related Work

There are different diagnosis methods available among that biopsy is the only sure way to diagnose a brain tumor. In biopsy surgeons removal of tissue for tumor cells is performed. The abnormal cells are to be checked under the microscope by a pathologist. A biopsy can show cancer, tissue changes that may lead to cancer, and other pathological conditions. So before the biopsy, we must have the proper location of the abnormal tissues. Also after biopsy when doctors go for surgery, they must know the tumor extent in the brain. To determine this we have to use the image processing of MRI brain images.\[12\][13] Finally, the problem definition is given below:

- It is very hard to conduct surgery without using image processing techniques.
- Structures like brain tissue, a tumor and the skull cannot be identified without image segmentation.
- In MRI images, the amount of data is too much for manual interpretation and analysis.
- It takes a long time for diagnosis without image processing techniques.
- There is a chance of the wrong diagnosis without image processing techniques.

A brain tumor is a group of abnormal cells that grow either inside the brain or around the brain. The tumor can destroy the healthy brain cells present in it but cause inflammation, brain swelling and pressure within the skull. The tumor is of Latin origin and means swelling. Symptoms may vary depending on the size and location of tumor. Drowsiness, Depression, Vomiting, Headache, Nausea, Personality changes, Irritability, Decreased cardiac and respiratory function and if not treated properly leads to coma. By using CT scan and MRI, Radiologists examine the patient. The images showed the brain structures, tumors size, and location to diagnose and plan the surgical approach for its removal.

In previous work, the authors use a standard classification forest (CF) as a discriminative multi-class classification model. The techniques in combined random forest (RF) classification with hierarchical CRF regularization as an energy minimization scheme for tumor segmentation, the authors introduced a symmetry feature and RF classification for automated tumor segmentation. Recently, the authors proposed a multi-modal modified tumor cut method for tumor and edema segmentation. The proposed method needs user interaction to draw maximum diameter of the tumor. Raviv et al. presented a statistically driven-set approach for segmentation of subject-specific MR scans. The technique is based on latent atlas approach, where common information from different MRI modalities is captured using spatial probability. However, this method also requires manual initialization of tumor seed and boundary for effective segmentation.

3 Proposed Work

Block Diagram:

Flow Graph:

Module Definition:

- A modular layout reduces complexity, facilities alternate (a vital thing of software maintainability), and outcomes in easier implementation by encouraging parallel improvement of various a part of the device. The software part of the program architecture embodies modularity split into one after the other, named addressable components known as modules that are integrated to satisfy hassle.
- Modularity is the unmarried characteristic of a software program that allows a program to be intellectually viable. The 5 critical standards that permit us to evaluate a design approach with
appreciate to its capability to outline an effective modular design are: Modular decomposability, Modular Comps capability, Modular Understandability, Modular continuity, Modular safety. The following are the modules of the project, which is planned in aid to complete the project with respect to the proposed system, while overcoming existing system and also providing the support for the future enhancement.

**Modules:**

1. Pre-processing
2. Image Segmentation
3. Feature extraction
4. Classification

**1. Pre-Processing:**
Pre-processing is an essential step for many of the image processing applications. The pre-processing technique used here is sharpening of the CT image. Thus, the finer details within the image are enhanced. The image obtained after the pre-processing process is suitable for further processing. The sharpening method uses a convolution method for contrast enhancement.

**2. Segmentation:**
In observation of the computer, a process of partitioning a digital image into multiple segments is called as image segmentation. The segmentation aim is to simplify and/or change the representation of an image into something that is more significant and easier to analyze. Image segmentation is usually used to locate objects and boundaries (lines, curves, etc.) in images. More exactly, image segmentation is assigning a label to every pixel in an image with the same label to share certain characteristics[15]. The output set of segments that cover the image entirely or a set of contours extracted from the image. Each of the pixels is similar with texture, color. Adjacent regions are different with respect to the same characteristics. The resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes is applied to a stack of images, typical in medical imaging[3]. Here, we are using image thresholding and binary image conversion for the segmentation of images.

**3. Feature Extraction:**
The output from the image segmentation steps had been taken as an input to the feature extraction step. The tumor features had been extracted like area, perimeter. This has been stored in a database for further classification of the tumor to find out whether it is cancer causing and its stages or normal stage.

**4. Classification**
The features obtained from the above steps are taken into account for the classification of tumors. The area of each tumor is taken for the staging process. The final decision is taken by the SVM classifier for tumor staging results.

**4 Simulation Results**

**Input Image:**

![Input Image](image1)

**Pre-Processed Image:**

![Pre-Processed Image](image2)

**Segmented Image:**

![Segmented Image](image3)

![Graphs](image4)
Feature Extraction:

5 Conclusion
In this work, we investigated texture based features with a commonly recognized classifier for the classification of brain tumor from MR brain images. From the lab results performed on the MRI image, it is clear that the analysis for the brain tumor detection is fast and accurate when compared with the manual detection performed by radiologists or clinical experts. The various performance factors also indicate that the proposed algorithm provides a better result and effectiveness of the proposed technique for identifying normal and abnormal tissues from MR images.

It concludes that the proposed method is suitable for integrating medical decision support systems for primary screening and diagnosis by the Radiologists.

In the future, to improve the accuracy of the present method and planning to investigate the selective scheme of the classifier by combining more than one classifier and feature selection techniques.

References
[16] https://www.google.co.in/search?q=magnetic+resonance+imaging%28mr+scan%29+in+brain&oq=magnetic+resonance+imaging%28mri+scan%29+in+brain&gs_l=img.3...5633.18648.0.19062.2.1.1.1.1.0.0.0.0.0.0.1.16.j0i30k1.0.QqaFvvKJ20E#imgrc=Vtx8FtJH93YO-M: