Extraction of Brain Tumor Attributes Using Contourlet Transform with Geometric Transform Invariant Technique

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Abstract

In this work, we present a novel 3D based geometric transform invariant for translatory, rotatory and scaling invariant method for detection of brain attributes in Brain MR images. The method provides computational aid in finding features like shape of the tumor, location of it and texture to diagnose from the given MR images. This method helps in finding and determining the location of tumour, various scales in it along with the possible orientations in very less time.

To improvise the accuracy of result, images are diagnosed with preprocessing steps that involves removal of noise, enhancement of images using different morphological operators.

Key Words: Geometric transform, morphological operators.
1. Introduction

Brain tumor analysis is done by experts and doctors, radiologists but its grading gives different conclusions which may differ from one doctor to another. So, for the ease of doctors, use of software based algorithms that incorporate edge detection and segmentation helps in segmenting the tumor are used. Segmentation of brain tumor from brain in Magnetic resonance imaging has become the evolving research area. The segmentation of anatomic structure in the brain plays a crucial role in neuroimaging analysis. Different computing numerical algorithms help researchers, physicians and neurosurgeons to investigate and diagnose the structure and function of brain in both health and disease. Automatic tumor segmentation and edge detection from MR images is a difficult task that involves various disciplines covering pathology, MRI physics, radiologist’s perception and image analysis based on intensity and shape.

Magnetic resonance imaging is noninvasive procedure and can be used safely for brain imaging as required. MRI images are used to produce accurate and detailed pictures of organs from different angles to diagnose any abnormalities. Two types of MRI high field for producing high quality images and low field MRI for smallest diagnosis condition. MRI is based on the principle of absorption and emission of energy in radio free range of electron magnetic spectrum. MRI is the best method for showing abnormalities of the brain such as stroke, hemorrhage, tumor multiple sclerosis and lesions. The problem here considered is to extract the attributes of brain images with noise. Gaussian noise & Rician noise deviate the extraction of detection of attributes. The preprocessing steps involve noise removal and enhancement in MR images.

2. Methodology Adopted

The methods which are quite effective in the removal of noise in an image are partial differential difference equation method. Along with this to get better results some variational methods with differential transforms are also applied to extract independent noise features.

For the upgradation of an image, noise removal only will not serve the purpose. The purpose is fulfilled by applying Partial difference equation based enhancement technique.

In partial difference based enhancement method, Partial difference equation deals with boundary value and eigen value problems. As studied, solution of the difference equation converges to the solution of differential equation.

Pre-processing Stage

Pre-processing stage envisages number of steps of image operations to get better and accurate results. Some of the morphological operators are applied for image enhancement, image sharpening and edge detection on the original image.
for finer results. Further, to improve the image quality, latest noise removal techniques are applied on the original image. Pre-processing consists of mainly following two steps.

**Denoising–Improving Image Quality**

Noise present in MRI Images is caused due to radio frequency pulses, radio frequency coil, field strength, receiver bandwidth or voxel volume [6]. The noise may also be due to system artifact. Noise present in the images is in the form of Gaussian noise, speckle noise, impulse noise, salt and pepper noise etc. Edge preserving bilateral filter, non-local means and total variation are some of the methods employed for eliminating Gaussian noise. Adaptive filters are preferred in place of median filters in this process. Although Median filters can be considered as an effective method for preserving edges during nonlinear filtering of removing noise. Median filters are also found useful in removing signal independent statistical outlines by processing the edges of the image and used to enhance & improve image which might have been destroyed by shot noise. However, in removing impulse noise low pass filters and median filters do not perform well, whereas adaptive filters perform well. Adaptive filters by modifying slightly the filtering method in Kernel sides of the image components are able to adjust themselves to local attributes and structures of the image. Hence, these filters are termed as self-adjusted digital filters. In fact, adaptive filters proposed in this paper are found to perform better than median filters in removing even the impulse noise. In preprocessing stage, adaptive filters are able to denoise non-stationary image also.

Adaptive filters in combination with contourlet transform are able to reduce the severe effects of speckle noise by adjusting according to signal content of the image.

**Brain surface Extraction**

For a radiologist, information given in T1 weighted magnetic resonance image (MRI) images about image background is not of much use. Rather, it increases the processing time. By removing non-significant information such as skull, image background, surface of the brain, eyes etc. of the patient from MRI, decreases the memory usage for storing this image which is not significant in the brain image processing. Brain Surface Extraction (BSE) algorithm is used to remove the areas outside the brain from a T1-weighted MRI which isolate the brain from the rest of the image using a series of image manipulations.

There are four steps involved in the BSE algorithm:
- Step-1 Removal of irregularities and discontinuities by filtering.
- Step-2 Detection of sharp and fine edges.
- Step-3 Morphological erosions using brain isolation and different operators.
- Step-4 Cleaning up of brain surface and image masking.
The image obtained after these two preprocessing steps is the noise free MR image with no brain surface. Now, the image is prepared for further processing to get better results.

**Image Enhancement**

After denoising and brain surface extraction, partial difference equation enhancement technique are used with double filter bank structure to obtain enhanced image. To unidirectional filter bank are used sequentially to create those points of discontinuity into linear structure.

3. **Processing**

The method adopted in this paper to segment the brain for the extraction of tumor in collected MR images is contourlet segmentation with geometric radiant invariant method. Radiant modelling is a physical modelling technique for segregating and differentiating regional boundaries using closed curves or surfaces that changes shapes when external force or internal influence is applied. Radiant models (including two-dimensional active regions and three-dimensional active surfaces) are artificial. These closed regions/surfaces may change its shape and size such as enlarge or shrink over a period of time, within an image being considered and may conform to particular features. The section below provides information about geometric radiant models used for the images segmentation in the field of medical science.

Geometric models move regions/surfaces inexplicitly as defined by a function to a particular level. Although number of improvements have been proposed in such models, some of the inherent difficulties such as spatial changes and firm convergence remained unresolved. To overcome these limitations, modified and improved geometric models are proposed. Caselles et al. [9] and Malladi et al. [10] have proposed a new methodology called Geometric Active Contour modelling. This modelling can handle region based changes without any additional task.

Capturing multiple objects is one of the most difficult task in the image processing and this method overcomes such limitations.

Geometric radiant models depend on curve theory which is implemented using level sets. On the other hand , the use of preprocessing steps are necessary because on applying geometric radiant methods to noisy images with unclear boundary may produce unpredictable result to the actual one and makes segmentation much tedious.

The steps involved in image analysis will as follows:

- Estimation of the position of the tumor in centroid form.
- Application of contourlet transforms.
- Decoding the image in binary format only for the tumor part.
- Convert the binary decoded tumor part through DFT transform.
4. Result

The given input image is filtered from noise and enhanced using morphological operators. Also, the result shows that the image is segmented and subjected to geometric transform invariant and decoded binary image is retrieved.

![Flowchart of the steps involved](image)

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Fig. 2: Col.-1 – Input image Col. 2– Segmented image & Col. 3 – Decoded binary image
5. Conclusion

In this paper a geometric transform invariant method along with contourlet segmentation is used for the extraction and classification of brain tumor portion in an image based on its position, shape, and size. The proposed method declares better result even with noised images. The accuracy of result is classified by constructing a database of large number of sample images.

References
