

# Segmentation of Tumor Region in MRI Images of Brain using Mathematical Morphology

## Ashwini Gade

Department of Electronics and Telecommunication  
MPSTME, NMIMS  
Mumbai, India.

ashwinigade036@gmail.com

## Rekha Vig

Department of Electronics and Telecommunication  
MPSTME, NMIMS  
Mumbai, India.

rekha\_vig@yahoo.co.in

## Vaishali Kulkarni

Department of Electronics and Telecommunication  
MPSTME, NMIMS  
Mumbai, India.

vaishalikulkarni6@yahoo.com

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## Abstract

This paper introduces an efficient detection of brain tumor from cerebral MRI images. The methodology consists of two steps: enhancement and segmentation. To improve the quality of images and limit the risk of distinct regions fusion in the segmentation phase an enhancement process is applied. We applied mathematical morphology to increase the contrast in MRI images and to segment MRI images. Some of experimental results on brain images show the feasibility and the performance of the proposed approach.

**Keywords:** Cerebral MRI Images, Mathematical Morphology, Tumor.

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## 1. INTRODUCTION

Many research work centres are focused on the dynamic growth in the region of cerebral cancer diagnosis because of the fact that cerebral cancer is spreading among world population [1]. We have observed in the US, nearly 3000 children are diagnosed with brain tumors. Almost 50% will die within few years, making it the most fatal cancer among children [2]. It's associated with neurological disabilities, retardation and psychological problems and increased risk of death. Despite over all increases in incidences and death from cerebral cancer in the general world population; Africans are more likely than other patients to die of the disease. In Tunisia, for instance, the cancers mortality is responsible for 14.8% of deaths among the elderly. They represent the second leading cause of death after cardiovascular diseases [3]. Due to its negative effects on affected people, the cancer diseases constitutes a high burden on national economy and a source of suffering for the family as well as the society [3].

Imaging plays a central role in the diagnosis of brain tumors. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are the high resolution techniques locate brain tumor. The information obtained will influence the treatment a patient will receive. The most widely used clinical diagnostic and research technique is MRI. It's an efficient medical imaging technique that has different methods (T1, T2, ARM, ...) having each particular property and an effective way that enables to clarify the various tissues and to obtain a 2D, 3D and even 4D sight (3D+T) of a part of the body, in particular of the brain. It's based on the principal of nuclear magnetic resonance (NMR). Due to various sequences various tissues with high contrast can be observed [4].

It is difficult in medical imaging diagnosis systems to separate cells and their nuclei from the rest of the image content [5]. As the process of separation is very important, much attention of the expert diagnosis system has to be paid to the segmentation stage. Segmentation is a crucial step in image processing tasks. In literature, there are different definitions of segmentation. Haralick, Zhang and Freixenet [6] summarize the segmentation definitions found in literature. From general point of view segmentation is the partitioning of an image into a set of homogeneous and significant regions having a single label and common or similar properties. Many algorithms were thus proposed during the last decades. They are based on various approaches: contour, region and texture.

In the image processing analysis, enhancement process improves the quality of images since the majority of images dealt with have low contrast and is a pre-treatment of segmentation process.

The paper is organized into IV Sections. Section -I is about Brain Tumor. Section-II presents the proposed method of tumor detection from cerebral a MRI image which consists of two steps: Enhancement and Segmentation. Enhancement Process is applied by mathematical morphology and segmentation process is also applied by mathematical morphology with increased size of structuring element. Experimental results are reported in section-III. Finally concluding remarks are drawn in section- IV.

## 2. PROPOSED METHOD

The proposed method of detection and segmentation of the tumor from the cerebral MRI Images is summarized in Figure: 1

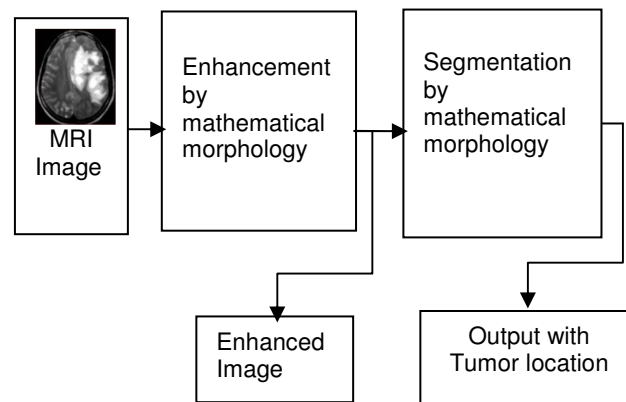


FIGURE 1: Steps of Proposed Method

### 2.1 Enhancement

Enhancement in medical imaging is to make image clearer, smoother and improves the quality of given image. It can be accomplished by removing noise, enhancing contrast, emphasizing edges and modifying shapes. Figure: 2 illustrate the enhancement process.

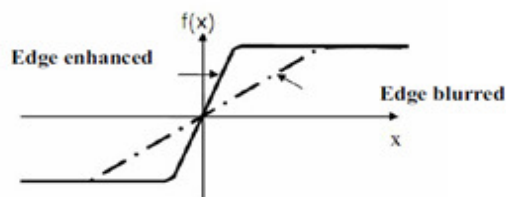


FIGURE 2: The Enhancement Process.

In blurred images, the intensity values of pixels on both sides of edge changes linearly. After performing image enhancement, there is drastic change in the intensity level on both sides of edge.

The enhancement techniques have widely applied in the field of radiology, where the subjective quality of images is important for diagnosis. Many general purpose tools for enhancement have developed and applied to medical images [8]. They include histogram modification, mean filters, Gaussian filters, linear shift invariant filters and morphological filters. For contrast enhancement based on mathematical morphology theory there are two methods: the first is Top-Hat which deals with images after the segmentation process. This algorithm enhances the edges of the segmented region of interest. The second algorithm deals with the contrast of the original image to enhance the segmentation process.

Here, we consider the Mathematical morphology for contrast enhancement. A detailed theory of mathematical morphology is provided in [9]. Experimentally, we found that structuring element as a disk of radius 7 yields the best performance of the morphological algorithm.

Image enhancement has applied successfully to different fields such as medical, industry and military fields [7].

### **2.1.1 Mathematical Morphology**

Mathematical morphology [10, 11] is a relatively new approach to image processing and analysis. This approach is based on set-theoretic concepts. In morphology objects present in an image are treated as sets. As the identification of objects and object features directly depend on their shape, mathematical morphology is becoming an obvious approach for various machine vision and recognition processes.

In morphology, the objects in an image are considered as set of points and operations are defined between two sets: the object and the structuring element (SE). The shape and the size of SE are defined according to the purpose of the associated application. Basic morphological operations are erosion and dilation. Other operation like opening (closing) is sequential combination of erosion (dilation) and dilation (erosion). Golay logic processor [12], Leitz Texture Analysis System TAS [13], the CLIP processor arrays [14] and the Delft Image Processor DIP [15] have started including morphological processor. Initially morphology dealt with binary images only and basic operation was dilation and erosion also known as Minkowski addition and subtraction [16] respectively.

#### **2.1.1.1 Tophat Transformation**

The *tophat transformation* [17] provides an excellent tool for extracting bright (respectively dark) features smaller than a given size from an uneven background. Gray-scale opening helps to remove the brighter areas from an image that is features that cannot hold the structuring element. Subtracting the opened image from the original one yields an image where the features that have been removed by opening clearly stand out. Similar thing is true for closing operation also. That means using a *closing* instead of an *opening* and subtracting the original image from the closed one helps us extract dark features from a brighter background. Let us call it a *black tophat* transformation as opposed to *white tophat* transformation in case of opening. Suppose the structuring element used in both opening and closing is a disk, or, more specifically, a discrete approximation of disk. Therefore, the bright tophat transformation decomposes an image into two parts.

An ordered sequence of morphological tophat filtering through opening (closing) of the image with a disk structuring element with different size extracts bright (dark) features from the image. These features resulting from the tophat transformation of the image can be amplified selectively to achieve local contrast stretching. Based on this we propose an enhancement method in the following section.

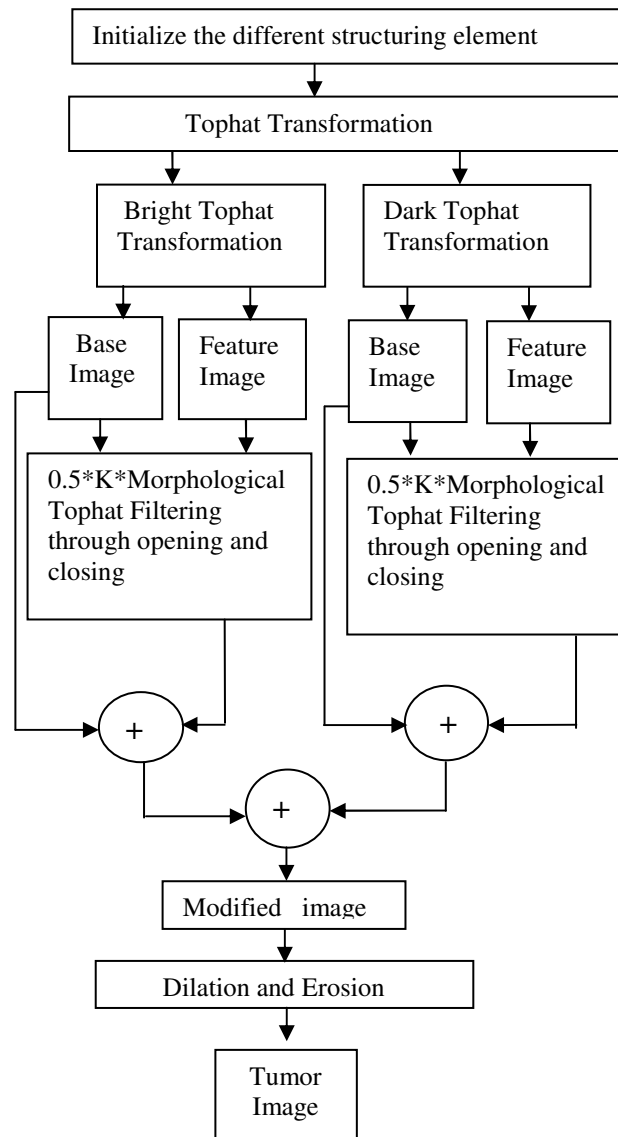
### 2.1.1.1.2 Enhancement using Mathematical Morphology

The bright Tophat transformation decomposes an image into two parts. This may be expressed in terms of gray scale morphological operators as

$$g(r, c) = \underbrace{(g \circ B)(r, c)}_{\text{Part-1}} + \underbrace{[g(r, c) - (g \circ B)(r, c)]}_{\text{Part-2}} \quad (1)$$

Where  $B$  is a disk in discrete domain. Let us call part 1 of “(1)” the *base image* with respect to  $B(r, c)$ . And let us call part 2 of “(1)” the *feature image* at size of  $B$  as it contains all the bright features of  $g(r, c)$ . The feature image [i.e. part 2 of “(1)”] gives a measure of local contrast in the original image due to presence of bright features.  $k$  is a global amplification factor and is greater than one. So this transformation makes bright features brighter and, thus, improves the quality of the image. And  $k_1 > k_2 > k_3 \dots$ , since we know that smaller the size of a bright feature, more should be its intensity for detectibility. It not give the better result therefore after that some morphological operations are applied on the image. The basic purpose of the operations is to show only that part of the image which has the tumor that is the part of the image having more intensity.

The proposed method is summarized in figure 3.



**FIGURE 3:** Steps of The Proposed Algorithm.

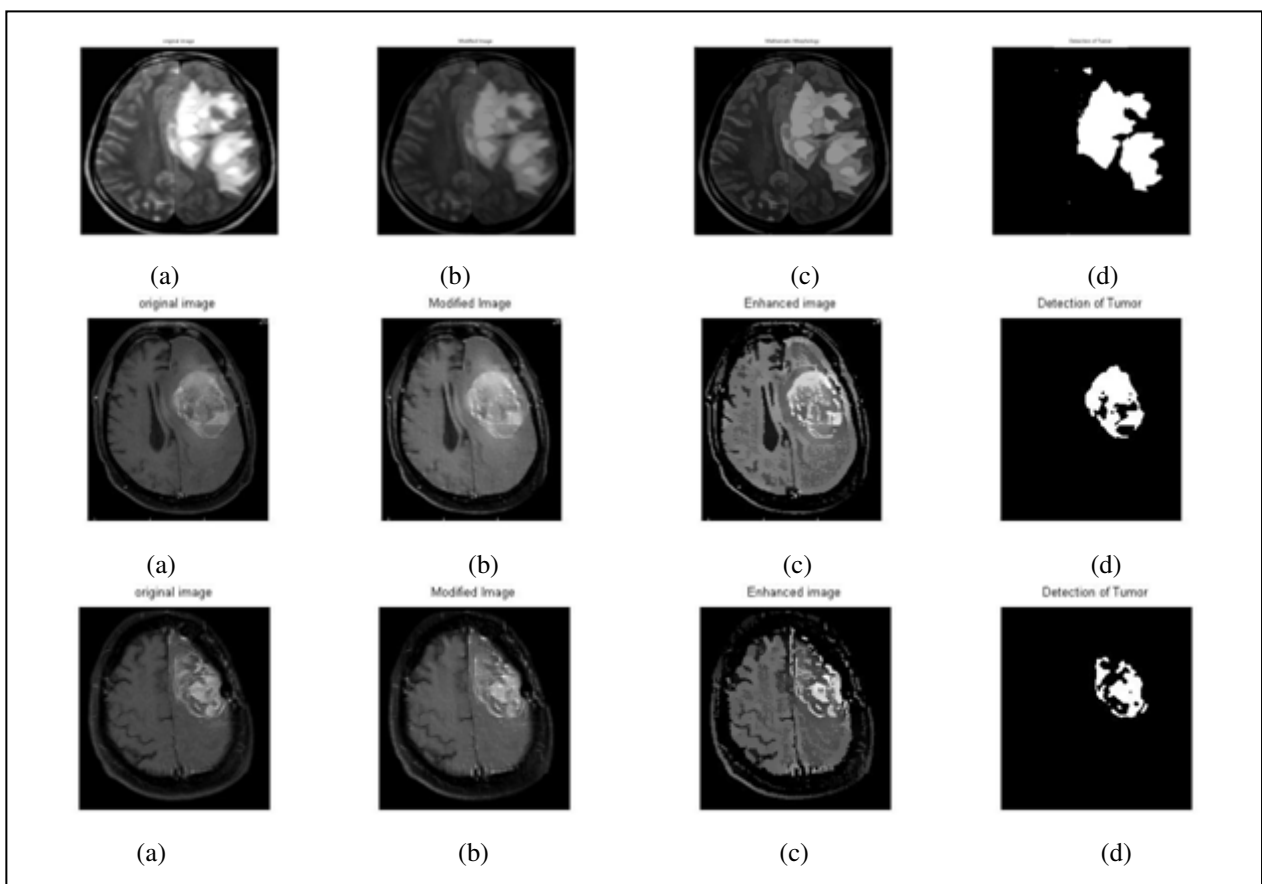
The basic commands used in this step are strel, imerode and imdilate, Imerode: It is used to erode an image. Imdilate: It is used to dilate an image.

## 2.2 Segmentation

After pre-processing phase, we adopt a segmentation algorithm. Segmentation is the partitioning of an image into homogeneous regions (Spatially connected groups of pixels called classes, or subsets) with respect to one or more characteristics or features. The organ's anatomy, the patient's position of catching image and other medical images characteristics add more difficulties to the problem of image segmentation. This explains the variety of segmentation methods. In literature there exist two types of segmentation techniques: edge based segmentation and region based segmentation.

Edge based segmentation aims at finding object boundaries and segmenting regions enclosed by the contours. Edge based techniques include Roberts, Prewitt, Robinson, Kirsch, Laplacian and Frein-Chen filters [18]. They prove to be computationally fast and don't require prior information about the image content. However a drawback of the edge approach is that the edges do not enclose the object completely.

In region-based techniques, segmentation is applied by identifying all pixels that belong to the object based on the intensity of pixels. They include region growing, watershed algorithm and thresholding [21]. In the medical image segmentation field, region growing technique can be applied in kidney segmentation, cardiac images, extraction of brain surface etc. The capability of generating joined regions and appropriately segmenting regions having matching property are the benefits of this segmentation method. One of the drawbacks of this method is that dissimilar starting points may not result growing into identical regions. In addition to this, since outcome of region growing is dependent on homogeneity criterion, failure in correctly choosing criterion may result in adjacent areas or regions not belonging to the object of interest [22].



**FIGURE 4:** Segmented Tumor.

Here we consider mathematical morphology same as implemented in image enhancement for segmentation of tumors. We applied several tests with different type and size of structuring element and come to conclude that Disk of radius 160 is the best type in image application.

### 3. EXPERIMENTAL RESULTS

The proposed algorithm has been tested on a set of biomedical images and the results have been compared with that of other methods. Here we present detailed study with example images containing MRI scan of human brain. The application of proposed method is illustrated in the

figure 4. figure (a) is the original MRI scan images; figure (b) Shows the modified image where the dark and bright Features are balanced; figure (c) is the output after mathematical morphology using Disk of size 7 and then figure (d) is the resultant segmented image after mathematical morphology using Disk with increased size of SE of figure (c)

The results of segmented tumor using mathematical morphology preserves the qualitative and quantitative tumor region better as compared to edge and region based segmentation.

#### 4. CONCLUSION AND FUTURE SCOPE

In this paper, an efficient detection of brain tumor has been introduced. It is based on mathematical morphology. The algorithm reduces the extraction steps and improves the quality of images. Due to the enhancement process applied the algorithm limits the risk of distinct region fusion in the segmentation phase. The enhancement and segmentation are performed by applying the mathematical morphology. The results show that this method can improve image quality and have good visual effect. The tumor area is effectively detected by using this algorithm which paves the way for the expert to decide the degree of malignancy or aggressiveness of a brain tumor. To classify a brain tumor as "benign" or "malignant" will be the subject of future research.

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