SOCIETY FOR SCIENCE AND EDUCATION
UNITED KINGDOM

JBEMi JOURNAL OF BIOMEDICAL ENGINEERING AND MEDICAL IMAGING

ISSN: 2055-1266
VOLUME 2 ISSUE 4

Extraction of Brain Tumour in MRI Images Using Marker Controlled Watershed Transform Technique in MATLAB

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ABSTRACT

In recent years, substantial research has been carried out in the field of image processing to evaluate different structures and information from images. Image processing techniques have played a pivotal role in a wide range of medical image applications. They have been widely used to design different computational algorithms for extracting clinical information from medical images in different modalities including MRI, CT and Ultrasound. This paper aims to propose the use of image processing techniques in the medical field. The objective of this paper is to develop a MATLAB based algorithm that can be used to extract a brain tumor from a MRI Image. In this research, we have performed some noise removal functions, segmentation techniques and morphological operations for detection and extraction which are the basic concepts of image processing. We have developed a Watershed Transform technique based on internal and external markers. The detection and extraction of tumor from MRI image of the brain is done by using MATLAB software.

Keywords— Medical Image Processing, MRI, Brain, Tumor, Extraction, Watershed Transformation, Marker Controlled Watershed Transform, MATLAB

1 Introduction

Image segmentation plays a significant role in the process of images and visions of computer. Image segmentation has become a pledging issue, especially due to the dependence of the problem on image modalities and on the imagined objects for the last twenty years. Image processing in medical science is significantly applied to magnetic resonance (MR) as images of the brain. Image segmentation is given much consideration and care during the last twenty years [23-26]. Biomedical images are formed by objects of varying shapes, sizes and intensities[1]–[4]. Segmentation of medical images is very difficult task due to overlapping of different tissues [5]. The incorrect quantification of object properties is usually produced by imprecise splitting of the touching /overlapping objects, for instances, area, perimeter, average intensity, etc. Thetransformational watershed gives us witha heavily mechanised tool for the

DOI: 10.14738/jbemi.24.1260
Publication Date: 14th July 2015
URL: http://dx.doi.org/10.14738/jbemi. 24.1260

solution of this problem and is therefore entirely used in numerous applications [7-11]. Watershed Transform is a segmentation method which is based on regions with homogenous properties of intensities [6]. The transformational mechanism was proposed and pioneered byDigabel and Lantuejoul [12] and later on was modified byBeucher et al [13].

In this paper, we have proposed a MATLAB based technique for extraction of brain tumour with the help of the marker- controlled watershed transformation. For instance, numerous MRIbrain images are used to display the targeted technique.

In Section 2 describes some basic contextuality for the watershed transformation and marker-controlled watershed transform is explained. Section 3 describes the proposed algorithm and its effective use in details. Section 4 describes the experimental consequences then wind-up in Section V.

2 Methodology

2.1 Watershed Transformation

The Watershed Transformation is constantly envisaged in a powerful and fast technique for both contour detection and region-based segmentation. In a head gear, water- shed segmentation lies on ridges to restore a proper segmentation, a property which is usually completed in contour detection where the boundaries of the objects are displayed as ridges. For region-based segmentation it is difficult or almost impossible to change the edges of the objects into ridges by ascertaining superiority map of the image. Watershed is normally managed by region growing based on a combination of markers to avoid dangerous over-segmentation [16-19].

2.2 Marker-Controlled Watershed Transform

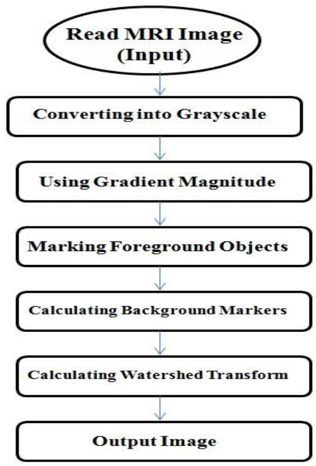
The marker-controlled watershed expresses an elaborated form over the traditional watershed transform. The laws of the marker-based segmentation are to transform the input image so that the watersheds of the transformed image resemble to the object boundaries [14-17]. The goal of the marker controlled segmentation is to detect the presence of the homogenous regions from the image by a set of morphological operations. Markers are connected components belonging to an image [17-18].

3 Proposed Algorithm

We have used different morphological operations to remove noise from structured elements in the images such as dilation, erosion, opening, and closing. To get the better filtered image we used erosion and dilation functions. For getting more refined result we used opening and closing operations with different structuring elements.

In this proposed algorithm, we first converted the image into gray-scale and then performed gradient magnitude as the segmentation function. The developed segmentation function results into a resultant image, whose foreground and background markers are the objects we are interested to segment. The whole proposed algorithm is discussed in detail in below images. The fig 1(a) shows a gray scale converted MRI image, which contains tumour in the brain. Fig 1(b) shows the gradient magnitude of gray scale image as a segmentation function, sobel edge masks, imfilter, and some simple arithmetic operations are performed to compute the gradient magnitude. Fig 1(c) shows the watershed transform directly on gradient magnitude.

Now, the foreground marker, background marker and object boundaries are found by using some morphological techniques such as opening-by-reconstruction, closing-by-reconstruction, erosion, dilation, reconstruction and thresholding operations, the results of these operations can been seen in images fig1(d)-1(m). Finally fig. 1(n) and 1(o) are the final watershed segmented output of the original image, where tumour of the brain is extracted out from the original MRI image.



Flowchart 1: Proposed Algorithm Flow chart

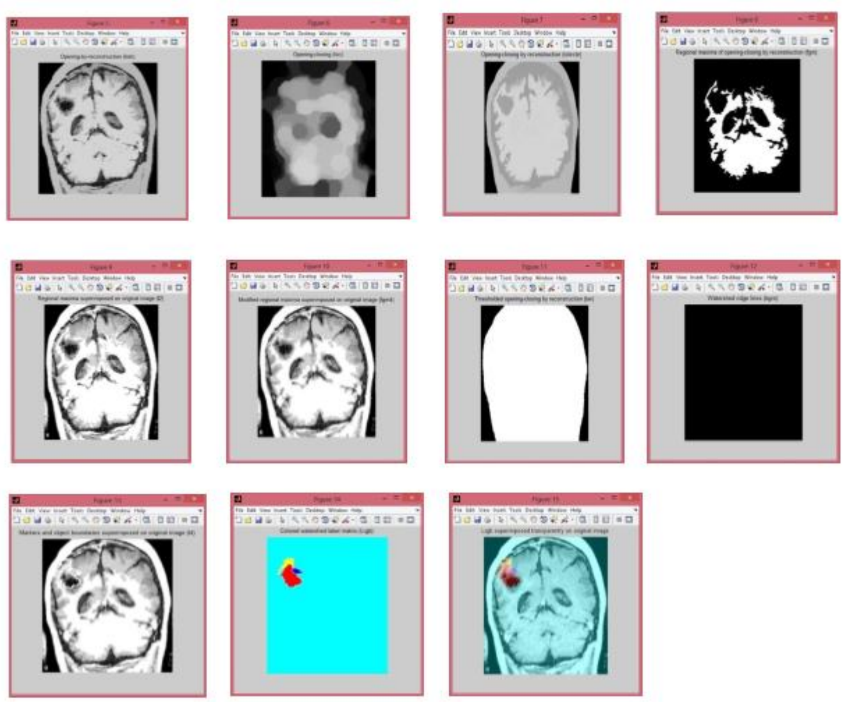


Figure 1. (a)grayscale converted, (b)gradient magnitude of grayscale image, (c)watershed transform, (d) opening, (e)opening-by-reconstruction, (f)opening-closing,(g) closing-by-reconstruction,(h)regional maxima of opening- closing ,(i) erosion,(j)dilation,(k)reconstruction,(l) modified regional maxima superimposed, (m) thresholding operations, (n) & (0) final watershed segmented output of the original image.

4 Mathematical Derivation:

Morphological operations transform the image. In this paper, erosion is applied to detect the tumor [27]. The erosion of A by B is given by the expression:

$A \ominus B = \{(i, j) : B(i, j)\}$

Where, A= the binary image, B= the structuring element

(i, j)= the center pixel of structuring element

4.1 Measuring the tumor region:

The area of the tumor region is calculated by the following equation:

Tumor area=Ax total number of pixel in the tumor region

A= V x H

Where, A=the area of each pixel

H=horizontal dimension of the image

V=vertical dimension of the image

H=1/horizontal resolution of the image

V=1/vertical resolution of the image

5 Results and Discussions

Multiple MRI images having a brain tumor were processed through the proposed algorithm in MATLAB software. The different image processing techniques such as morphological operations, segmentation, watershed transformation, marker-controlled watershed transformation were used to acquire the result in the form of refined extraction of the brain tumor region. The result of these image processing techniques and algorithm can be seen in following four MRI images.

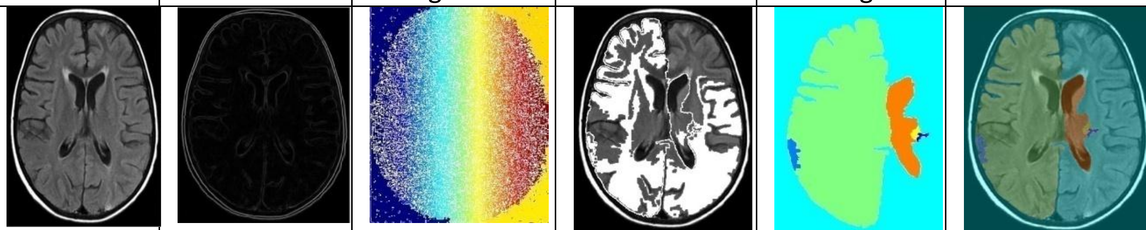
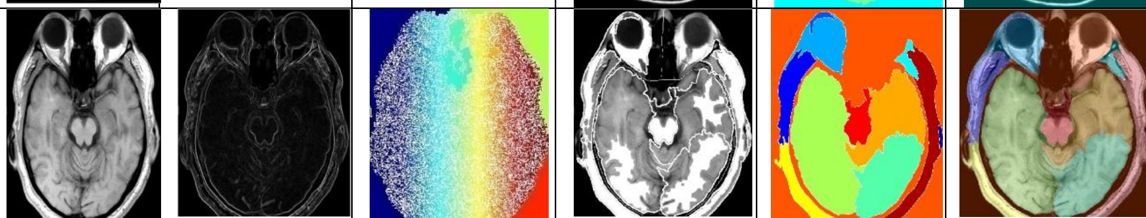
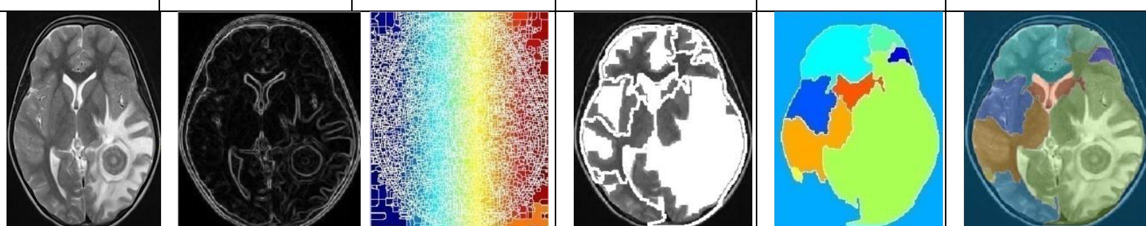
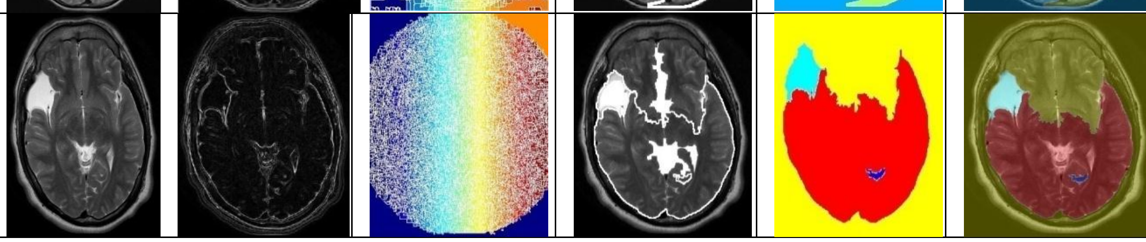
S. No.	Original Image	Gradient Magnitude	Watershed Transform of Gradient Magnitude	Image Markers	Watershed on Marker Image	Final Image
I1						
I2						
I3						
I4						

Figure 2: Original Image, Gradient Magnitude, Watershed Transform of Gradient Magnitude, Image Markers, Watershed on Marker Image and Final Image.

6 Conclusion

In this paper, we have proposed an algorithm for tumor extraction from MRI Images by markers and morphological operations. The experimented results shows that the proposed Marker Controlled Watershed transform algorithm gives better results for extracting brain tumor from MRI images as compared to conventional watershed transformation or simple morphological operations. The execution of proposed algorithm is mainly based on markers and is divided into three main steps i.e pre-processing, marker calculation and final watershed segmentation. This algorithm is able to extract the tumor or irregularity from a MRI image in a better way. Thus it may be used in medical diagnosis to assist clinicians and radiologists in more befitting manner. This technique can be merged and extended with some advanced techniques to improve results in case of high resolution images.

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