



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



Sudan University of Science and
Technology

College of Engineering

DEPARTMENT OF BIOMEDICAL ENGINEERING

RESEARCH TITLE:

HYBRID TECHNIQUE IN MRI SEGMENTATION METHODS

Submitted by:

HADEEL SAEED BASHIR

NEHAL HAJ ALFAKI MOHAMEED

BIAN OMER ALKHALIFA

Supervised by:

DR.ZAINEB ADAM

2015

بسم الله الرحمن الرحيم

قال تعالى :

(﴿ وَقُلْ رَبِّ زِدْنِي عِلْمًا ﴾)

صدق الله العظيم

سورة طه الآية (144)

وقال تعالى :

(﴿ وَاخْفِضْ لَهُمَا جَنَاحَ الذُّلِّ مِنَ الرَّحْمَةِ وَقُلْ رَبِّ ارْحَمْهُمَا كَمَا رَبَّيْتَنِي صَغِيرًا ﴾)

صدق الله العظيم

سورة الأسراء الآية 24

DEDICATION

do not write Dedicate only to strangers

And loved ones We understand either part of the

Book do not need to sign in the paper

AKNOWLEDGMENT

In order for us to complete this project to its
best

We are grateful to several person and friends

Firstly ,we would like to grate **supervisor,**
Dr.Zaineb Adam

Who always offered support and ideas to make
the project success, in addition we must grate all
whose introduced their
assistances for us.

Finally,we would like to extend our greatest
utmost gratitude to our families, particular
parents who have stuck with

TABLES OF CONTENTS:

Subject	
الآية القرآنية	I
Dedication	II
Acknowledgement	III
Table of contents	IV
Abstract	VI
مستخلص البحث	VII
Abbreviation	VIII
Chapter one	
Introduction	
1.1 General veiw	1
1.2 Problem statement	2
1.3 Objectives	2
1.3.1 General Objective	2
1.3.2 Specific Objective	2
1.4 The Thesis layout	3
Chapter two	
Theoretical background	
2.1 Tumor	4
2.1.1 Types of Tumor	4
2.2 Brain tumor	5
2.3 Medical imaging	6
2.4 Magnetic Resonance Imaging (MRI)	6
2.5 filters	8
2.6 General approaches to segmentation are	9
Chapter Three	
Literature Review and Related Work	
Literature Review and Related Work	11

Chapter four Methodology	
4.1 Proposed Methodology	13
4.1.1 Image Acquisition Stage	14
4.1.2 Pre Processing Stage	14
4.1.3 Processing Stage	17
4.1.5 Output image	22
Chapter five The Result and Discussion	
5.1 The Result	23
5.2 Discussion	35
Chapter six Conclusion and Recommendation	
6.1 Conclusion	37
6.2 Recommendation	37
References	38

Abstract

Brain image segmentation is one of the most important parts of clinical diagnostic tools, brain images mostly contain noise, inhomogeneity and sometimes deviation, therefore, accurate segmentation of brain images is a very difficult task, however the process of accurate segmentation of these images is very important and crucial for a correct diagnosis by clinical tools, this research presented a review of the methods used in brain segmentation, the review covers imaging modalities, magnetic resonance imaging, methods for noise reduction and segmentation, the purpose of research to compare between methods and combine it to improve the quality of image segmentation, it's conclude with a discussion on the trend of future research in brain segmentation.

المستخلص

يعتبر تقسيم او تجزيء صور الدماغ أحد أهم أجزاء التشخيص الطبي , معظم صور الدماغ تحتوي على تشويش أو تأثيرات تحول دون وضوح الصورة , التقسيم الدقيق لصور الدماغ يعتبر مهمة صعبة للغاية في حالات عدم تجانس الصور وفي بعض حالات الانحدار أو الاختلاف , على اية حال عملية التقسيم الدقيق لهذه الصور مهم جدا و أمر محسوم للتشخيص الصحيح بواسطة الاجهزة الطبية , يحتوي هذا البحث على الطرق المستخدمة في تقسيم الدماغ مع تغطية قيود التصوير , التصوير بالرنين المغنطيسي وطرق تقليل التأثيرات والتشويشات التي تؤثر على الصورة بالإضافة الى التقطيع أو التقسيم , وختم البحث بمناقشة التوجهات المستقبلية للبحوث في مجال تقسيم او تقطيع صور الدماغ.

Abbreviation

MRI	Magnetic resonance imaging
CT	Computed tomography
NMR	Nuclear Magnetic resonance
RF	Radio frequency
3D	Three dimensional image
SNR	Signal to noise ratio
MS	Multiple sclerosis

Chapter One

Introduction

Chapter One

Introduction

1.1 General view

In medical imaging, segmentation of images plays a vital role in stages which occur before implementing object recognition; image segmentation helps in automated diagnosis of brain diseases and helps in qualitative and quantitative analysis of images such as measuring accurate size and volume of detected portion. Accurate measurements in brain diagnosis are quite difficult because of diverse shapes, sizes and appearances of tumors, tumors can grow abruptly causing defects in neighboring tissues also, which gives an overall abnormal structure for healthy tissues as well, we will develop a technique of segmentation of a brain tumor by using segmentation in conjunction with morphological operations[1].

MRI is basically used in the biomedical to detect and visualize finer details in the internal structure of the body; this technique is basically used to detect the differences in the tissues which have a far better technique as compared to computed tomography, so this makes this technique a very special one for the brain tumor detection and cancer imaging [1]

For an MRI test, the area of the body being studied is placed inside a special machine that contains a strong magnet, pictures from an MRI scan are digital images that can be saved and stored on a computer for more study, the images also can be reviewed remotely, such as in a clinic or an operating room, in some cases, contrast material may be used during the MRI scan to show certain structures more clearly.

Magnetic resonance imaging (MRI) is done for many reasons, it is used to find problems such as tumors, bleeding, injury, blood vessel diseases, or infection,

you may be able to have an MRI with an open_machine that doesn't enclose your entire body, but open MRI machines aren't available everywhere, the pictures from an open MRI may not be as good as those from a standard_MRI_machine.

CT uses ionizing radiation but MRI uses strong magnetic field to align the nuclear magnetization then radio frequencies changes the alignment of the magnetization which can be detected by the scanner, that signal can be further processed to create the extra information of the body.

Image segmentation is the division of an image into regions or categories, which correspond to different objects or parts of objects; every pixel in an image is allocated to one of a number of these categories [1]

1.2 Problem statement

The diagnosis of images must be precise thus using the inappropriate method of segmentation might lead to decrease image quality.

1.3 Objectives

The objectives of this research were classified into General and specific objectives.

1.3.1 General Objective

To explain the MRI segmentation methods and compare between them:

1.3.2 Specific Objective

- I. To differentiate between three methods of segmentation there are: thresholding, watershed and morphological operators.
- II. To use the watershed method because it is has high efficiency in image segmentation.

III. To combine between them to obtain of increase the quality of image diagnosis.

1.4 The Thesis layout

This project is arranged in the following manner:

Chapter one is an introduction, Chapter tow focuses on Theoretical background.

The literature review is covered in chapter three; Proposed Methodology is described chapter four, Chapter five focuses on Results and Discussions. Chapter six focuses on Conclusion and Recommendation, and Reference.

Chapter Two

Theoretical background

Chapter Two

Theoretical background

2.1 Tumor

The word tumor is a synonym for a word neoplasm which is formed by an abnormal growth of cells Tumor is something totally different from cancer.

2.1.1 Types of Tumor

There are three common types of tumor:

- I. Benign.
- II. Pre-Malignant.
- III. Malignant (cancer can only be malignant) [1]

I. Benign Tumor

A benign tumor is a tumor is the one that does not expand in an abrupt way; it doesn't affect its neighboring healthy tissues and also does not expand to non-adjacent tissues, moles are the common example of benign tumors.

II. Pre-Malignant Tumor

Premalignant tumor is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

III. Malignant Tumor

Malignancy (mal- = "bad" and - ignis = "fire") is the type of tumor, that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer. Bar Graph is given below, showing number of persons who have diagnosed from tumor and number of persons who died of tumor [1].

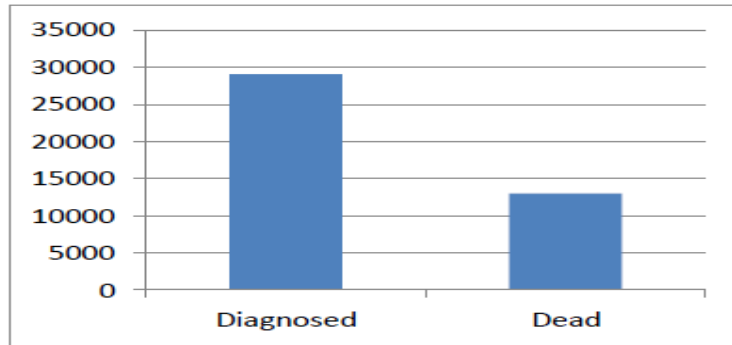


Figure 1.1: Analysis of tumor diagnosis [1]

2.2 Brain tumor

Brain, heart and lung etc. are the most important parts of the human body, and then, all parts of the body are controlled by the brain cells, therefore, brain is a vital organ of the body, nowadays brain tumor is a very serious disease among children and adults, the most deadly and intractable diseases are brain tumor, brain tumor's location and quickly spreading make a critical problem in treatment of tumor, thus image segmentation and detection are vital method to solve the medical problem of the various diseases, imaging of the brain tumor can be done by computer tomography (CT) scan, magnetic resonance image (MRI) scan, Ultrasound, etc, in this research MRI scan is used to implement the system. [2]

Now days, one of the main cause for increasing mortality among children and adults is brain tumor, it has been concluded from the research of most of the developed countries that number of people suffering and dying from brain tumors has been increased to 300 per year during past few decades, pie chart is given below, which shows rate of tumor diagnosis in some countries [1]

Brain Tumors Diagnosed

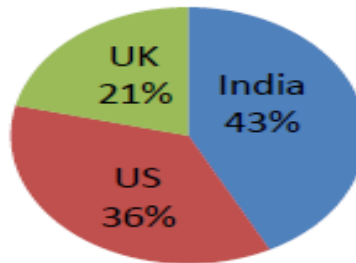


Figure 1.2: Rate of tumor diagnosis per year [1]

2.3 Medical imaging

Is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease, medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities.

Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually considered part of pathology instead of medical imaging. [3]

2.4 Magnetic Resonance Imaging (MRI)

A magnetic resonance imaging instrument (MRI scanner), or "nuclear magnetic resonance (NMR) imaging" scanner as it was originally known, uses powerful magnets to polarize and excite hydrogen nuclei (single proton) in water

molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body [4] .

The MRI machine emits a RF (radio frequency) pulse that specifically binds to hydrogen. The system sends the pulse to the area of the body to be examined; the pulse makes the protons in that area absorb the energy needed to make them spin in a different direction, this is the "resonance" part of MRI, the RF pulse makes them (only the one or two extra unmatched protons per million) spin at a specific frequency, in a specific direction, the particular frequency of resonance is called the Lamoire frequency and is calculated based on the particular tissue being imaged and the strength of the main magnetic field [4] .

MRI uses three electromagnetic fields: a very strong (on the order of units of teslas) static magnetic field to polarize the hydrogen nuclei, called the static field; a weaker time-varying (on the order of 1 kHz) field(s) for spatial encoding, called the gradient field(s); and a weak radio-frequency (RF) field for manipulation of the hydrogen nuclei to produce measurable signals, collected through an RF antenna. Like CT, MRI traditionally creates a two dimensional image of a thin "slice" of the body and is therefore considered a tomography imaging technique, modern MRI instruments are capable of producing images in the form of 3D blocks, which may be considered a generalization of the single-slice, tomography, concept , unlike CT, MRI does not involve the use of ionizing radiation and is therefore not associated with the same health hazards, for example, because MRI has only been in use since the early 1980s, there are no known long-term effects of exposure to strong static fields and therefore there is no limit to the number of scans to which an individual can be subjected, in contrast with X-ray and CT [5]

However, there are well-identified health risks associated with tissue heating from exposure to the RF field and the presence of implanted devices in the body,

such as pace makers, these risks are strictly controlled as part of the design of the instrument and the scanning protocols used.

Because CT and MRI are sensitive to different tissue properties, the appearance of the images obtained with the two techniques differ markedly, in CT, X-rays must be blocked by some form of dense tissue to create an image, so the image quality when looking at soft tissues will be poor, in MRI, while any nucleus with a net nuclear spin can be used, the proton of the hydrogen atom remains the most widely used, especially in the clinical setting, because it is so ubiquitous and returns a large signal, this nucleus, present in water molecules, allows the excellent soft-tissue contrast achievable with MRI [5] .

2.5 filters

Image filters produce a new image from an original by operating on the pixel values, filters are used to suppress noise, enhance contrast, find edges and locate features, and most filters work locally with “nearby” pixel values.

The simplest filters are convolution filters, which are linear filters that compute weighted averages of the input values examples:

- I. Mean (moving average).
- II. Gaussian.

Another type of filter is a ranking filter which sorts the input values and select a value, to improve the results finally the segmentation results will be used to extract quantitative information from the images, such as:

- I. Median.
- II. Minimum.
- III. Maximum.

Generic filters such as the mean, Gaussian or median filters are only “valid” under very simplistic assumptions on the nature of noise and/or image [6] .

2.6 General approaches to segmentation are

2.6.1 Stale approaches

- I. Canny.
- II. Sobel.
- III. Thresholding.
- IV. Edge-based methods.
- V. Region-based methods.

2.6.2 Modern procedure

- I. Watershed.
- II. Morphological Operators.

I. Sobel Operator

Sometimes called sobel filters, is used in image processing within edge detection algorithms and creates an image which emphasizes edges.

II. Canny

It's smoothing effect, good localization and response, enhances signal to noise ratio and immune to noisy environment but it difficult to implement to reach real time response.

III. Thresholding

Threshold segmentation is one of the simplest segmentation methods, the input gray scale image is converted into a binary format, the method is based on a threshold value which will convert gray scale image into a binary image format, and the main logic is the selection of a threshold value [1] .

IV. Edge-based

Segmentation, an edge filter is applied to the image, pixels are classified

As edge or non-edge depending on the filter output and pixels which are not separated by an edge are allocated to the same category [7] .

V. Region-based

Segmentation algorithms operate iteratively by grouping together pixels which are neighbors and have similar values and splitting groups of pixels which are dissimilar in value, will be considered which can either be fully automatic or require some manual intervention [7] .

VI. Watershed

It is one of the best methods to group pixels of an image on the basis of their intensities, pixels falling under similar intensities are grouped together, and it is a good segmentation technique for dividing an image to separate a tumor from the image.

Watershed is a mathematical morphological operating tool; watershed is normally used for checking output rather than using as an input segmentation technique because it usually suffers from over segmentation and under segmentation [1] .

VII. Morphological Operators

After converting the image in the binary format, some morphological operations are applied on the converted binary image, the purpose of the morphological operators is to separate the tumor part of the image [1] .

Chapter Three

Literature Review and Related Work

Chapter Three

Literature Review and Related Work

In 2010 a study was conducted by Mohammed Shajib Khadem in Sweden which investigated two algorithms to segment brain tissues and to implement the competent one through simulations by MATLAB software, image pre-processing, edges and boundaries detection, histogram thresholding and segmentation with graph cuts performed in applying the selected method, segmentation results comparison by the existing software tool of the normalized cut algorithm and applied simulations of the min-cut/max flow algorithm provided quantitative brain image analysis and better segmentation outputs comparing with the normalized cut methods [8].

Another study was done in 2010 by Saif Dawood Salman Al.shaikhli et.al used a new method of tumor line detection and segmentation to separate the abnormal from the normal surrounding tissue to get a real identification of involved and non involved area that help the surgeon to distinguish the involved and noninvolved area precisely, the method which used was watershed method and image processed by using MATLAB to detect the tumor boundaries in MRI image for different cases, the result was very clear for physician to distinguish the area of tumor for surgical planning [9].

In 2012 a study was conducted by Anam Mustaqeem et.al to detect brain tumor using medical imaging techniques, the main technique used was segmentation, which is done using a method based on threshold segmentation, watershed segmentation and morphological operators and was experimented with MRI scanned images of human brains, this experiments were applied on various images and results were extraordinary and gave efficient results [1].

In 2014 a study was conducted by Swezin Oo et.al to detect the brain tumors by using MRI images which included test the brain image process, image filtering, skull stripping, segmentation, and morphological operation, calculation of the tumor area and determination of the tumor location, morphological operation of erosion algorithm was applied to detect the tumor. The detailed procedures were implemented using MATLAB; the experimental results indicated that the proposed method efficiently detected the tumor region from the brain image [2].

Another study was done by Roopali R.Laddha et.al in 2014 to detect brain tumor using medical imaging techniques, the main technique used was segmentation, which is done using a method based on threshold segmentation, watershed segmentation and morphological operators, the proposed segmentation method was experimented with MRI scanned images of human brains: thus locating tumor in the images, samples of human brains were taken, scanned using MRI processes and then were processed through segmentation methods thus provided efficient end results [10].

Chapter Four

Methodology

Chapter four

Methodology

4.1 Proposed Methodology

This part explains the methodology of processing depend on three steps, there are Image acquisition, Pre-processing and Processing (segmentation) as shown in figure (4.1).

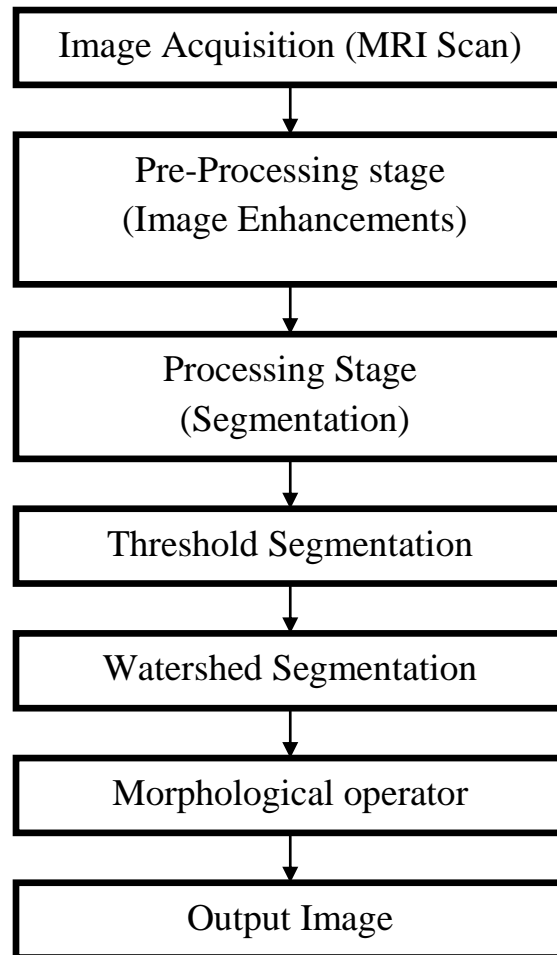


Figure 4.1: Flow Chart of Proposed Methodology

4.1.1 Image Acquisition Stage

We are obtained the images from database of HARVRD university, using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements, these matrices are dependent on matrix size and its field of view, images are stored in MATLAB and displayed as a gray scale image of size 256*256, the entries of a gray scale image are ranging from 0 to 255, where 0 shows total black color and 255 shows pure white color, entries between this range vary in intensity from black to white.

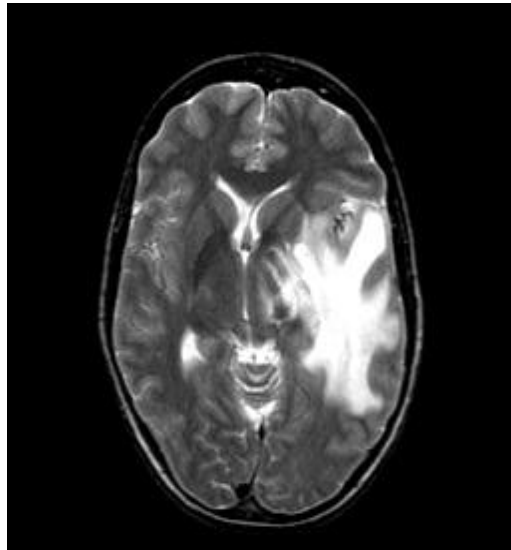


Figure 4.2: Brain image with tumor

4.1.2 Pre Processing Stage

In this phase image is enhanced in the way that finer details are improved and noise is removed from the image, most commonly used enhancement and noise reduction techniques are implemented that can give best possible results, enhancement will result in more prominent edges and a sharpened image is obtained, noise will be reduced thus reducing the blurring effect from the image, in

addition to enhancement, image segmentation will also be applied, this improved and enhanced image will help in detecting edges and improving the quality of the overall image, edge detection will lead to finding the exact location and size of tumor, there are steps in this phase:

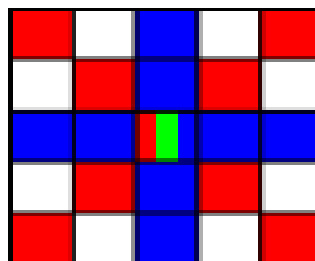
A. Noise Removal

Commonly types of noise in MR images is Gaussian noise and Rician noise, many filters are used to remove the noise from the images, here we used hybrid median and bilateral.

I. Hybrid Median

Its improved version of median filter, which removes the noise better than median, in the hybrid median filter value of pixel is determined by the median of the neighboring pixels, this filter is less sensitive than the outliers.

The hybrid median filter takes two medians: in an “X” -shown as red color- and in a “+” -shown as blue color- centered on the pixel, the output is the median-shown as green color- of these two medians and the original pixel value.



When the hybrid median filter applied on the original image with tumor, the result is shown in below figure:

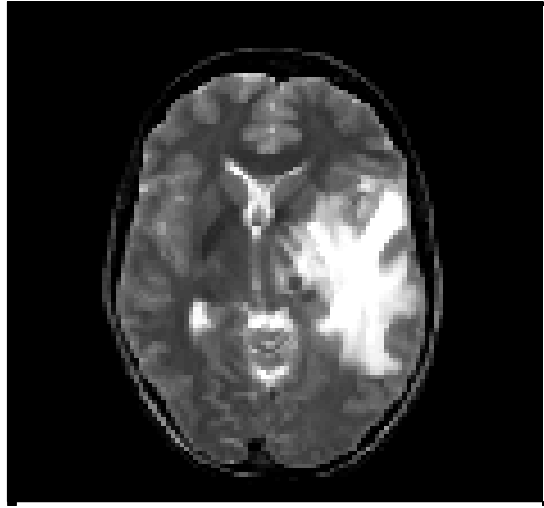


Figure 4.3: Brain image applied Hybrid median filter

II. Bilateral Filter

Is ubiquitous in computational photography application, it is technique to smooth image while preserving edges, it is more efficient type of filter, Bilateral filter has several qualities that explain its success: It's formulation is simple , depends only on two parameters(size and contrast) and can be used in a non-iterative manner, when bilateral applied the result is:

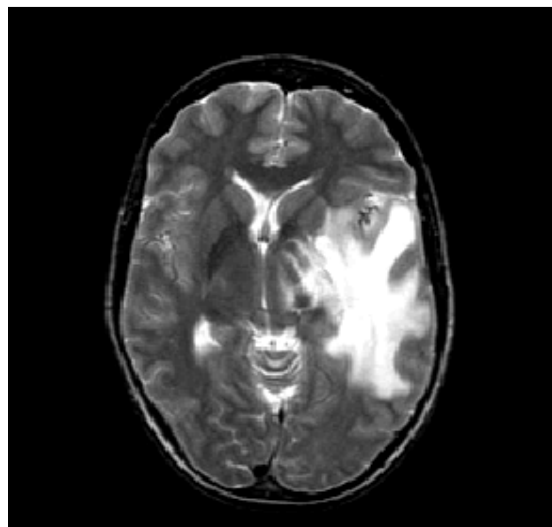


Figure 4.4: Brain image applied Bilateral filter

B. Image Enhanced

To enhance the boundaries of the objects in the image used bilateral filter, Bilateral filter gives very high rated results and used very widely to enhance the finer details of the object.

C. Image Sharpening

Sharpening of the image can be achieved by using different high pass filters, as now noise is been removed by using different filters, we need to sharpens the image as we need the sharp edges because this will help us to detect the boundary of the tumor.

4.1.3 Processing Stage

Image segmentation is based on the division of the image into regions, division is done on the basis of similar attributes, similarities are separated out into groups, basic purpose of segmentation is the extraction of important features from the image, from which information can easily be perceived, brain tumor segmentation from MR images is an interesting but challenging task in the field of medical imaging.

In this stage we apply different procedure of segmentation methods mention and applied the old methods as: Sobel operator and Canny, and combine three methods based on others, to achieve best possible result, these methods: Threshold segmentation, Watershed and Morphological operator.

I. Sobel operator

The Sobel operator is a discrete differential operator, the operator utilizes two 3x3 kernels: one estimates the gradient in the x-direction, while the other one estimates the gradient in the y-direction, due to Sobel operator's smoothing effect,

It is less sensitive to noise present in images, on the other hand smoothing affects the accuracy of edge detection, in other words the Sobel method does not produce image with high accuracy for edge detection, but its quality is adequate enough to be used in numerous applications, sobel operator applied to original image in figure below:



Figure 4.5: Sobel operator

II. Canny

The Canny operator is widely known as the optimal detector, developed by John F. Canny in 1986, there are multiple steps to implement the Canny operator, first a Gaussian filters is used to smooth the image to remove noise in an image. second compute the gradient magnitude similar to Sobel operator, third non-maximum suppression is applied in which the algorithm removes pixels that are not part of an edge, the final step involves the use of hysteresis thresholding along edges, hysteresis uses two thresholds, upper and lower, if a pixel gradient is higher than the upper threshold, then the pixel will be marked as an edge, if a pixel gradient is below the lower threshold, then the pixel will be discarded, finally if the pixel gradient is between the two thresholds then only the pixel that is connected

above the upper threshold is marked as an edge, canny operator applied to the original image and then resulted in below figure:

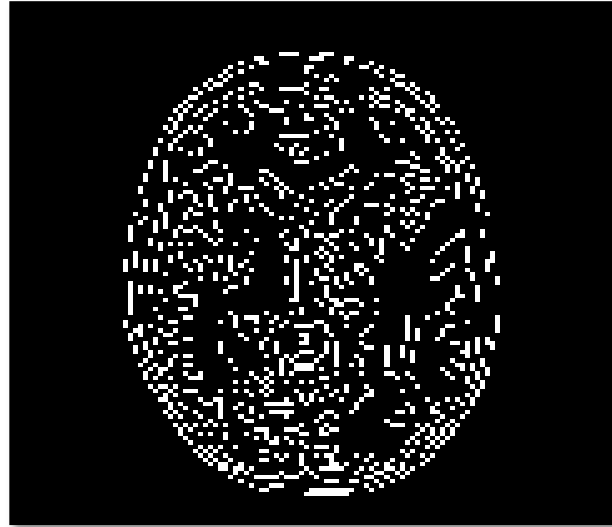


Figure 4.6: Canny

III. Threshold segmentation

Thresholding is the simplest and most commonly used method of segmentation, given a single threshold, t , the pixel located at lattice position (i, j) , with grayscale value f_{ij} , is allocated to category 1 if: $f_{ij} \leq t$:

Otherwise, the pixel is allocated to category 2.

In many cases t is chosen manually by the scientist, by trying a range of values of t and seeing which one works best at identifying the objects of interest

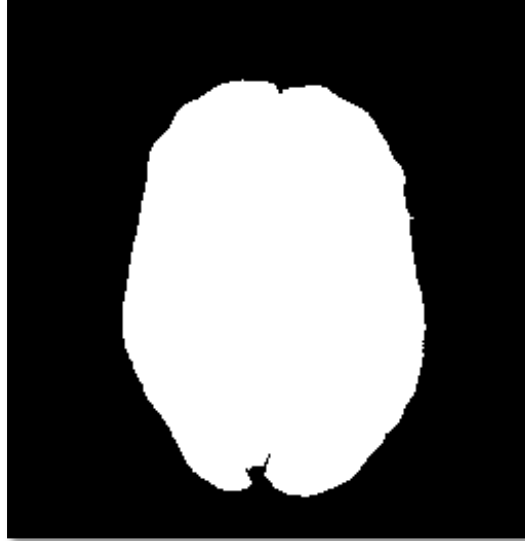


Figure 4.7: Threshold Segmentation

IV. Watershed

It is one of the best methods to group pixels of an image on the basis of their intensities, for using watershed segmentation different methods are used, two basic principle methods are given below: the computed local minima of the image gradient are chosen as a marker, in this method an over segmentation occurs, after choosing marker region merging is done as a second step.

Watershed transformation using markers utilizes the specifically defined marker positions, these positions are either defined explicitly by a user or they can be determined automatically by using morphological tools.

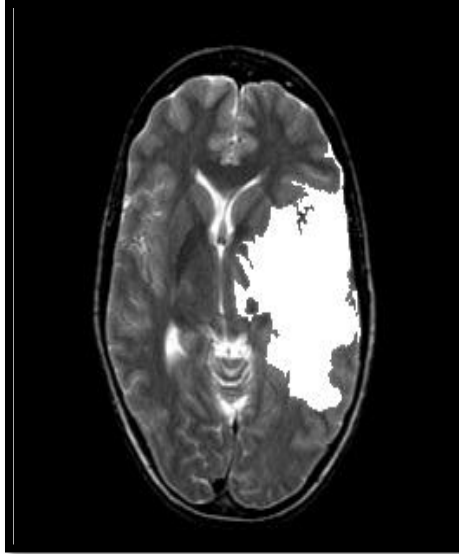


Figure 4.8: Watershed

V. Morphological Operators

It's the last step in the post processing; it used to separate the tumor part of the image, now only the tumor portion of the image is visible, shown as white color, this portion has the highest intensity than other regions of the image, some of the commands used in morphing are given below:

- i.** Strel: used for creating morphological structuring element.
- ii.** Imerode: used to erode (Shrink) an image.
- iii.** Imdilate: used for dilating (filling, expanding) an image.



Figure 4.9: Morphological Operators

4.1.5 Output image

After preprocessing, processing and post processing the final result it shown and tumor is displayed as white portion in the image.



Figure 4.10: output image

Chapter Five

The Result and Discussion

Chapter five

The Result and Discussion

5.1 The Result

When the input image- brain image has the tumor region- is loaded into the test image process, this image is needed to do preprocessing, in this research there are two filters which are used to remove the noise, first one is hybrid median filter applied the input brain image and subtracts original image from denoisy image.

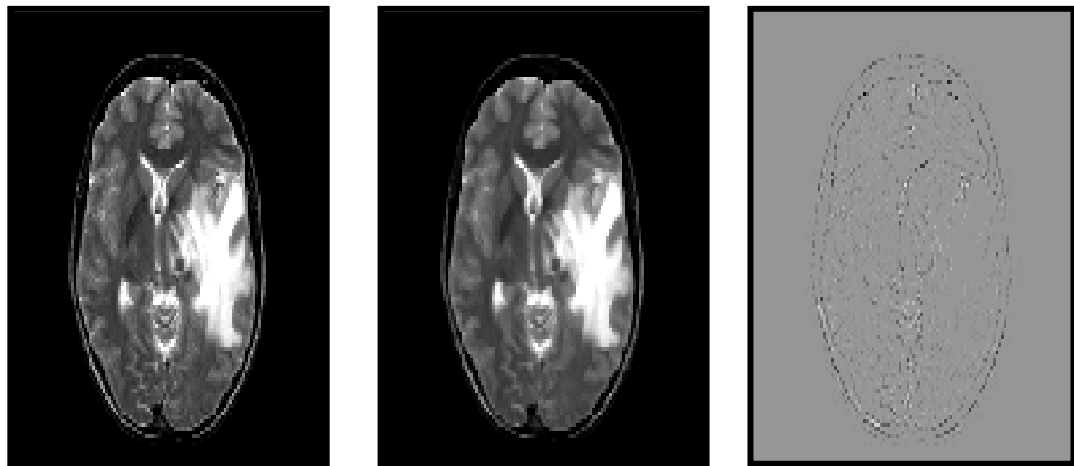


Figure 5.1: (a) Original image (b) Denoisy image (c) Residual image

Another filter is bilateral filter is applied to the input brain image, the noise is removed to get the smoothed image and was subtracts the original image from denoisy image, the resulted image of the preprocessing step is shown in below figure.

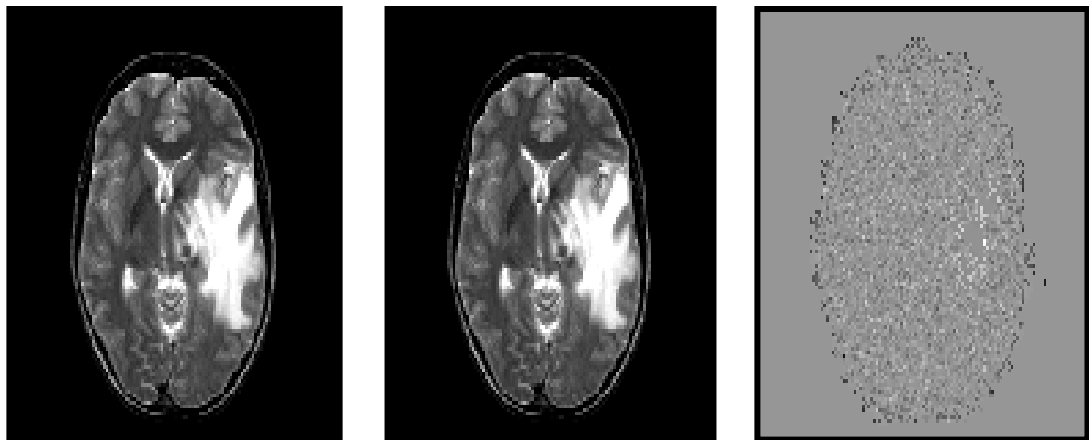


Figure 5.2: (a) Original image (b) Denoisy image (c) Residual image

After preprocessing the resulted image is loaded into processing stage, when used the old approaches of segmentation may include sobel and canny operators, below image it shown that, first applied the sobel operator and subtracts original image from denoisy image.

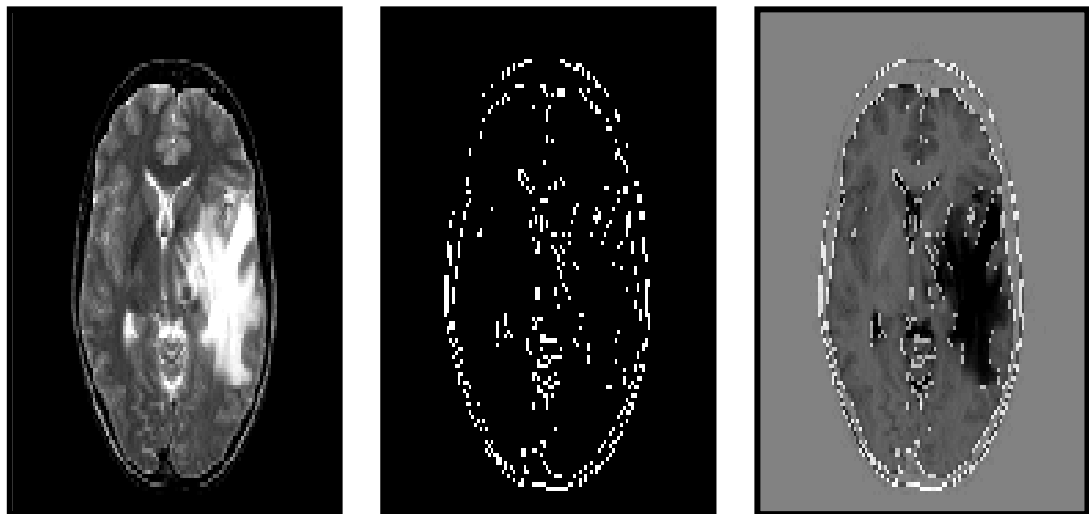


Figure 5.3: (a) Original Image (b) Detected edges image (c) Residual image

And then applied the canny operator and subtracts original image from denoisy image shown in the below figure.

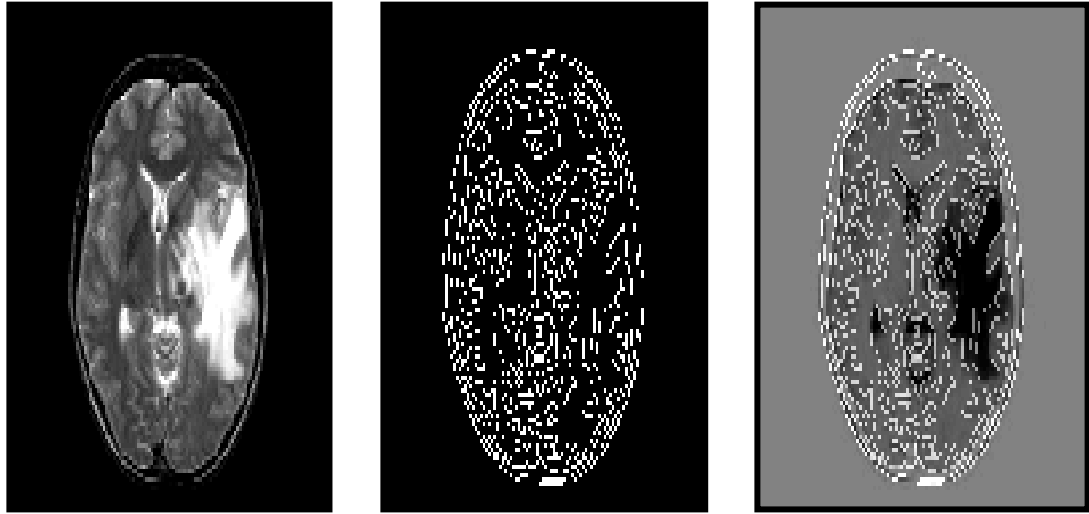


Figure 5.4: (a) Original image (b) Detected edges image (c) Residual image

But now a day the most commonly used is thresholding, watershed and morphological operator, in this research used morphological operator based on watershed and thresholding, in the following figure the result of threshold segmentation applied on the images, is based on threshold value

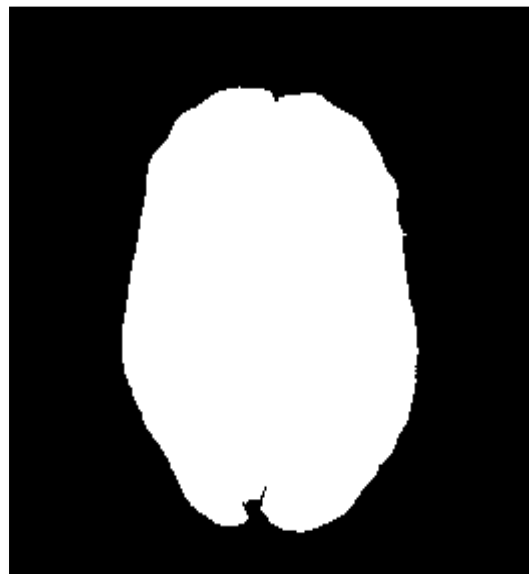


Figure 5.5: Applied Thresholding Segmentation

Then there is a technique called watershed segmentation which is applied on the resulted image obtained after threshold segmentation, in the below figure white spot is shown, which is the result of watershed segmentation applied on the images, this is basically the area with the intensity values higher than the defined threshold, high intensity areas mostly comprises of tumors, so through watershed based on threshold segmentation we can specify the location of tumor.

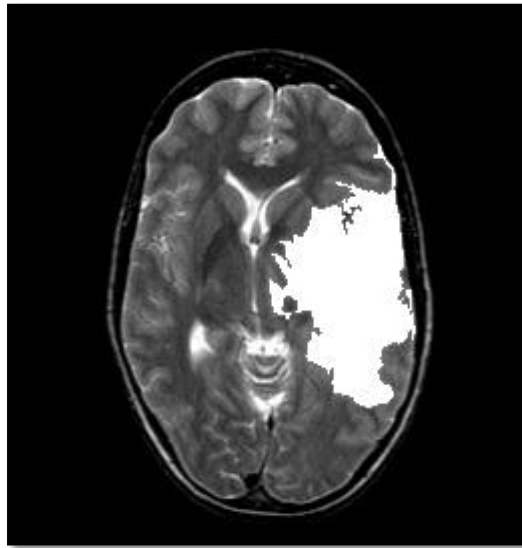


Figure 5.6: Applied Watershed Segmentation based on Thresholding

Watershed included many function that resulted many output images shown below:

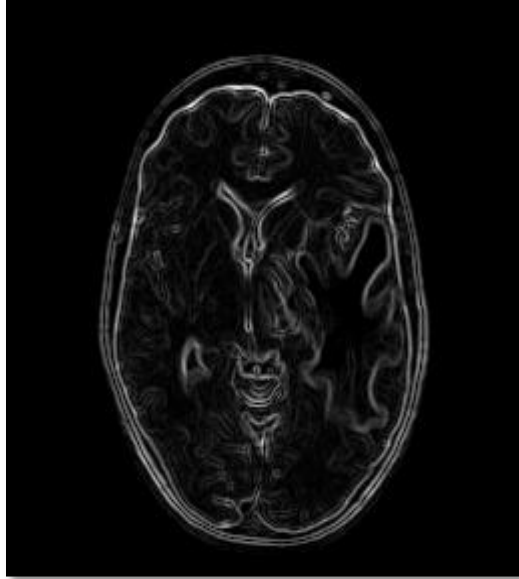


Figure 5.7: Gradient magnitude

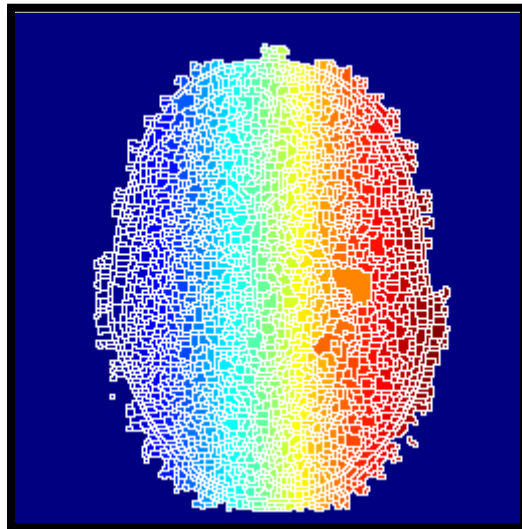


Figure 5.8: Watershed transform of gradient magnitude

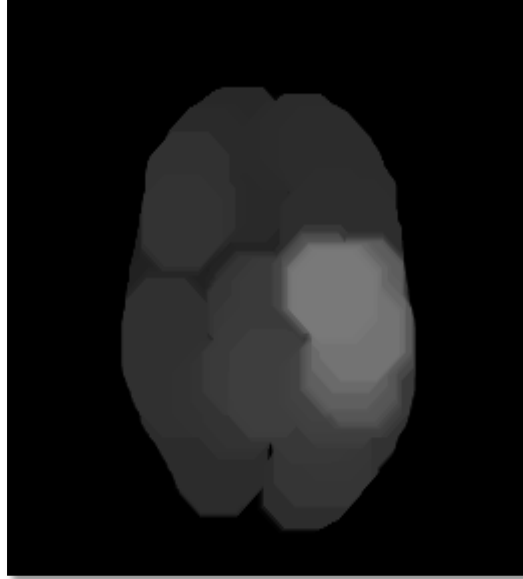


Figure 5.9: Opening

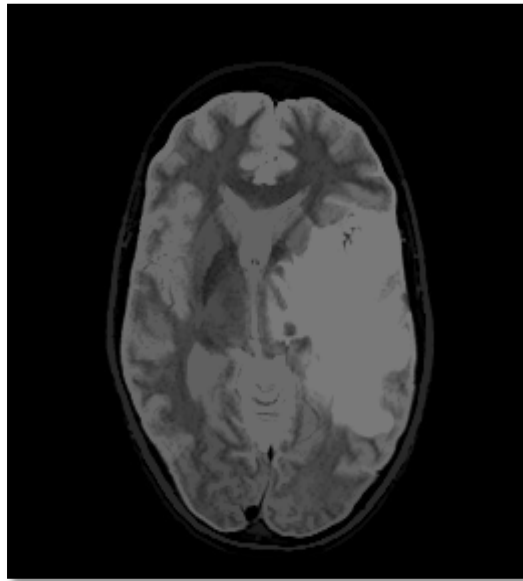


Figure 5.10: Opening-by-reconstruction



Figure 5.11: Opening-closing

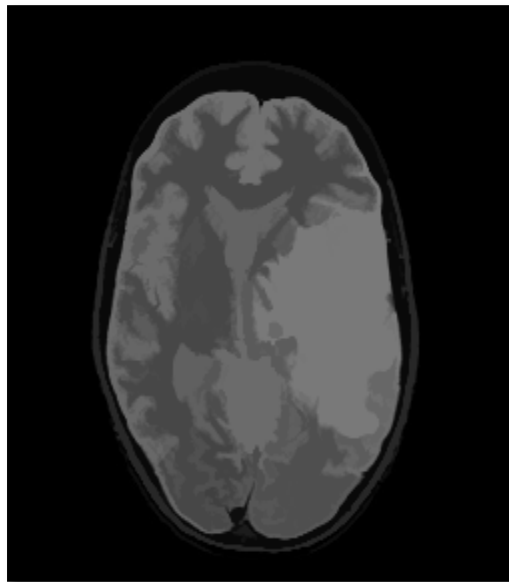


Figure 5.12: Opening-closing by reconstruction

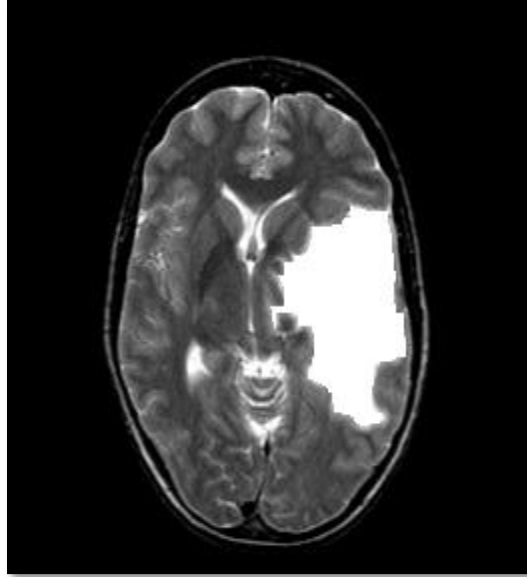


Figure 5.13: Modified regional maxima superimposed on original image



Figure 5.14: Watershed ridge lines

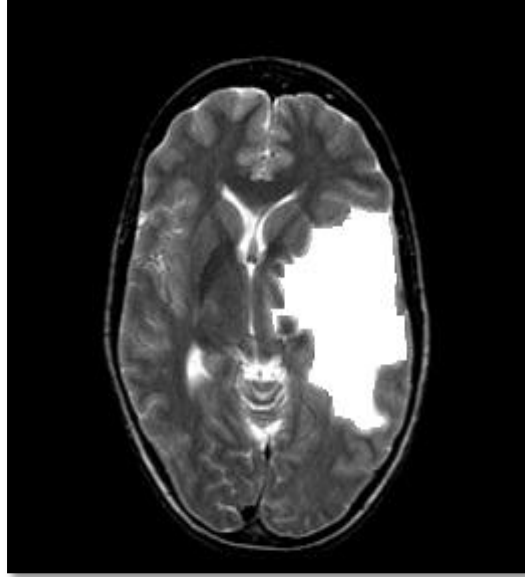


Figure 5.15: Markers and object boundaries superimposed on original image

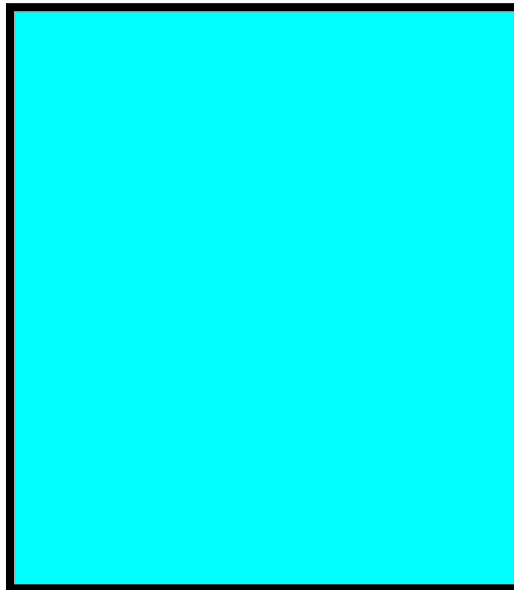


Figure 5.16: Colored watershed label matrix

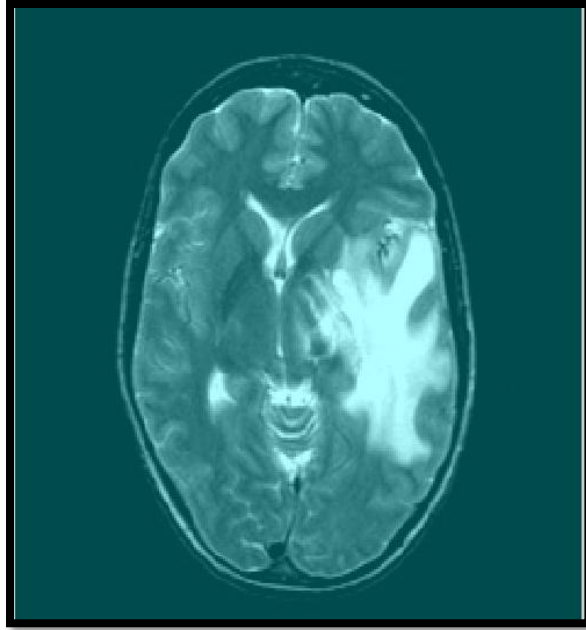


Figure 5.17: Lrgb superimposed transparently on original image

Morphological operators are applied after the watershed segmentation, the results are quite prominent and only the portion which contains tumor is highlighted, the portions with the high intensity values are detected through threshold and watershed segmentation these portions are marked through morphological operators, this technique is very efficient.

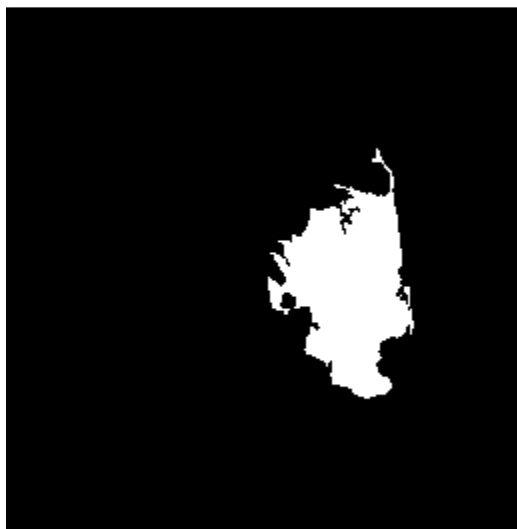


Figure 5.18: Applied morphological operator to detect the tumor as white portion

Morphological operator have some function it used in segmentation, figure 5.19 contains the resulted image obtained after applying functions like erosion, and figure 5.20 contains the resulted image of dilation function which is applied after the erosion.

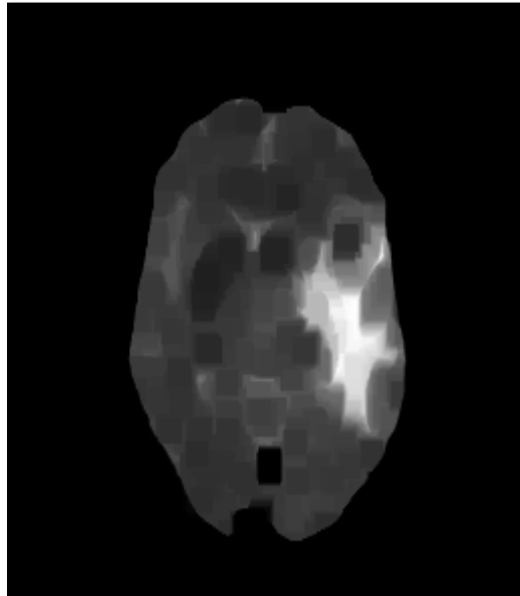


Figure 5.19: Imerode with strel

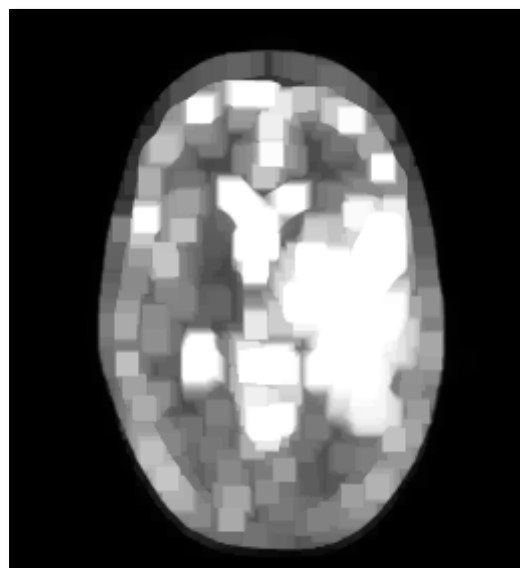


Figure 5.20: Imdilate with strel

Tumor is displayed as white portion in the image, tumor detected as white portion and the result of subtracts the original image from last image after filtration and segmentation.

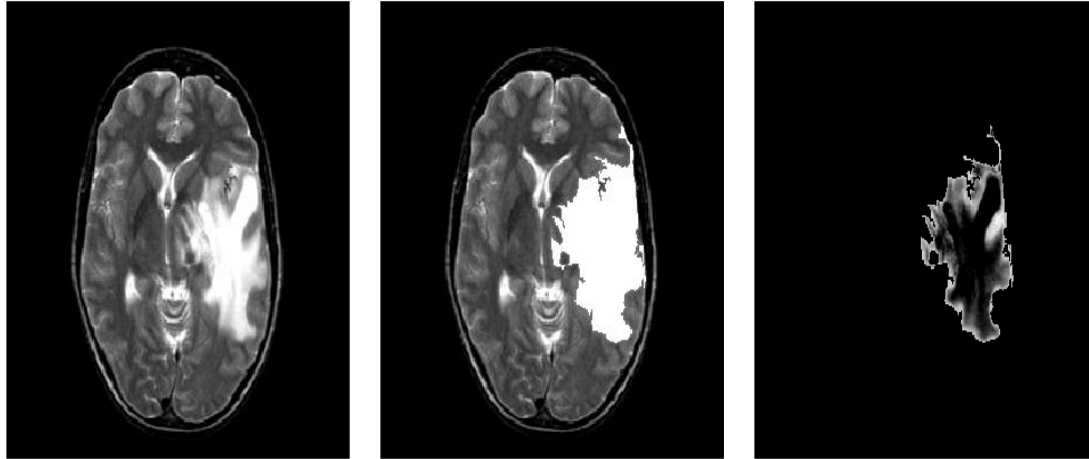


Figure 5.21 : (a) Original image

(b) Last image

(c) Residual

5.2 Discussion

The reasons that lead to this work is to separate the infected area in a gray image from the surrounding tissue by identification the boundaries as well as give an accurate detection of the brain tumor, all that assist the surgeon and physician to diagnose the infected area or remove the tumor from the brain without damaging the surrounded tissue.

In this work, the brain image testing process has been done, this method is given the reliable result for the brain image, if the brain image has the tumor region, the further processing steps are needed to be done, the preprocessing step is important to segment the brain image, bilateral filter shown in figure(5.1) and hybrid median filter shown in figure (5.2)are applied in this step to enhance image (noise removal and Sharpening) , comparison between them is resulted that bilateral filter is better than hybrid median filter based on signal to noise ratio (SNR) as shown in a table below:

Figures / filters	Bilateral filter	Hybrid median filter
Figure number i	60.0654	22.9192
Figure number ii	56.3200	21.6513
Figure number iii	58.2381	21.4345
Figure number iv	57.5831	20.9675

Table 5.1: show SNR applied on four images with brain tumor

After the preprocessing, the brain image is free from noise and this smoothed image is ready to be used in further processing, a stale methods of segmentation (sobel and canny) as mentation and applied to the image shown as figure(5.3) and figure(5.4), and then found that the result is not more efficient , after that the new methods of segmentation is used Threshold segmentation was

applied as shown as figure(5.5) and then watershed segmentation based on threshold segmentation has been done as shown in figure(5.6), therefore the intensity of normal brain tissues and that of tumor region is split up into groups, after segmentation this resulted image is divided into the normal brain region and the tumor region to get the final segmentation map, after that the tumor region is detected from the final segmentation map using morphological operation as shown as figure(5.18) from the above we can find the result is very clear and useful for differentiating abnormal region for many purposes like surgery or treatment by gamma camera.

finally ,we found the output image of watershed segmentation method based on threshold better and clearly for diagnosis purposes than output image of segmentation by threshold method only and stale methods (canny and sobel).

Chapter six

Conclusion and Recommendation

Chapter six

Conclusion and Recommendation

6.1 Conclusion

Generally, image segmentation has been an active research field for the last several decades; moreover, it is a most challenging and most active research field in the image processing, image segmentation is the preliminary stage of almost all image analyzing tools, there exist a variety of state-of art methods and good prior knowledge for brain MRI segmentation, but still brain MRI segmentation is a challenging task and there is a need for future research to improve the accuracy, precision and speed of segmentation methods, using improved atlas based methods, parallelization and combining different methods can be the way for making improvement in brain segmentation methods, with increasing knowledge about the relationship between different disorders with anatomical deviation, brain segmentation is used as first stage in tools for detection and analyzing them, for example Alzheimer and Multiple sclerosis (MS) are disorders which can be studied based on deviation in structures of the brain.

6.2 Recommendation

Future work must be extending to this proposed methodology such as colored image based on segmentation of 3D images, for this purpose it need a classification method to organize three dimensional objects into separate feature classes whose characteristics can be further help into diagnosis of brain diseases.

References:

- [1] 2012;Mustaqeem A, Javed A, Fatima T. An Efficient Brain Tumor Detection Algorithm Using Watershed & Thresholding Based Segmentation. *Int J Image, Graph Signal Pr ocess.* 4(10):34–9.
- [2] 2014.Swe Zin Oo, Aung Soe Khaing.Brain Tumor Detection And Segmentation Using Watershed Segmentation And Morphological Operation.IJRET: International Journal Of research in Engineering and Technology.
- [3] (November 2010) Roobttom CA ,Mitchell G, Morgan . HughesS Mitchell;Morgan .Hughes"Radiation reduction startigies in cardiac CT.65(11).
- [4] Accessed on 18 June 2013.Magnetic Resonance Image, [Online Available], www.CEwebservice.com,
- [5] Retrieved 17 November. European Magnatic Resonance Forum.
- [6] (1990)."Turkowski,KenFilters for common Resampling tasks".
- [7] (2008) Frucci,Maria;Sanniti di Baja,Gabriella "from segmentation to Binarizahion of Gray-level images"
Journal of pattern Recognition.
- [8] (2010).Khadem, Mohammad Shajib. "MRI Brain image segmentation using graph cuts".
- [9] 2.4 (2010).Salman, Saif D., and Ahmed A. Bahrani. "Segmentation of tumor tissue in gray medical images using watershed transformation method."
International Journal of Advancements in Computing Technology.
- [10] 2014, 607-611.Roopali R.Laddha et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (1) .