# IDENTIFICATION OF BRAIN TUMORS IN 2D MRI USING REGION BASED SEGMENTATION METHOD

**KRITHIKA.R**

**10PCA09**

**Project Report submitted to Avinashilingam Deemed University for Women, Coimbatore in partial fulfillment of the requirements for the Master's Degree in Computer Applications**

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**SIGNATURE OF THE HEAD OF THE DEPARTMENT**

**SIGNATURE OF THE SUPERVISOR**

**SIGNATURE OF THE EXTERNAL EXAMINER**

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# SYNOPSIS

Segmentation through region based segmentation method is widely used because it is fast, robust and free of tuning parameters. However, the segmentation method requires an automatic seed generator, and has problems to label unconnected pixels (unconnected pixel problem). This project performs the region based segmentation 2D MRI image. This approach was extended to a fully automatic and complete segmentation method by using the pixels with the smallest gradient length in the not yet segmented image region as a seed point. The methods were implemented in MRI images. A region growing segmentation method is proposed to segment brain tumor from MRI images. Furthermore, the model is simple but robust, thus allowing for a certain degree of deviation from model constraints and still delivering the expected segmentation result.

# CONTENTS

# 1. INTRODUCTION

## 1.1 Problem Description

Brain tumor segmentation and detection are vastly important in medical diagnostics because it provides information related to anatomical structures as well as potential abnormal tissue necessary to delineate appropriate surgical planning. As the segmentation of anatomical regions of the brain is the fundamental problem in medical image analysis. Segmentation of Brain tumor appropriately is a difficult task in MRI. The MRI image is an image that produces a high contrast images indicating regular and irregular tissues that help to discriminate the overlapping in margin of ach limb. But when the edges of tumor is not sharpen then the segmentation results are not accurate i.e. segmentation may be over or under. This may be happened due to initial stage of the tumors. So in this project is  a modified method of tumor line detection and segmentation is used to separate the irregular from the regular surrounding tissue to get a real identification of involved and noninvolved area that help the surgeon to distinguish the involved area precisely. The method proposed here is seeded region growing method to detect the tumor boundaries in 2D MRI for different cases. This method that can be validated for segmentation on 2D MRI Data. In this study, after a manual segmentation procedure, this approach can be converted into fully automated approach.

The methods to segment brain tumors are snakes segmentation, level set segmentation, watershed segmentation, region-growing segmentation etc. The region growing segmentation is preferred for its wide range of applications and automatic features. Preprocessing experiments are carried out to find which type of filtering will be more beneficial. This reduces the effect of the speckle and preserves the tumor edges thereby provide the foundation for a successful segmentation. The desired tumor area is selected from the segmented image to calculate the volume.

- Tumors may be relatively small
- Wide variety of shape
- Partial voluming can be confused as lesions
- Requires knowledge of neighboring structures
- Common MRF scheme over smooth’s segmentation, hard to balance

## 1.2 Motivation of the work

Each year more than 200,000 people in the India as well as United states are diagnosed with a primary or metastatic brain tumor.Brain cancer remains one of the most incurable forms of cancer, with an average survival period of one to two years.The chances of surviving for a person with a brain tumor greatly depends on all of the following:

- **type of tumor**
- **size of the extent**
- **location of the tumor**
- **presence or absence of metastasis**
- **age**
- **overall health, and medical history**

## 1.3 Objective of the project

Detection and segmentation of Brain tumor accurately is a challenging task in MRI. The MRI image is an image that produces a high contrast images indicating regular and irregular tissues that help to distinguish the overlapping in margin of each limb. All finding methods may suffer with the problem if there is no growth of tumor and any small white part is there. But when the edges of tumor is not sharped then the segmentation results are not accurate i.e. segmentation may be over or under. This may be happened due to initial stage of the tumors. A method of tumor detection based on region based segmentation of the MRI and if it is detected then to segment it automatically is proposed to separate the irregular from the regular surrounding tissue to get a real identification of involved and noninvolved area that help the surgeon to distinguish the involved area precisely. The method is implemented using MATLAB 7.11(R2010b)Magnetic Resonance Images having brain tumors and also on images without any abnormality to detect the tumor boundaries in 2D MRI for different cases.

# 2. SYSTEM SPECIFICATION

This section describes the hardware and software specification needed for both development and implementation phases of the project.

## 2.1 Hardware Requirements

Processor : Intel® Core i5 processor

RAM : 4 GB

Hard disk : 500 GB

Monitor : 15 Inch Lenovo Monitor

Keyboard : 108 Normal keyboard

Pointing device : USB Optical Mouse

## 2.2 Software Requirements

Tool : MATLAB ,version 7.11(R2010b)

Operating System : Microsoft Windows XP

## 2.3 ABOUT THE SOFTWARE

### 2.3.1 MATLAB

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or Fortran.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB uses software developed by the LAPACK and ARPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

**Key Features of MATLAB:**

- High-level language for technical computing.
- Development environment for managing code, files, and data.
- Interactive tools for iterative exploration, design, and problem solving.
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization and numerical integration.
- 2-D and 3-D graphics functions for visualizing data.
- Tools for building custom graphical user interfaces.
- Functions for integrating MATLAB based algorithms with external applications and languages such as C,C++,Fortran ,java, COM and Microsoft Excel.

**TOOLBOXES:**

MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

**THE MATLAB SYSTEM:**

The MATLAB system consists of five main parts:

**Development Environment:**

The set of tools and facilities that help you use MATLAB functions and files. Many of these tools are graphical user interfaces. It includes the MATLAB desktop and Command Window, a command history, and browsers for viewing help, the workspace, files, and the search path.

**THE MATLAB MATHEMATICAL FUNCTION LIBRARY:**

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine, and complex arithmetic, to more sophisticated functions like matrix inverse, matrix eigen values, Bessel functions, and fast Fourier transforms.

**THE MATLAB LANGUAGE:**

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

**HANDLE GRAPHICS:**

This is the MATLAB graphics system. It includes high-level commands for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level commands that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

**THE MATLAB APPLICATION PROGRAM INTERFACE (API):**

This is a library that allows you to write C and Fortran programs that interact with MATLAB. It include facilities or calling routines from MATLAB (dynamic linking), calling MATLAB as a computational engine, and for reading and writing MAT-files.

**IMAGE PROCESSING IN MATLAB:**

Images and pictures as mentioned in the preface, human beings are predominantly visual creatures . We not only look at things to identify and classify them, but it can scan for differences, and obtain an overall rough feeling for a scene with a quick glance. Humans have evolved very precise visual skills. It can identify a face in an instant we can differentiate colors. It can process a large amount of visual information very quickly. However, the world is in constant motion stare at something for long enough and it will change in some way. Even a large solid structure, like a building or a

mountain, will change its appearance depending on the time of day (day or night),amount of sunlight (clear or cloudy), or various shadows falling upon it. They are concerned with single images snapshots of a visual scene. Although image processing can deal with changing scenes, we shall not discuss it in any detail in this text. For our purposes, an image is a single picture which represents something. It may be a picture of a person, of people or animals, or of an outdoor scene, or a microphotograph of an electronic component, or the result of medical imaging.

## Interfacing with other languages:

MATLAB can call functions and subroutines written in the C programming language or FORTRAN. A wrapper function is created allowing MATLAB data types to be passed and returned. The dynamically loadable object files created by compiling such functions are termed "MEX-files" (for MATLAB executable).

Libraries written in Java, ActiveX or .NET can be directly called from MATLAB and many MATLAB libraries (for example XML or SQL support) are implemented as wrappers around Java or ActiveX libraries. Calling MATLAB from Java is more complicated, but can be done with MATLAB extension, which is sold separately by Math Works, or using an undocumented mechanism called JMI (Java-to-Mat lab Interface), which should not be confused with the unrelated Java Metadata Interface that is also called JMI.

As alternatives to the MuPAD based Symbolic Math Toolbox available from Math Works, MATLAB can be connected to Maple or Mathematica. Libraries also exist to import and export MathML.

**SOME APPLICATIONS:**

Image processing has an enormous range of applications. Every area of science and technology can make use of image processing methods. Here is a short list just to give some indication of the range of image processing applications.

**1.Medicine**

- Inspection and interpretation of images obtained from X-rays, MRI or CAT scans
- Analysis of cell images, of chromosome karyo types.

**2. Agriculture**

- Satellite/aerial views of land, for example to determine how much land is being used for different purposes, or to investigate the suitability of different regions for different crops
- Inspection of fruit and vegetables distinguishing good and fresh produce from old.

**3. Industry**

- Automatic inspection of items on a production line
- Inspection of paper samples.

**4. Law enforcement**

- Fingerprint analysis
- Sharpening or de-blurring of speed-camera images.

# 3. SYSTEM STUDY ANALYSIS

System analysis is the general term that refers to an orderly and structured procedure for identifying and solving problems. It involves the study of proposed system to understand how they function. This knowledge will helps to identify what the new system should include.

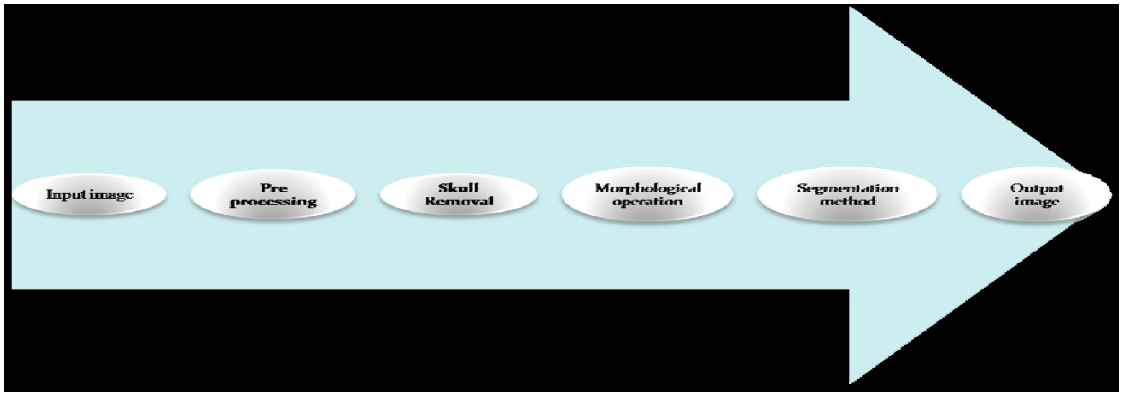
## 3.1 Proposed system

In proposed system a region based segmentation method is used to detect the tumor boundaries in 2D MRI for different cases. This method that can be validated segmentation on 2D MRI data . In this method the users need not select the seed point manually therefore there is no human intervention . In this project work the brain tumor is considered to be fixed size and their structure may be of any type like snakelike or circular shaped.

### Advantages of Proposed system

- Semantic similarity provides more relevant results a existing system. It is very fast than existing system.
- The performance of the system is improved.

## Proposed diagram:



## 3.2 Feasibility study

All projects are feasible, given unlimited resources and infinite time. Before going further in to the steps of software development, the system analyst has to analyze whether the proposed system will be feasible for the organization and must identify the customer needs. The main purpose of feasibility study is to determine whether the problem is worth solving. The success of a system also lies in the amount of feasibility study done on it. Many feasibility studies have to be done on any system.

### 3.3.1 Economical feasibility

Before going further in to the development of the proposed system, the system analyst has to check the economic feasibility of the proposed system and the cost for running the system which is composed with the cost benefit that can achieve by implementing the system. Thus the system is economically feasible. System design is process of planning a new system to document or altogether replace the old system.

### 3.3.2 Operational feasibility

During feasibility analysis operational feasibility study is a must. This is because of software engineering principles operational feasibility or in other words usability should be very high. A thorough analysis is done and found that the system is operational.

### 3.3.3 Technical feasibility

The system analyst has to check the technical feasibility of the proposed system. Taking account of the hardware that is used for the system development, data storage, processing and output, makes the technical feasibility assessment. The system analyst has to check whether the company or user who is implementing the system has enough resource available for the smooth running of the application. Actually the requirements for this application are very less and thus it is technically feasible.

# 4. SYSTEM DEVELOPMENT

### 4.1.1.Preprocessing method

This step applies preprocessing filters like mean , median filters to increase the clarity of image, and reduce the noise from the image**.** For the preprocessing method HAAR filter is used to reduce the noise in the given input image .

### 4.1.2 Edge detection method

This is preprocessing step which is required to produce better results. Skull is outer part of the brain surrounding it i.e. the removal of its non-cerebral tissues. The main problem in skull-stripping is the segmentation of the non-cerebral and the intracranial tissues due to their homogeneity intensities. Edge detection method is used for the removal of the skull part .Some observations are required to find the range of gray value of skull portion. Following are the steps which are involved in skull removal process:

- First of all find the size of the image and store the no of rows and columns in separate variables.
- Perform iteration for half of the columns and all rows
- Process half of image to convert white pixels into the black pixels by setting their gray value to zero.
- Same steps is repeated for the remaining column and row.

### 4.1.3Morphological operation

Morphology mainly deals with the contour and structure of the object. So this is used to perform object extraction, noise removal procedure etc . For the same purpose these operations are applied to enhance the object boundary and to remove the noise from the image. The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. In the

morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The rule used to process the pixels defines the operation as dilation or erosion. One important part in morphological operation is to choose the structuring element. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood .Two-dimensional, or flat, structuring elements are typically much smaller than the image being processed. The centre pixel of the structuring element, called the origin, identifies the pixel of interest the pixel being processed. The pixels in the structuring element containing 1's define the neighborhood of the structuring element. In this project work DISK shape are taken as structuring element. In the operation of image dilation and erosion we are considering disk structuring element of varying radii so that the obtained image is free from small unwanted parts. In MATLAB working environment there are two built in functions used for dilation and erosion . These morphological functions position the origin of structuring element, its center element over the pixel of interest in the input image. For pixels at the border of the image, parts of the neighborhood defined by the structuring element can extend past the border of the image. To process border pixels, the morphological functions assign a value to these undefined pixels, as if the functions had padded the image with additional rows and columns. The value of these padding pixels varies for dilation and erosion operations.

### 4.1.4.Segmentation Method

The result obtained after morphological operation is taken as input in this stage. This approach to segmentation examines neighboring pixels of initial “Segmented points” and determines whether the pixel neighbors should be added to the region. The process is iterated on, in the same manner as general data clustering algorithms. The main goal of segmentation is to partition an image into regions. Some segmentation methods such as "Thresholding" achieve this goal by looking for the boundaries between regions based on discontinuities in gray levels or color properties . Region-based segmentation is a technique for determining the region directly.

The basic formulation for Region-Based Segmentation is:

(*b*) *Ri* is a connected region, i = 1, 2, ...,n

(*d*) *P*(*Ri*) = *TRUE* for *i* = 1,2,...,*n*.

*P*(*Ri*) is a logical predicate defined over the points in set *P*(*Rk*) and is the null set.

(a) means that the segmentation must be complete; that is, every pixel must be in a region.

(b) requires that points in a region must be connected in some predefined sense.

(c) indicates that the regions must be disjoint.

(d) deals with the properties that must be satisfied by the pixels in a segmented region. For example *P*(*Ri*) = TRUE if all pixels in *Ri* have the same gray level.

(e) indicates that region *Ri* and *Rj* are different in the sense of predicate *P*.

**Important Issues About Region Growing**:

**1.More information of the image is better.**

Obviously, the connectivity or pixel adjacent information is helpful for us to determine the threshold..

**2.The value, “minimum area threshold”.**

No region in region growing method result will be smaller than this threshold in the segmented image.

**3.The value, “Similarity threshold value“.**

If the difference of pixel-value or the difference value of average gray level of a set of pixels less than “Similarity threshold value”, the regions will be considered as a same region.

The criteria of similarities or so called homogeneity we choose are also important. It usually depends on the original image and the segmentation .

“Region growing” is a procedure that groups pixels or sub regions into larger regions based on predefined criteria. The basic approach is to start with a set of “seed” points and from these grow regions by appending to each seed those neighboring pixels that have properties similar to the seed. Selection of the seed depends on the nature of the problem. When a priori information is not available, the procedure is to compute at every pixel the same set of properties that ultimately will be used to assign pixels to regions during the growing process . The selection of similarity criteria depends not only on the problem under consideration but also on the type of the image data available. For example, the analysis of land use satellite imagery depends heavily on the use of color. Grouping pixels with the same gray level to form a region without paying attention to connectivity would yield a segmentation result that is meaningless in the context of this discussion.

Another problem in region growing is the formulation of a stopping rule. Basically, growing a region should stop when no more pixels satisfy the criteria for inclusion in that region. Criteria such as gray level, texture and color are local in nature and do not take into account the history of the region growth. Additional criteria that increase the power of a region growing algorithm utilize the concept of size, likeness between a candidate pixel and the pixels grown so far and the shape of the region being grown.

In the region growing segmentation, the first aim is to determine the initial seed points. In this application, it is known that the pixel of defective welds tends to have the maximum allowable digital value. Based on this information, the starting points all pixels having values of 255 are selected. The points thus extracted from the original image

# The advantages and disadvantages of region growing

We briefly conclude the advantages and disadvantages of region growing.

**Advantages**：

1. Region growing methods can correctly separate the regions that have the same properties we define.

2. Region growing methods can provide the original images which have clear edges with good segmentation results.

3. The concept is simple. We only need a small number of points to represent the property we want, then grow the region.

4. We can determine the seed points and the criteria we want to make.

5. We can choose the multiple criteria at the same time.

6. It performs well with respect to noise.

**Disadvantage**：

1. The computation is consuming, no matter the time or power.

2. Noise or variation of intensity may result in holes or over segmentation.

3. This method may not distinguish the shading of the real images.

We can conquer the noise problem easily by using some mask to filter the holes or outlier. Therefore, the problem of noise actually does not exist. In conclusion, it is obvious that the most serious problem of region growing is the power and time consuming

# 5. SYSTEM DESIGN

Design is the first process in the development phase of any engineered system. System design is a modeling process. The inputs to the design are the software requirements and the output will be the design specification applicable to all software design. System design is to deliver the requirements as specified in the feasibility report. The main objectives of the design are

- Practicality
- Efficiency
- Cost
- Flexibility
- Security

System design is a process of planning a new system or to the complement of the existing system. The design is based on the limitations of the existing system and the requirements specification gathered in the phase of system analysis. The major steps in the design phase are input design, output design.

## 5.1 INPUT DESIGN

As the project is concentrated fully matching the template over the input image so the input parameters which is consider for the process are Gray scale image.

**Gray scale image**

A grayscale (or gray level) image is simply one in which the only colors are shades of gray. The reason for differentiating such images from any other sort of color image is that less information needs to be provided for each pixel. In fact a ‘gray’ color is one in which the red, green and blue components all have equal intensity in RGB space,

and so it is only necessary to specify a single intensity value for each pixel, as opposed to the three intensities needed to specify each pixel in a full color image.

Often, the grayscale intensity is stored as an 8-bit integer giving 256 possible different shades of gray from black to white. If the levels are evenly spaced then the difference between successive gray levels is significantly better than the gray level resolving power of the human eye

## 5.2 OUTPUT DESIGN

Output design generally refers to the results and information that are generated by the system. As images are taken as input, various techniques of image processing are being applied to generate variety of output. In this project, set of images are generated as expected output such as processed images. The success and failure of the system depends on the output. The outputs generated by the system are checked for its consistency and the output is provided simple so that the user can handle them with ease.

# 6. SYSTEM TESTING AND IMPLEMENTATION

## 6.1 SYSTEM TESTING

Testing plays vital role in the success of the system. It is an iterative process of both validating functionality and attempting to break the software. It makes a logical assumption that if all the parts of the system are correct.. It can also be stated as the process of validating and verifying that a software product/application meets the business and technical requirements that guided its design and development, so that it works as expected and can be implemented with the same characteristics. Software testing, depending on the testing method employed, can be implemented at any time in the development process, however the most test effort is employed after the requirements have been defined and coding process has been completed. The objective of system testing is to find the problems and fix them to improve quality. The testing steps are as follows

- Unit testing
- Integration testing
- Validation Testing
- Acceptance testing

### 6.1.1 UNIT TESTING

Unit testing focuses verification effort on the smallest unit of the software. This testing was carried out during programming stage itself. Each module was tested individually and the corresponding errors generated were reviewed and rectified.

In this project, each module is tested separately. The input image is given and every module is tested separately to check whether the system provides required output.

### 6.1.2 INTEGRATION TESTING

Integration testing, also known as integration and testing(I&T), is a software development process which program units are combined and tested as groups in multiple ways. A comprehensive integration testing is carried out using integrated test plans in the design phase of the development as guide to ensure the behavior of functions with images.

In this project all modules are integrated and run as a single application. Each module is dependent on one another. The performance of the system will be estimated only after performing all the modules.

### 6.1.3 VALIDATION TESTING

Validation testing is performed in an approach to verify whether the product functions in a reasonably expected manner by the researchers. After the integration of the modules, the validation test is carried out to the system. It is a test to determine whether a system fulfills its requirements. In this project, this test involves checking whether the product is being designed in such a way that it performs error free in every phase of the system. It was found that all the modules work well together and meet the overall ystem function and performance.

# 7. CONCLUSION

This project will give following expected outcomes:

- A fast approach for tumor identification and segmentation.
- Improved output segmented image as compare to other approaches.
- An approach which detects the tumor in brain image and needs no human interference.

This method can be useful in many areas:

- In this approach an region based method, for segmentation of tumor section, saves lots of human interference, and may be useful for many other approaches where texture selection is tough task.
- This approach may be useful for neurologist and doctors for identifying brain tumor section, and many other parts of human brain.

# 8. SCOPE FOR THE FUTURE DEVELOPMENT

This is region growing segmentation method for segmentation of brain tumor in MRI; in which it is possible to determine abnormality is present in the image or not. We proposed a new, robust, fast and fully automatic algorithm. The algorithm needs no prior information or training process. By taking into account both the spatial features and regions of the MRI, we successfully find the selective points and the segmentation results obtained are very much accurate. There are only a small amount of pixels which are misclassified.

This method gives better results compared to other methods. The future work is to reduce the total execution time so that along with good result the execution time can be reduced. Other than Area of interest “Seeded Growing Region” method can also be implemented to avoid over segmentation and to get images with more clarity. Further this may also implemented for the better result.

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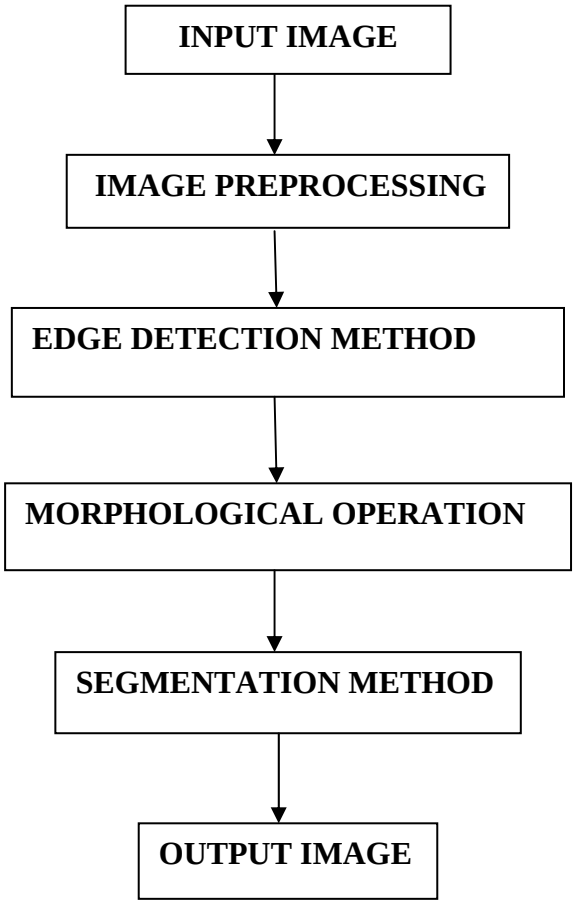
# 10. APPENDIX

## 10.1 SYSTEM FLOW DIAGRAM



## 10.2 SCREEN SHOTS

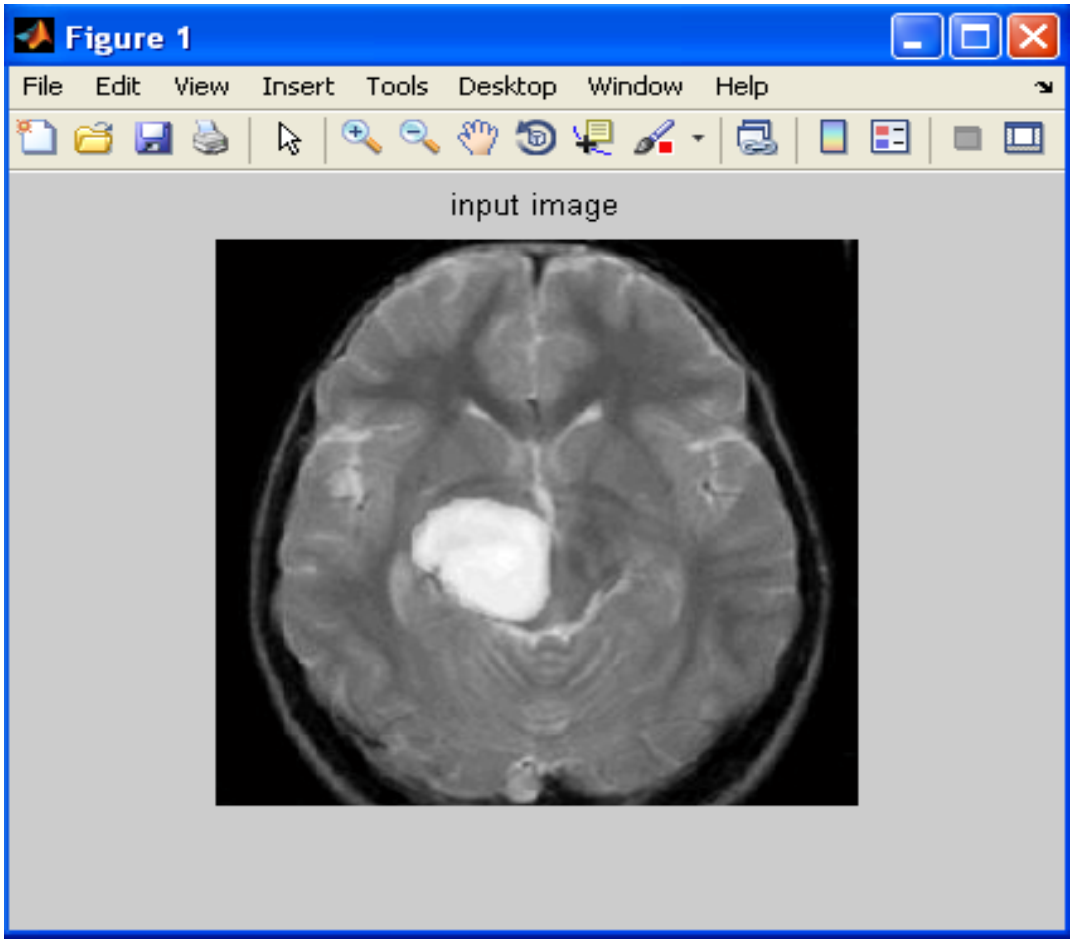



**Fig.10.2.1 INPUT IMAGE**

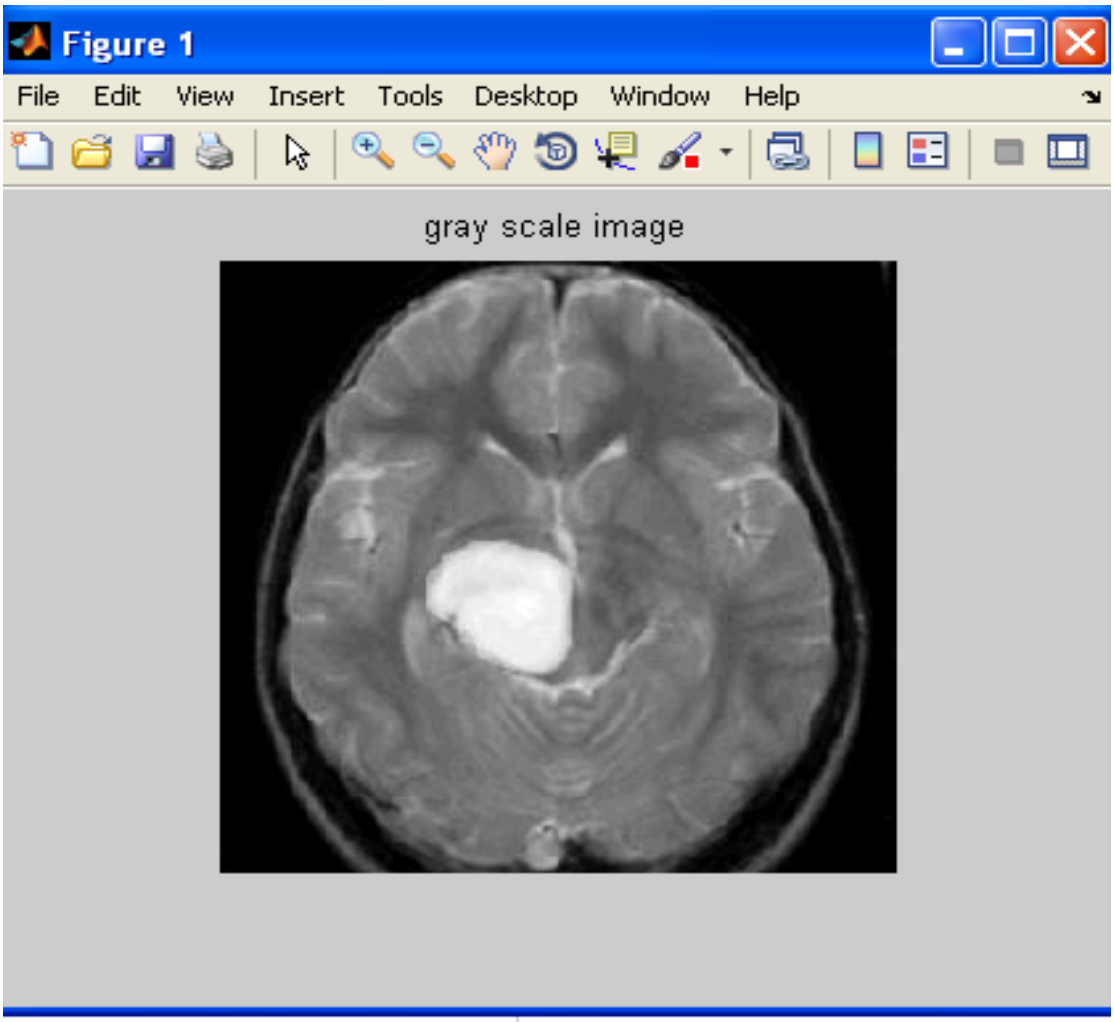



**Fig.10.2.2 GRAY SCALE IMAGE**

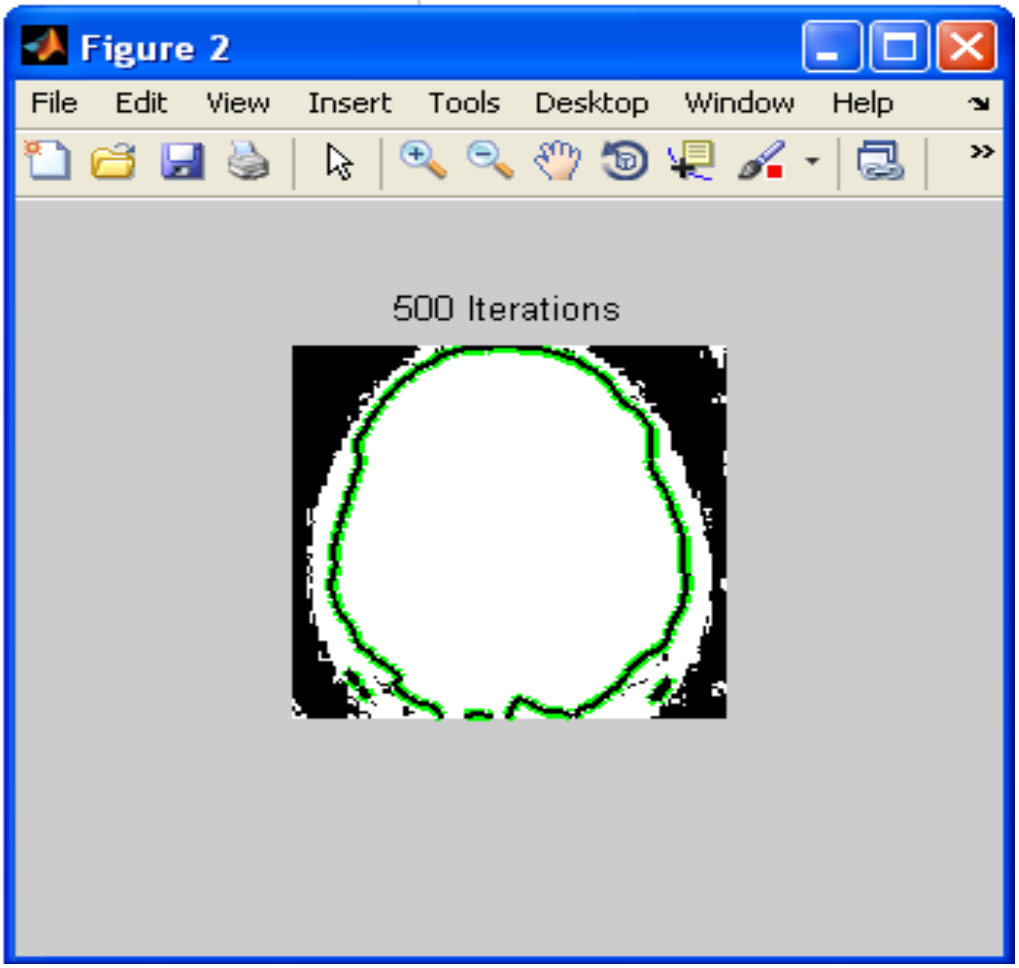



**Fig.10.2.3 ITERATION**

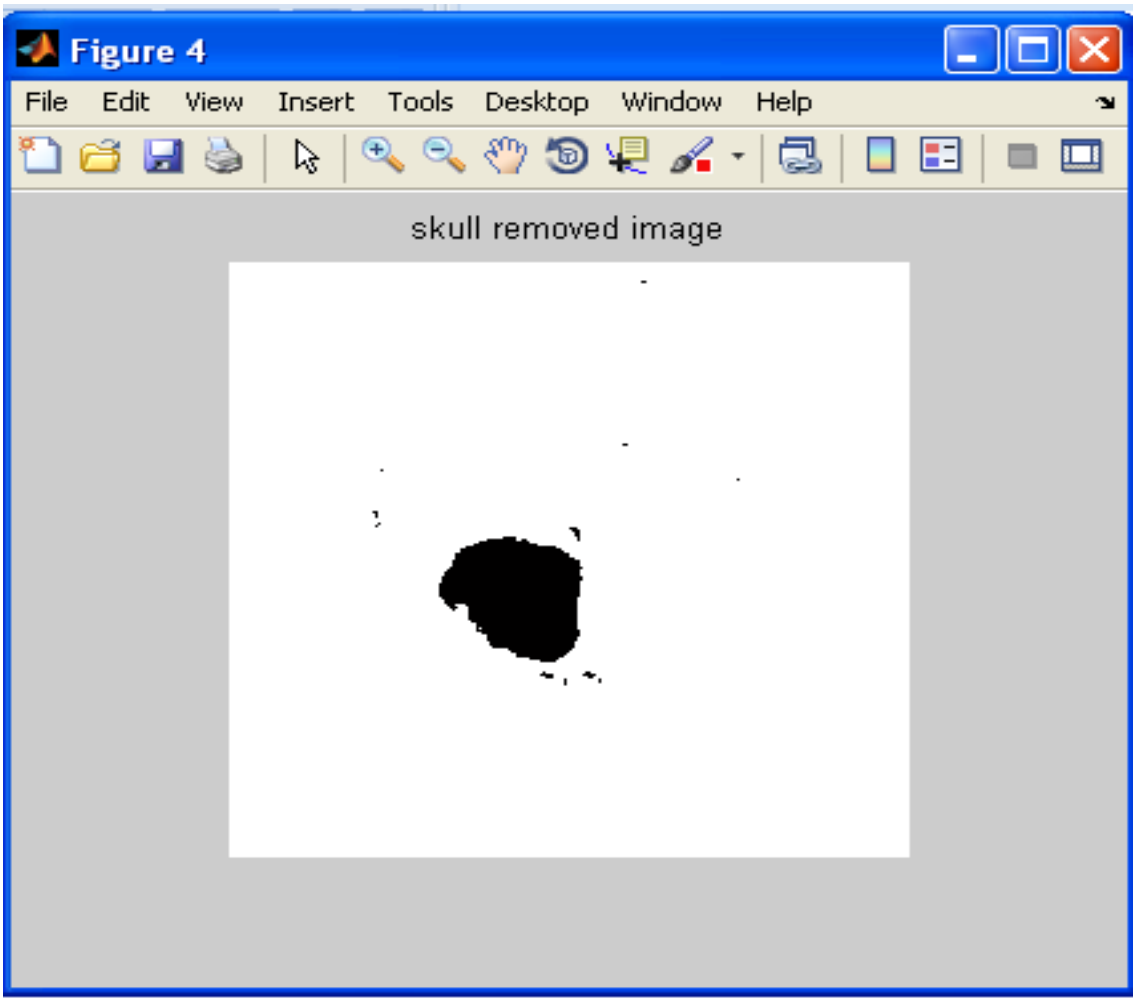



**Fig.10.2.4 SKULL REMOVED IMAGE**

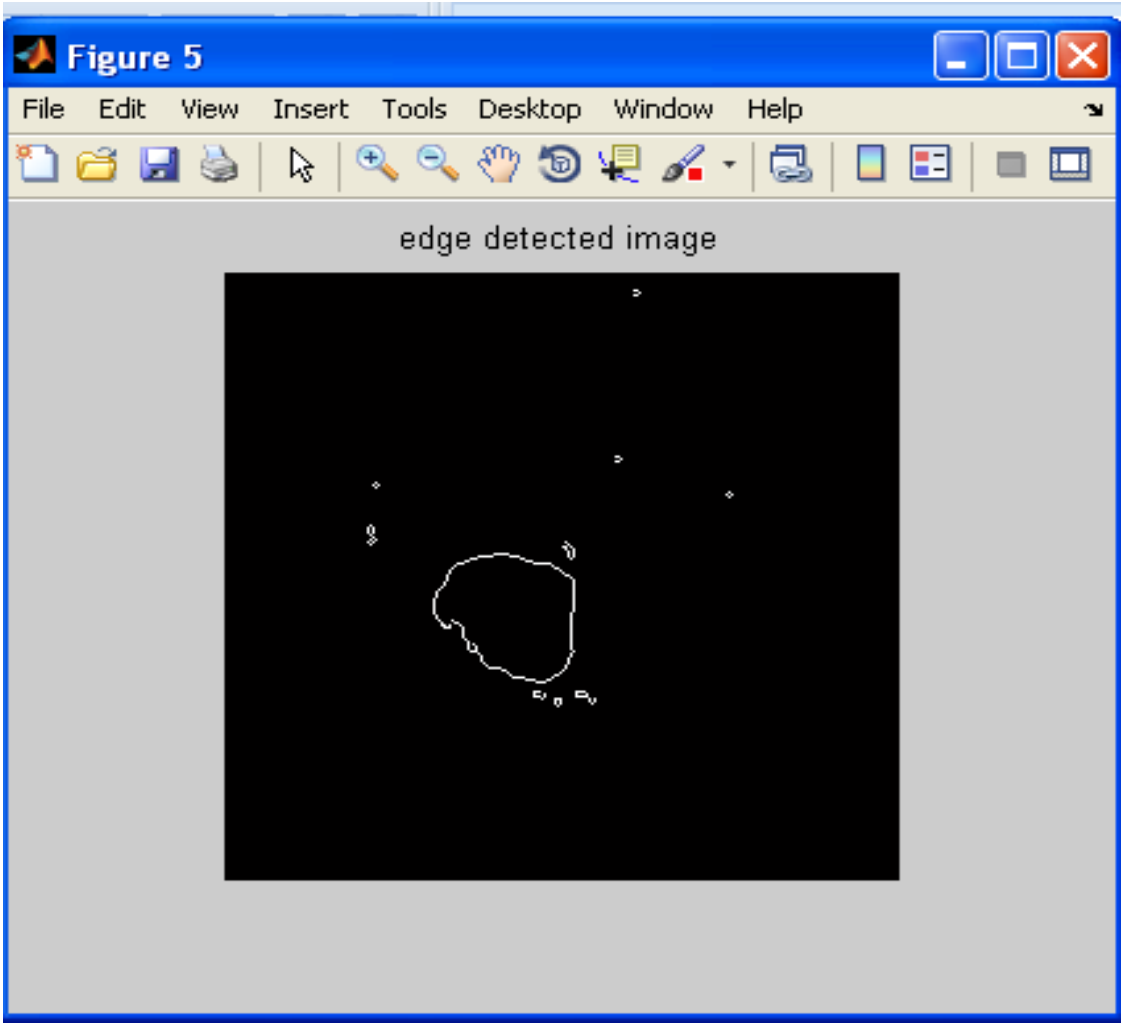



**Fig.10.2.5 EDGE DETECTED IMAGE**

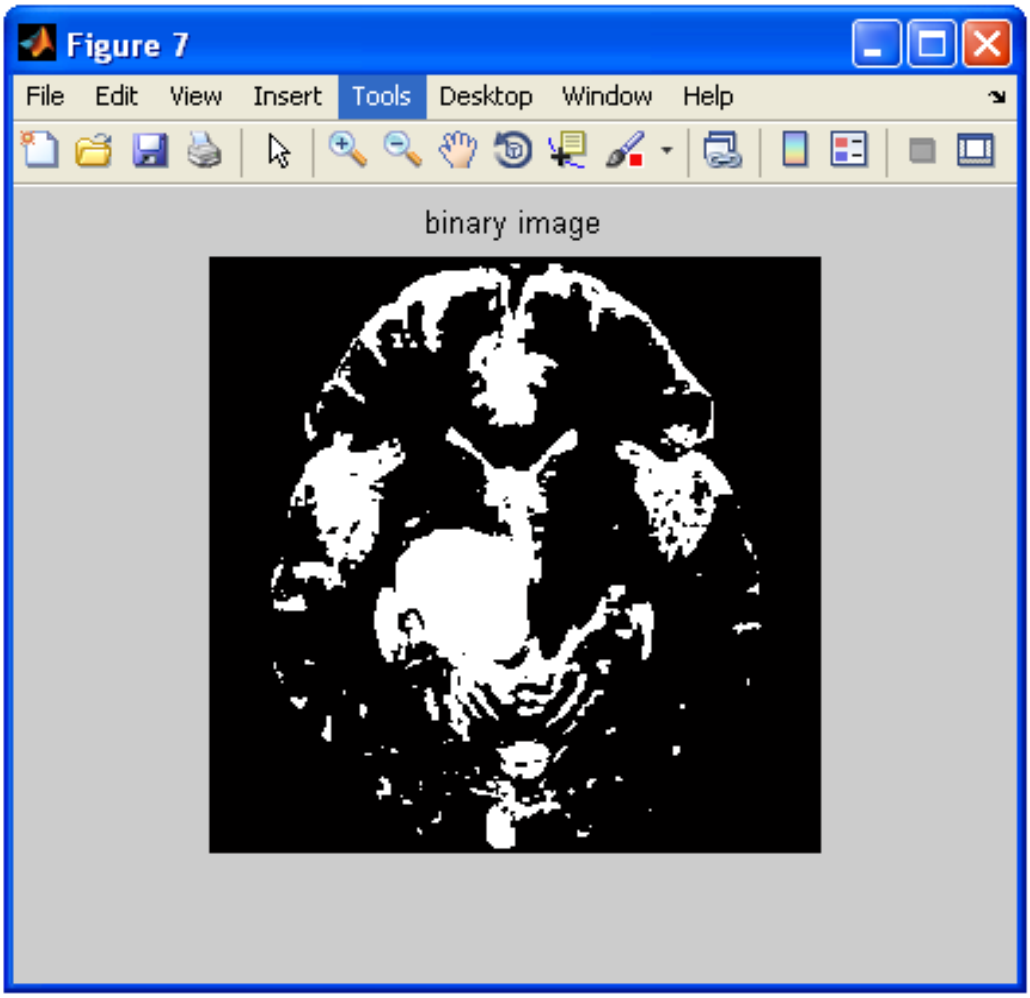



**Fig.10.2.6 BINARY IMAGE**

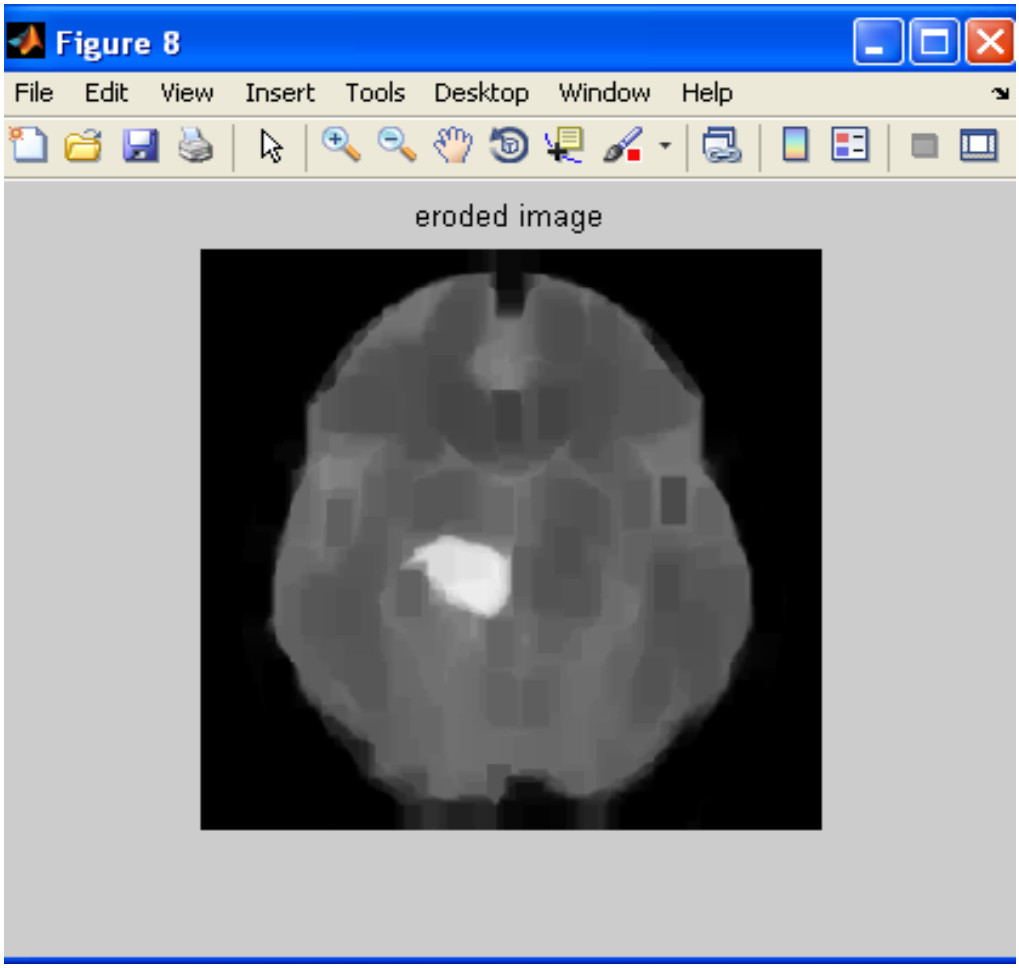



**Fig .10.2.7 EDGE DETECTED IMAGE**

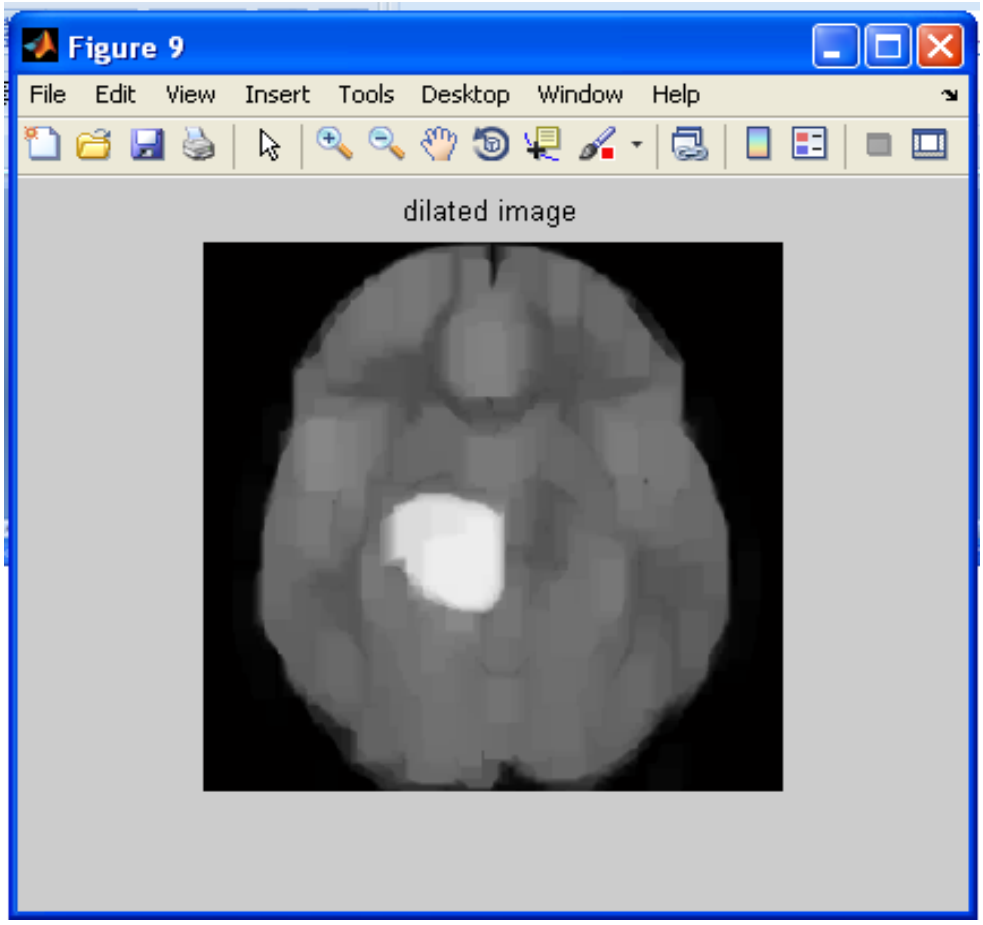



**Fig.10.2.8 DILATED IMAGE**

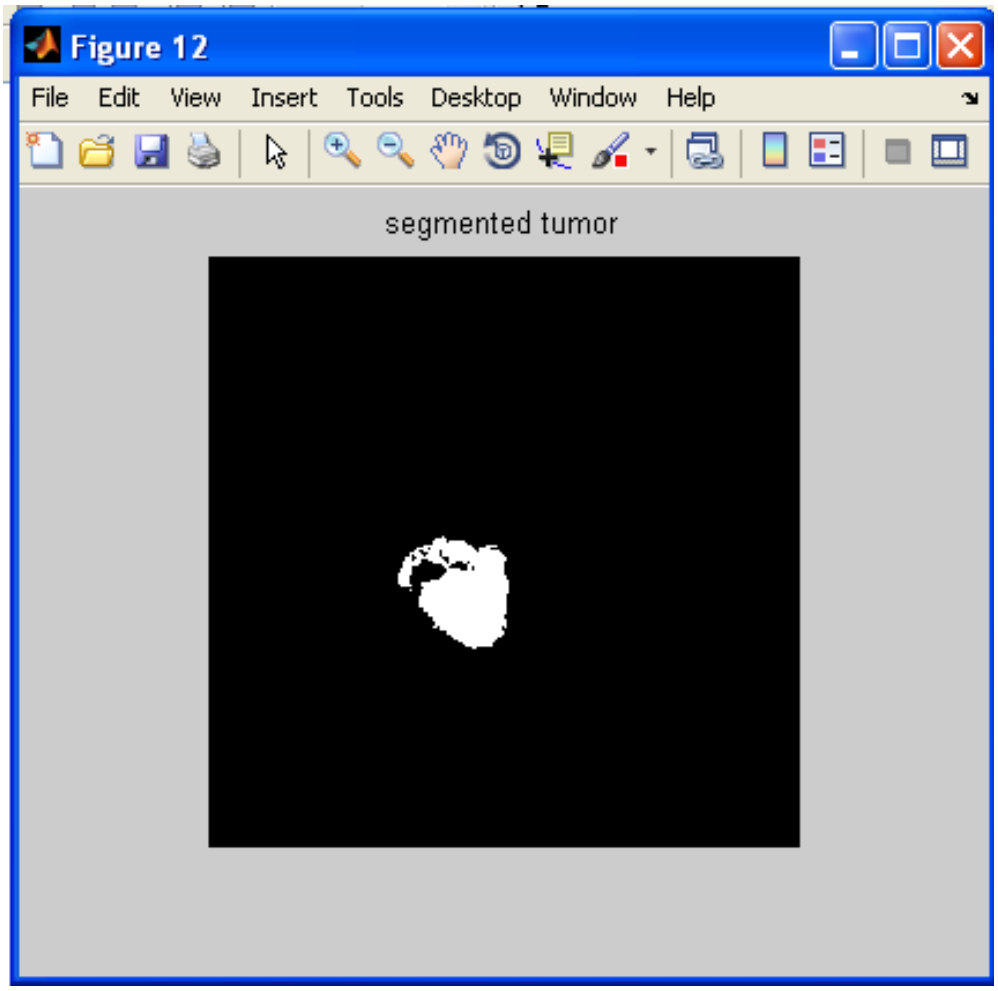



**Fig.10.2.9 SEGMENTED IMAGE**