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Brain Tumor Detection System

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Abstract: Brain tumor is an abnormal growth of brain cells within the brain. Detection of brain tumor is a challenging problem, due to complex structure of the brain. The automatic segmentation has great potential in clinical medicine by freeing physicians from the burden of manual labeling; whereas only a quantitative measurement allows to track and modeling precisely the disease. Magnetic resonance (MR) images are an awfully valuable tool to determine the tumor growth in brain. But, accurate brain image segmentation is a complicated and time consuming process. MR is generally more sensitive in detecting brain abnormalities during the early stages of disease, and is excellent in early detection of cases of cerebral infarction, brain tumors, or infections. So, in this project we put forward a method for automatic brain tumor diagnostics using MR images. The proposed system identifies and segments the tumor portions of the images successfully.
Keywords: MR, 2D Image, BrainTumor

I. INTRODUCTION

The human body is composed of many types of cells. Each cell has a specific function. The cells in the body grow and divide in an orderly manner and form some new cells. These new cells help to keep the human body healthy and properly working. When some cells lose their capability to control their growth, they grow without any order. The extra cells formed form a mass of tissue which is called tumor. The early detection of tumor is utmost important as it can save human lives. The accurate segmentation of tumors is also essential, as it can assist the medical staff in the planning of treatment and intervention. The manual segmentation of tumors requires plenty of time even for a well-trained expert. A fully automated Segmentation and quantitative analysis of tumors is thus a highly beneficial service. However, it is also a very challenging one, because of the high variety of anatomical structures and low contrast of current imaging techniques which make the difference between normal regions and the tumor hardly recognizable for the human eye. A brain tumor is defined as abnormal growth of cells within the brain or central spinal canal. Some tumors can be cancerous thus they need to be detected and cured in time. The exact cause of brain tumors is not clear and neither is exact set of symptoms defined, thus, people may be suffering from it without realizing the danger. Primary brain tumors can be either malignant (contain cancer cells) or benign (do not contain cancer cells).

Brain tumor occurred when the cells were dividing and growing abnormally. It is appear to be a solid mass when it diagnosed with diagnostic medical imaging techniques. There are two types of brain tumor which is primary brain tumor and metastatic brain tumor. Primary brain tumor is the condition when the tumor is formed in the brain and tended to stay there while the metastatic brain tumor is the tumor that is formed elsewhere in the body and spread through the brain.

The symptom having of brain tumor depends on the location, size and type of the tumor. It occurs when the tumor compressing the surrounding cells and gives out pressure. Besides, it is also occurs when the tumor block the fluid that flows throughout the brain. The common symptoms are having headache, nausea and vomiting and having problem in balancing and walking. Brain tumor can be detected by the diagnostic imaging modalities such as CT scan and MRI. Both of the modalities have advantages in detecting depending on the location type and the purpose of examination needed.

II. PRESENT PRACTICES AND TECHNOLOGY

A. Existing System

Magnetic Resonance Imaging (MRI) is a technique used primarily in medical settings to produce high quality images of human body's internal anatomy. Each image is of thin slice through the body, with the typical distance between slices being a few millimeters. Tumor detection at early stage is very difficult task for doctors to identify. MRI images are more prone to noise and other environmental interference. So it becomes difficult for doctors to identify tumor and their causes. The existing works has given good performance in the detection and diagnosis process, but those literary works have some drawbacks in the methods were exploited in the tumor detection and diagnosis process. Many detection and segmentation techniques are available, but the in the existing works no efficient method is utilized in the tumor detection. Most probably the tumor detection process attains the high performance in terms of the features, extracted from the tumor area, but the existing methods lacks in the feature extraction process. Also the technique lacks deep learning and thereby, the results attained are not supposed to be effective for complex database.

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1) Drawbacks

a) The conventional method for tumor detection in MRI image is human inspection.

b) The MRI also contains noise caused due to operator intervention which can lead to inaccurate classification.

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

d) The method may not distinguish the shading of the real image.

III.PROBLEM STATEMENT AND ANALYSIS

A. Problem Statement

The main reason for detection of brain tumors is to provide aid to clinical diagnosis. Automated detection of tumor in MRI images is necessary as high accuracy is needed when dealing with human life. The aim of this project is to provide a system that guarantees the presence of a tumor by combining several procedures to provide a foolproof method of tumor detection in MRI brain images. The resultant image will be able to provide information like dimension and position of the tumor which will provide a better base for the diagnosis to decide the curing procedure, so we are proposing "Brain Tumor Detection System" Which provides better accuracy.

B. Proposed System

1) The main aim of this research is to provide a better brain tumor detection technique by solving the drawbacks that currently exist in the literary works. Thus, we intended to propose a new tumor detection technique to detect the tumor from the brain MRI images, using deep learning.

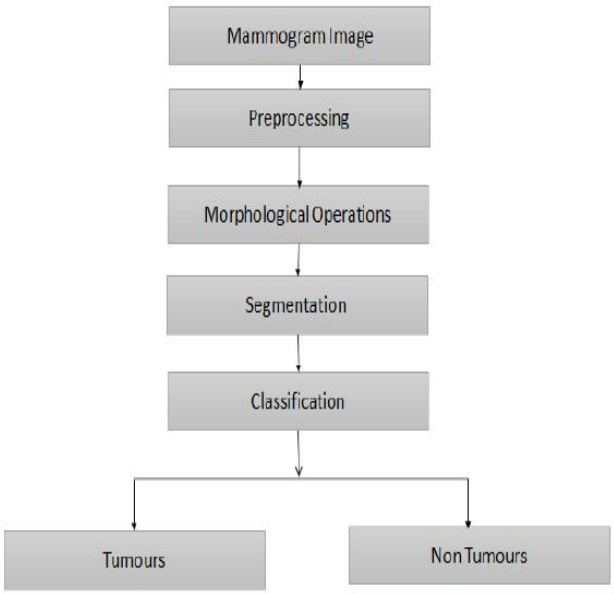
2) The proposed technique includes four major steps, namely pre-processing, morphological operations, segmentation, and classification. Initially, the input brain images will be subjected to pre-processing, where the noise in the images will be removed.

3) Then, the tumor region in the images will be segmented by the proposed clustering approach, named k-Means clustering. Thus, the proposed technique, will classify the images into either normal or abnormal class. The implementation of the proposed technique will be in MATLAB

4) The performance of the proposed technique will be evaluated in terms of accuracy, sensitivity, and specificity. Finally, the performance attained by the proposed technique will be compared with the existing works.

5) The performance of our proposed technique will be tested by using more number of brain images, and the results related to brain images will be compared with the conventional brain tumor detection techniques.

C. System Flow



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IV. INFORMATION GATHERING AND ANALYSIS (LITERATURE SURVEY)

To select a topic, we have collected information from various sources (web sites, literature, etc.). According to the information collected we came to know that the current system is not computerized system.

A. Paper1

Paper Name- Literature Survey on Detection of Brain Tumor from MRI Images

Authors-

1. Ms. Riddhi.S.Kapse
2. Dr. S.S. Salankar
3. Ms.Madhuri.Babar

Theme: A variety of algorithms were developed for segmentation of MRI images by using different tools and methods. Alternatively this paper presents a comprehensive review of the methods and techniques used to detect brain tumor through MRI image. This approach consists of the implementation of Simple Algorithm for detection of range and shape of tumor in brain part with the help of MRI images. Tumor is vast growth of tissues in any part of the body. Tumor area can be distinguished according to its characteristics. According to the type of tumor patient need to get treatment. So, brain tumor is very serious disease, because it will grow in limited space inside the skull. It needs to be recognized atearly stages because it may lead to death. In this paper used segmentation technique to detect tumor.

B. Paper2

Paper Name- Brain Tumor Detection based on Multi-parameter MRI Image Analysis

Authors-

1. Rajeev Ratan
2. Sanjay Sharma
3. S. K. Sharma

Theme: Segmentation of anatomical regions of the brain is the fundamental problem in medical image analysis. While surveying the literature, it has been found out that no work has been done in segmentation of brain tumor by using watershed in MATLAB Environment. In this paper, a brain tumor segmentation method has been developed and validated segmentation on 2D MRI Data. This method can segment a tumor provided that the desired parameters are set properly. MR is generally more sensitive in detecting brain abnormalities during the early stages of disease, and is excellent in early detection of cases of cerebral infarction, brain tumors, or infections. In this research we put forward a method for automatic brain tumor diagnostics using MR images. The proposed system identifies and segments the tumor portions of the images successfully.

C. Paper3

Paper Name- Brain Tumor Segmentation by Modified K-Mean With Morphological Operations.

Authors-

1. Rajeev Kumar
2. Dr. K. James Mathai.

Theme: Most research in developed countries show that the numbers of people who have brain tumors have died due to the actual fact of inaccurate detection. Generally, CT scan or MRI that is directed into intracranial cavity produces a whole image of brain. This image is visually examined by the physician for detection & identification of brain tumor. However this technique of detection resists the accurate determination of stage and size of tumor. To avoid that, this project uses 'modified k-mean with morphological operations'-a computer aided technique for segmentation (detection) of brain tumor based on the combination of two algorithms. This technique allows the segmentation of tumor tissue with accuracy and reproducible similar to manual segmentation. In addition, it also reduces the time for analysis. At the end of the process the tumor is extracted from the MRI images and its actual position and the shape also determined. The stage of the tumor is displayed based on the number of area calculated from the cluster.

In modified k-mean segmentation algorithm, optimize number of clusters are used. Generally morphological operation is used for object extraction and noise removal. Here it is used to enhance the object boundary and to remove the noise from the images. The addition of morphological operation added more accuracy in results. Here the affected areas have been calculated. To analyze the result for its accuracy, scholar has calculated the following parameters: Peak signal-to noise ratio (PSNR), Mean squared error (MSE), Root-mean-square error (RMSE) and minimal execution time.

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D. Paper4

Paper Name- Brain Tumor Detection through MR Images: A Review of Literature

Authors-

1. Ritu Rana
2 .Parvinder Singh

Theme: A brain tumor is an abnormal growth of tissue in the brain or central spine that can disrupt proper brain function and creates an increasing pressure in the brain. This paper is intended to present a comprehensive review of the methods of brain tumor detection through Magnetic Resonance Imaging (MRI) technique used in different stages of Computer Aided Detection System (CAD). It also provides a brief background on brain tumor in general and non-invasive imaging of brain tumor in order to give a comprehensive insight into the field.

Lastly, the paper concludes with a concise discussion and provides a direction toward the upcoming trend of more advanced research studies on brain image segmentation and tumor detection.

E. Paper 5

Paper Name- Image Segmentation and Classification of MRI Brain Tumor: A Review

Authors-

1. Somya Yadav
2. K. K. Singh, PhD

Theme: In image classification, an image is classified according to its visual content. This paper also discuss how to extract information about the tumor, then in the first level i.e pre-processing level, the parts which are outside the skull and don't have any information are removed and then anisotropic diffusion filter is applied to the MRI images in order to remove the noise.

In this paper we have tried to explain how by applying the algorithm, the tumor area is displayed on the MRI image and the central part is selected as sample points for training. Then Support Vector Machine classifies the boundary and extracts the tumor.

V. PROJECT SCOPE AND ANALYSIS

A. Project Scope

1) Discuss about image processing techniques.
2) Discuss about identification of brain tumor.
3) Discuss about how to detect and identify brain tumor using image processing techniques.
4) Discuss about the issues in the field.

B. Assumption

We are providing MRI images as input.

C. Exclusion

It is works only for 2D image not for 3D images.

D. Issues

If there is problem with input image then we cannot get right result.

E. Risk

If result is not accurate then diagnosis will go wrong decision.

VI. REQUIREMENT ANALYSIS AND FEASIBILITY STUDY

A. Functional Requirements

In functional requirement of our project include requirement of the modules in the project what are the input for each module and what is the output for each module is included in this functional requirement.

1) Selecting the MRI scan images of brain.
2) Extracting only tumor region from the MRI images
3) Finding the boundary of the tumor.
4) Creating a GUI for easy access of the program.

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B. Non-Functional Requirements:

1) *Reliability:* This software attempts to insure appropriate content but assume no responsibility for external manipulations.
2) *Availability:* The software for Extraction of brain tumor from MRI images can be available in all the systems who have MATLAB installed.
3) *Usability:* The system should be easy to use and simple to understand.
4) *Accuracy:* The system should perform its process in accuracy to avoid problem.

VII. SOFTWARE REQUIREMENT ANALYSIS AND SPECIFICATION

A. Tools

MATLAB (matrix laboratory):

1) It is a multi-paradigm numerical computing environment and proprietary programming language.
2) It is used to process images one generally writes function files.
3) It is intended primarily for numerical computing.
4) Developed by MathWorks.

B. Software Hardware Requirements

1) 64-bit Windows
2) 4 GB RAM
3) 1TB Hard Disk

VIII. SYSTEM DESIGN AND ANALYSIS

A. Project Module Architecture

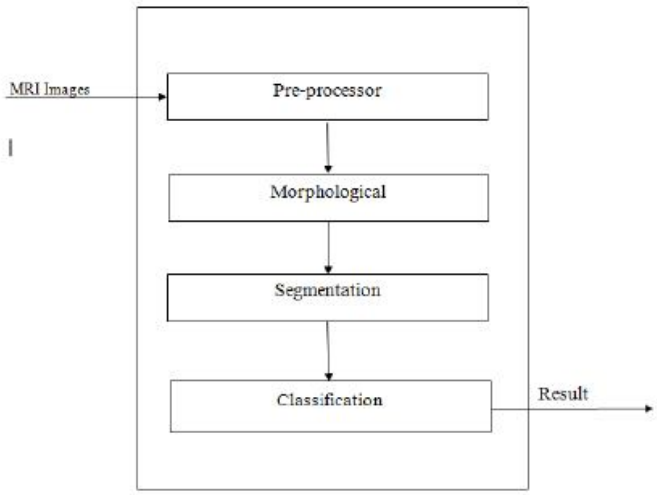

Fig: 8.1. System Architecture of Tumor Detection System

Above diagram shows the architecture of Tumor Detection System. As shown in above fig each module performs it's different task mentioned below:

1) *Pre-processing:* The MRI brain images are acquired and are given as input to Pre-processing stage. Pre-processing is needed as it provides improvement in image data which enhances some of the image features which are important for further processing.
2) *Morphological Operations:* This techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels.
3) *Segmentation:* is done for finding the location of the tumor in the brain image. Segmentation is the process of dividing an image into multiple segments. The aim of segmentation is to change representation of image into something which is more easy to analyze. The result of watershed segmentation is label image.

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B. System Design and Modeling

1) Functional Modeling Data Flow Diagram

DFD level 0:

fig: 8.2.1.1 DFD Level 0

A DFD shows what kind of information will be input to and output from the system, where the data will come from and go to, and where the data will be stored. It does not show information about the timing of process or information about whether processes will operate in sequence or in parallel.

2) Dynamic Modeling

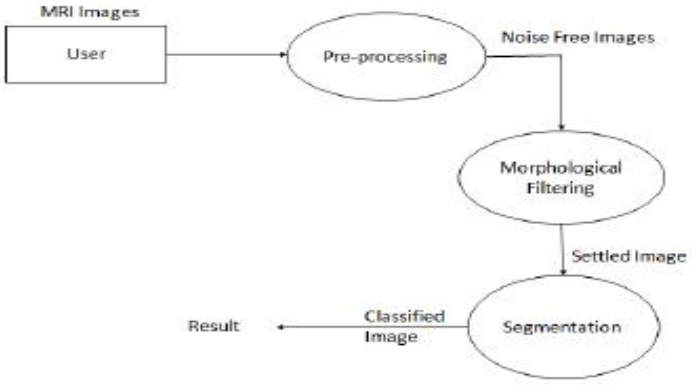

fig: 8.2.1.2 DFD Level 1

3) Sequence Diagram

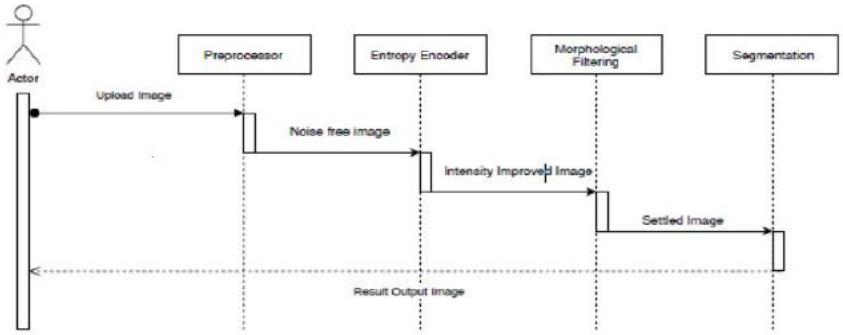

fig: 8.2.2.1 Sequence Diagram

A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios.

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IX. IMPLEMENTATION AND CODING

A. *Algorithms*

1) *K-mean Clustering:* K-Means clustering A cluster is a collection of objects which are similar between them and are dissimilar to the objects belonging to other clusters. Clustering is an unsupervised learning method which deals with finding a structure in a collection of unlabeled data. A loose definition of clustering could be the process of organizing objects into groups whose members are similar in some way. K-means clustering is an algorithm to group objects based on attributes/features into k number of groups where k is a positive integer. The grouping (clustering) is done by minimizing the Euclidean distance between data and the corresponding cluster centroid. Thus the purpose of k-means clustering is to cluster the data.

2) *Algorithm*

a) Give the no of cluster value as k.
b) Randomly choose the k cluster centers
c) Calculate mean or center of the cluster
d) Calculate the distance between each pixel to each cluster center
e) If the distance is near to the center then move to that cluster.
f) Otherwise move to next cluster.
g) Re-estimate the center.

B. *Functions Used For Developing System In Matlab:*

1) *BrainMRI_GUI_OpeningFcn(hObject, eventdata, handles, varargin)*

BRAINMRI_GUI, by itself, creates a new BRAINMRI_GUI or raises the existing.
where
hObject handle to figure
eventdata reserved - to be defined in a future version of MATLAB
handles structure with handles and user data (see GUIDATA)
varargin command line arguments to BrainMRI_GUI (see VARARGIN)

2) *Load Image*

Function pushbutton1_Callback(hObject, eventdata, handles)
where
hObject handle to pushbutton2 (see GCBO)
eventdata reserved - to be defined in a future version of MATLAB
handles structure with handles and user data (see GUIDATA)

3) *Morphological Operation*

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors

4) *Bwlabel (BW)*

Returns the label matrix L that contains labels for the 8-connected objects found in BW.

5) *Regionprops(BW,properties)*

Returns measurements for the set of properties specified by properties for each 8-connected component (object) in the binary image, BW. stats is struct array containing a struct for each object in the image.

a) *imadjust(I):* Maps the intensity values in grayscale image I to new values in J. By default, imadjust saturates the bottom 1% and the top 1% of all pixel values. This operation increases the contrast of the output image J.
b) *reshape(A,m,n):* returns the m-by-n matrix B whose elements are taken column-wise from A. An error results if A does not have m*n elements.
c) *zeros(___,typename) – :* returns an array of zeros of data type typename. For example, zeros('int8') returns a scalar, 8-bit integer 0. You can use any of the input arguments in the previous syntaxes.
d) *MinMax:* block outputs either the minimum or the maximum element or elements of the inputs. You choose whether the block outputs the minimum or maximum values by setting the Function parameter.
e) *centroid:* returns the x-coordinates and the y-coordinates of the centroid of a polyshape.

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f) dataset(varspec,'ParamName',Value): creates dataset array A using the workspace variable input method varspec and one or more optional name/value pairs (see Parameter Name/Value Pairs).

g) *abs(X):* returns the absolute value of each element in array X.

h) *ismember(A,B):* returns an array containing logical 1 (true) where the data in A is found in B. Elsewhere, the array contains logical 0 (false). If A and B are tables or timetables, then ismember returns a logical value for each row. For timetables, ismember takes row times into account to determine equality. The output, Lia, is a column vector.

i) *floor(A):* rounds the elements of A to the nearest integers less than or equal to A. For complex A, the imaginary and real parts are rounded independently.

j) *imfill(BW,locations):* performs a flood-fill operation on background pixels of the input binary image BW, starting from the points specified in locations.

X. TESTING

A. *What is Testing?*

Testing is a process of executing a program or application with the intent of finding the software bugs. It can also be stated as the process of validating and verifying that a software program or application or product: Meets the business and technical requirements that guided its design and development.

Software testing is very important because of the following reasons: Software testing is really required to point out the defects and errors that were made during the development phases. It's essential since it makes sure of the Customer's reliability and their satisfaction in the application.

B. *Software Testing Techniques*

There are different methods that can be used for software testing.

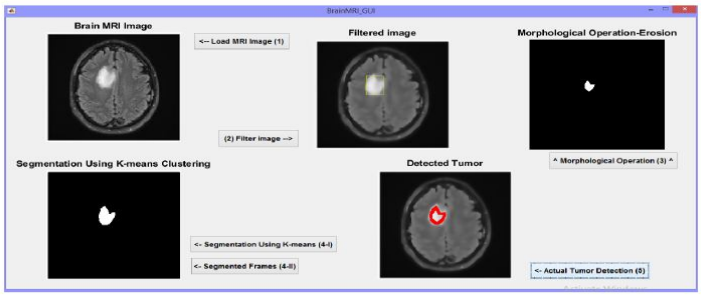
1) *Black Box Testing:* The technique of testing without having any knowledge of the interior workings of the application is called black-box testing. The tester is oblivious to the system architecture and does not have access to the source code. Typically, while performing a black-box test, a tester will interact with the system's user interface by providing inputs and examining outputs without knowing how and where the inputs are worked upon. Black-box testing is a method of software testing that examines the functionality of an application without peering into its internal structures or workings. This method of test can be applied virtually to every level of software testing: unit, integration, system and acceptance.

2) *White Box Testing:* White-box testing is the detailed investigation of internal logic and structure of the code. White-box testing is also called glass testing or open-box testing. In order to perform white-box testing on an application, a tester needs to know the internal workings of the code. The tester needs to have a look inside the source code and find out which unit/chunk of the code is behaving inappropriately.

3) *Grey Box Testing:* Grey-box testing is a technique to test the application with having a limited knowledge of the internal workings of an application. In software testing, the phrase the more you know, the better carries a lot of weight while testing an application. Mastering the domain of a system always gives the tester an edge over someone with limited domain knowledge. Unlike black-box testing, where the tester only tests the application's user interface; in grey-box testing, the tester has access to design documents and the database. Having this knowledge, a tester can prepare better test data and test scenarios while making a test plan.

C. *Testing Methodology*

1) *Testing1:* Use high quality image as input:



Result: Provide accurate result.

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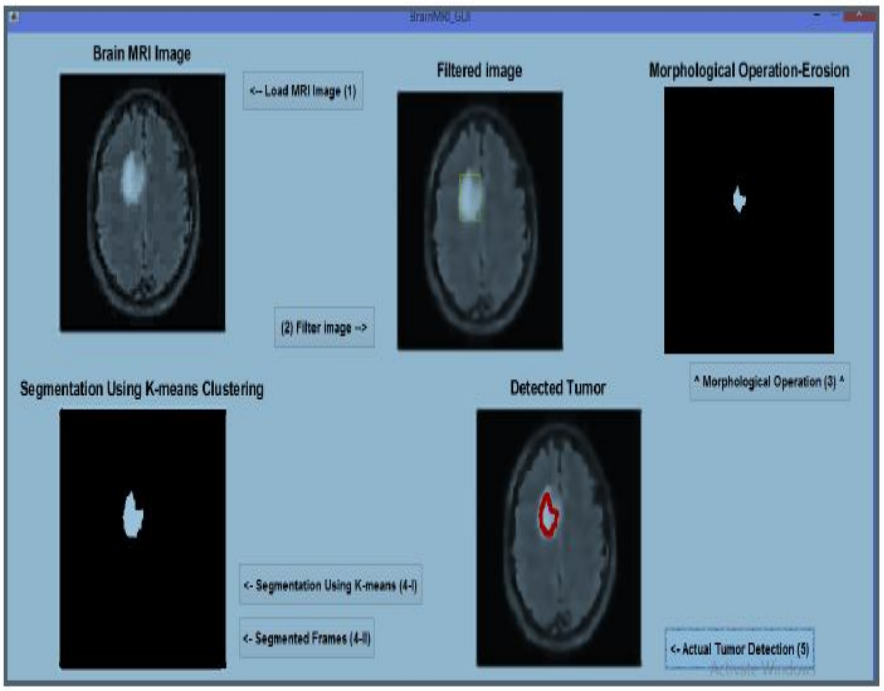
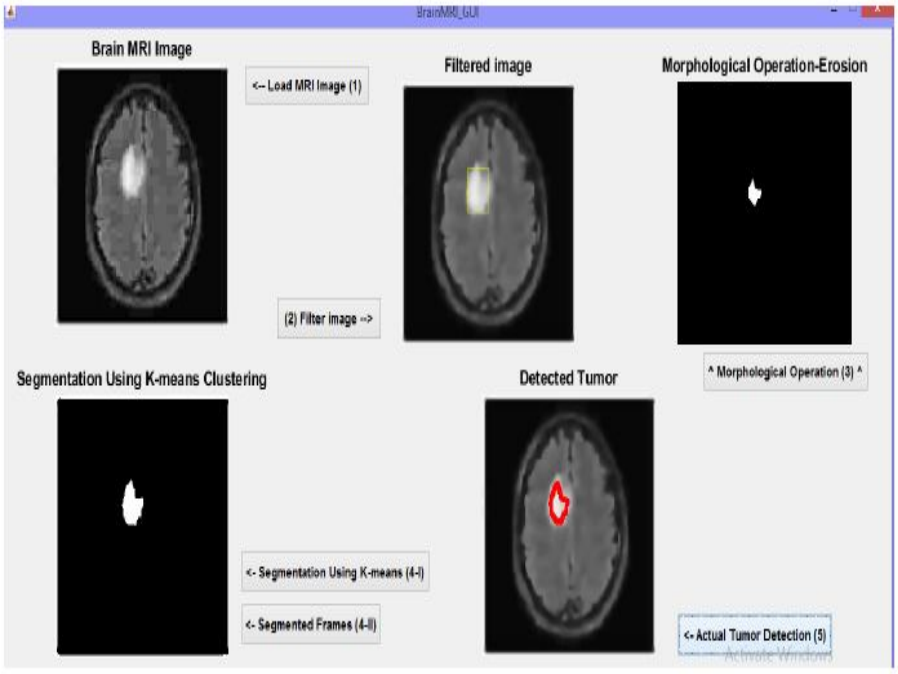
2) *Testing2:* Use medium quality image as input.



Result: tumor detected but image portion is blurring.

3) *Testing3:* Use low quality image as input:



Result: image portion is much blurring than medium quality iamge.

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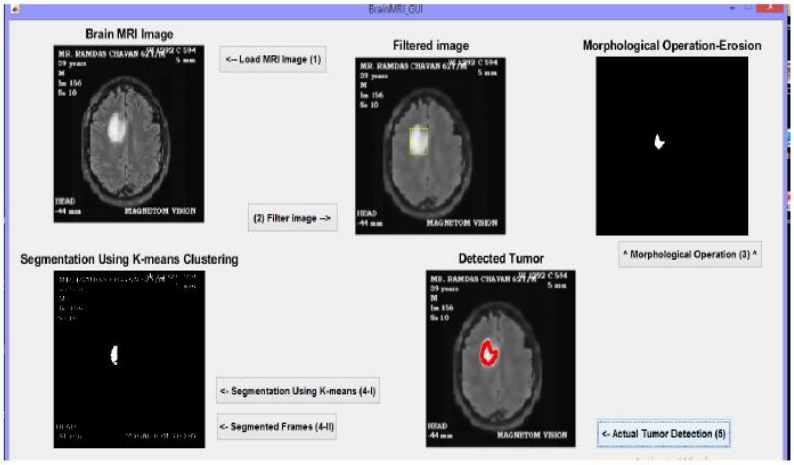
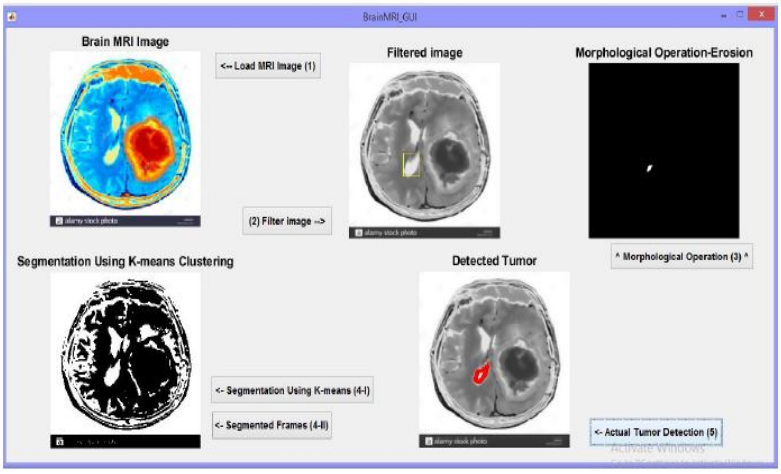
4) *Testing4:* Use real time image with text as input



Result: Operations performed properly and provide correct result.

5) *Testing5:* Use color image as input



Result: tumor not detected properly.

XI. RISK MANAGEMENT AND ANALYSIS

A. *Risk Management*

The Risk Analysis means risk containment and mitigation. Most software engineering project are inherently risky because of the variety potential Problems that might arise. The software project risk may be due to new and unproven Technologies, user and functional requirements, complex application and system architecture, performance and organizational issues.

B. *Risk Analysis Includes Following Points*

1) Identification of Risk: Here, mostly the identification of source or root of the risk is done.
2) Classification of Risk: There are various types of risk that user risk, software risk, hardware risk, network risk according to it risk has been get classify.
3) *Plan for Minimizing the Risk:* What should the methodology that the user has to follow for planning the risk minimization.
4) *Implement Mitigation Action:* What kind of proper work or action that should have to perform in terms of controlling the risk.
5) *Communicate Risk Status Throughout the Project:* What is the risk status at each and every stage of the project is get monitored and Communicated to the project concerns people.

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Sr no	Risk	Identification of Risk	Classification of risk	Plan for minimizing the risk	Implement mitigation action	Communicate Risk status.
1	Tumor detection accuracy is not good	When there is problem with input images	Data accuracy risk	Take a multiple sample of same MRI image.	Do proper management of multiple images.	By checking through the result of detection
2.	Risk of system slow	Time taken for performing operations	Software risk.	Use highly configured systems.	Do proper management of system	By checking the time taken for getting result

XII. LIMITATIONS AND FUTURE SCOPE

A. Limitations

1) Limitations of Proposed system:
2) Need most of clear and sharp image for better result.
3) Color image not be given proper result.
4) Only work on MRI black white and grayscale image.
5) Image processing done only on 2D images.
6) System accepts input images in the format of .jpg, .png and .bmp only.

B. Future Scope

1) Different classifiers can be used to increase the accuracy combining more efficient segmentation and future extraction techniques 0077ith real and clinical based cases by using large dataset covering different scenarios.
2) Try to use 3D and 4D images as input to the system.

XIII. USER MANUAL

A. System GUI Screenshot

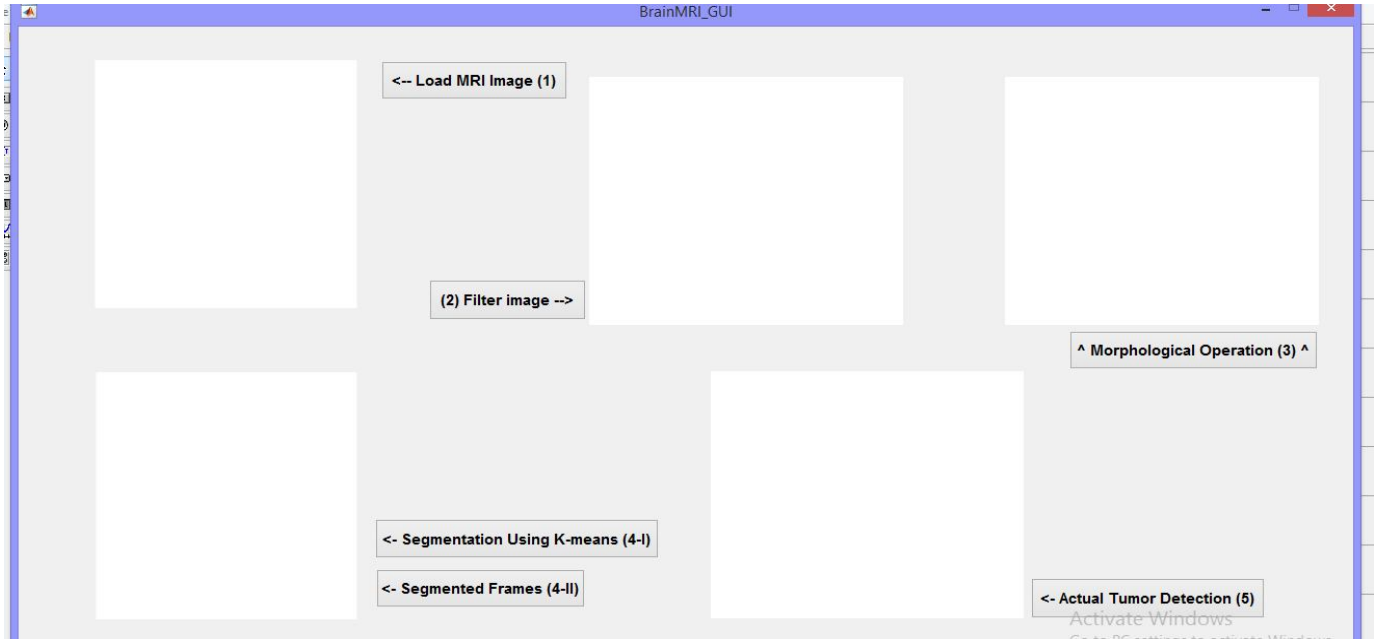

fig: 13.1.System GUI

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1) Step1: Load Image

Click on button load MRI image and pick any image from stored images.

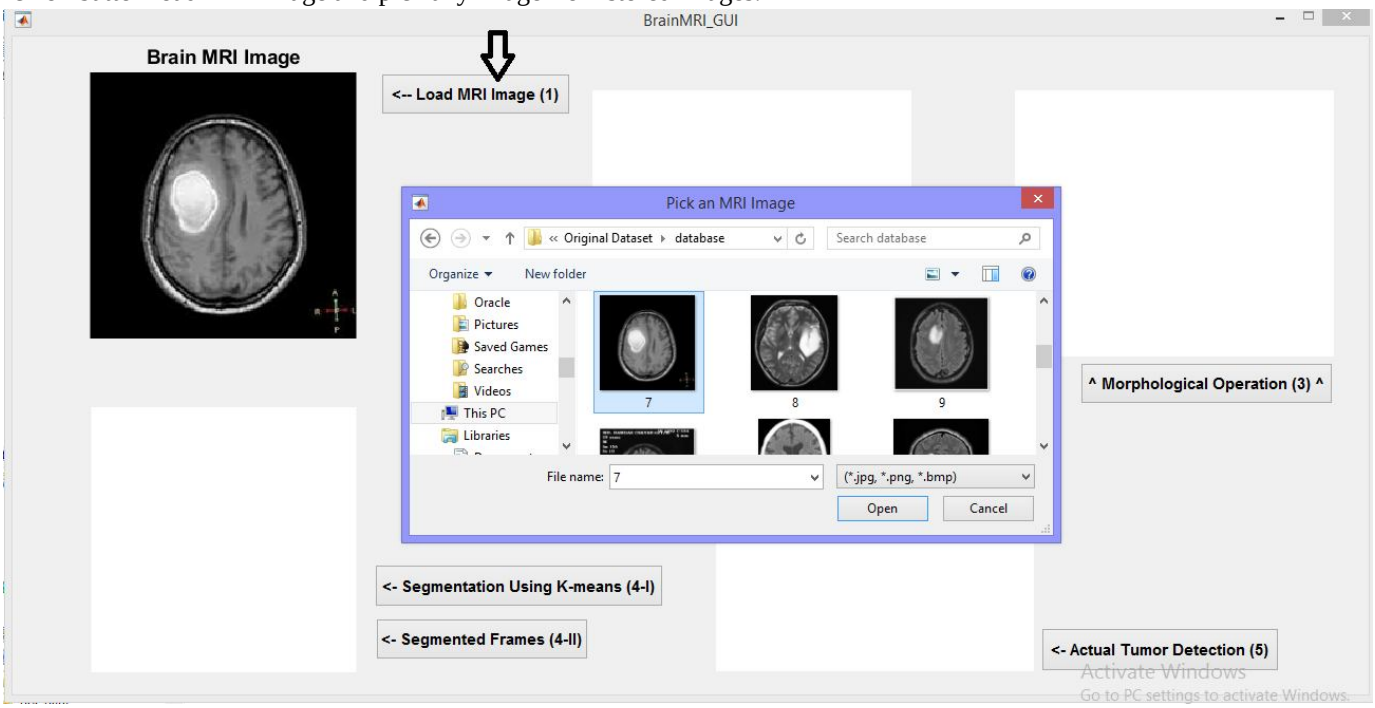

Fig: 13.2 Step1: Loading image

2) Step2: Filter Image.

Click on button filter image and see result.

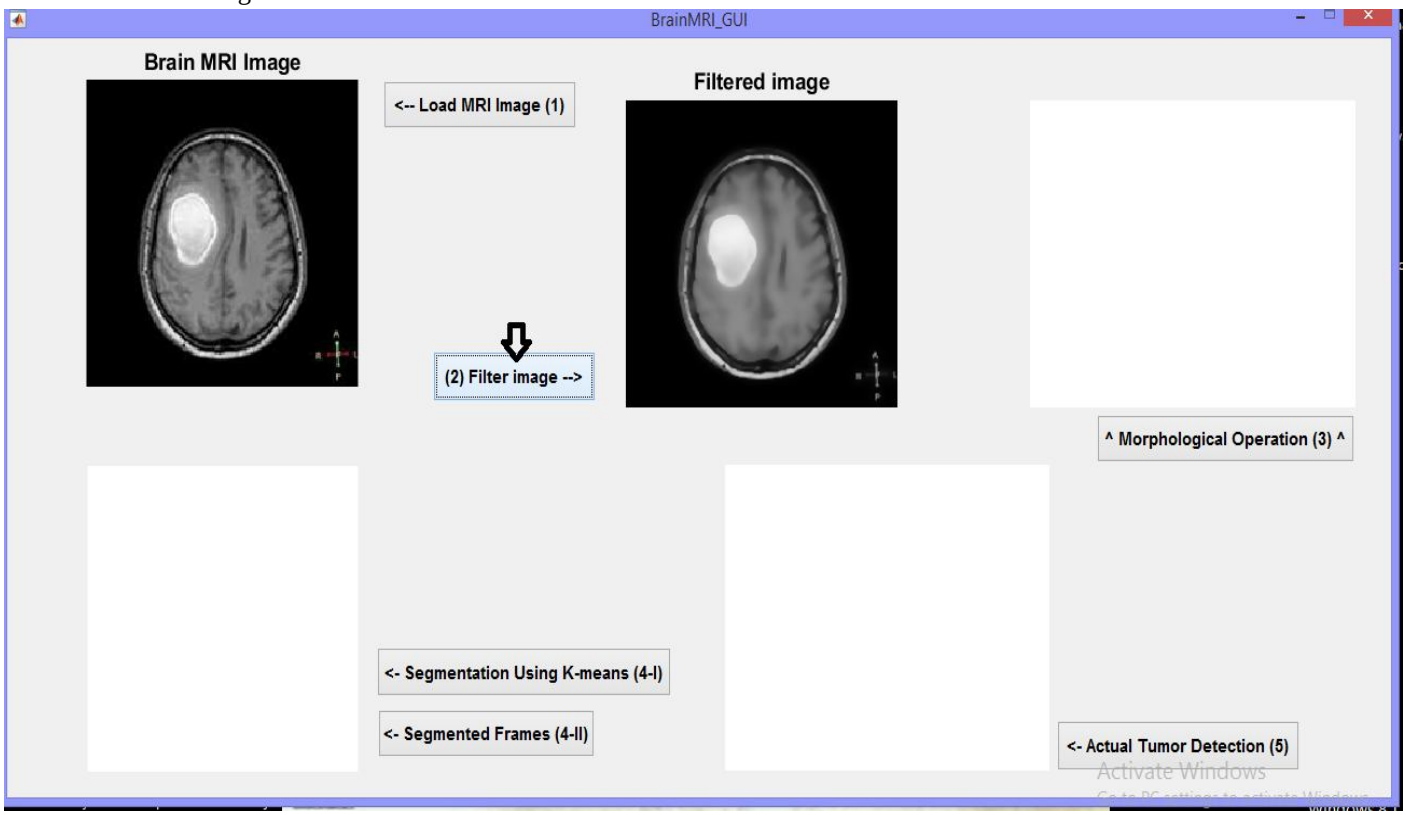

Fig: 13.3 Step2:Filtering Image

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3) Step3: Morphological operation.

Click on button Morphological operation and see result

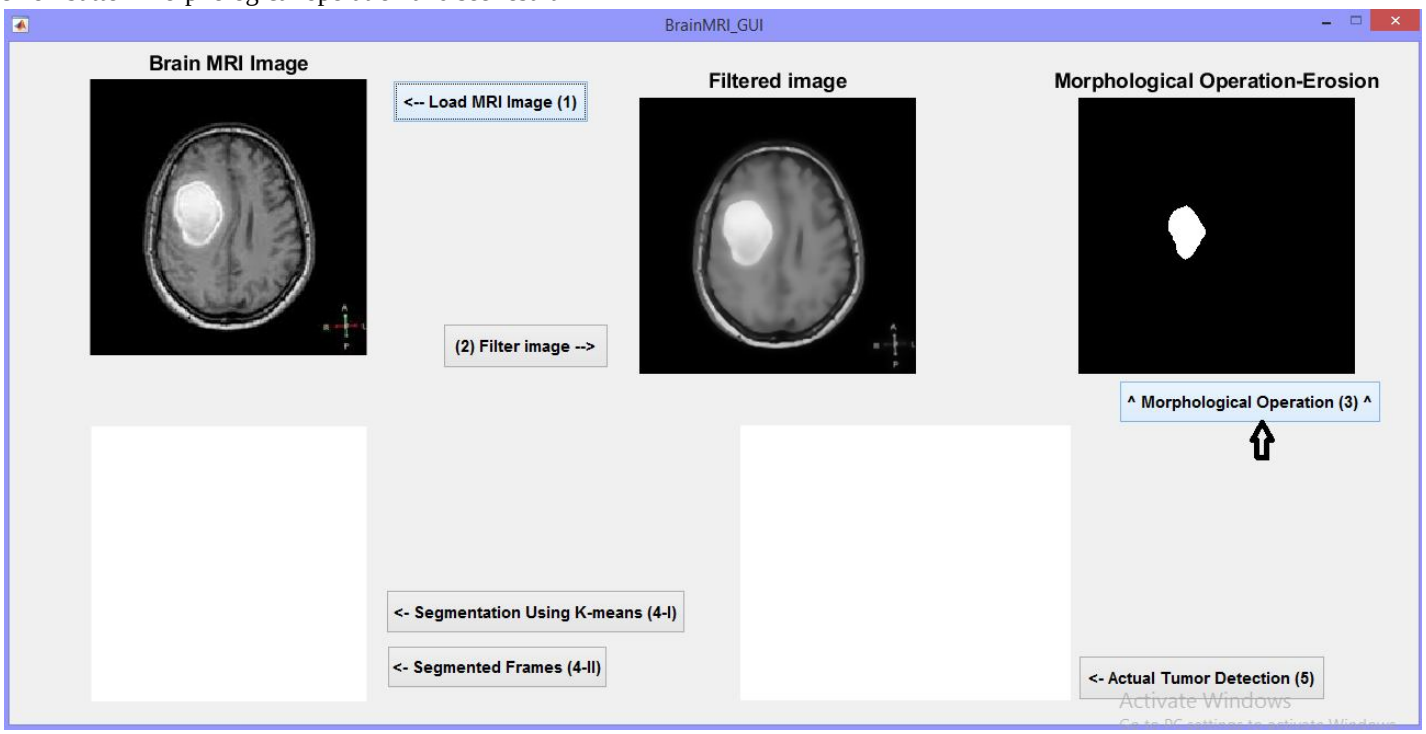

Fig:13.4 Step3:Morphological Operation

4) Step 4-I: Segmented image.

Click on button segmentation using K-Means for seeing segmented tumor portion.

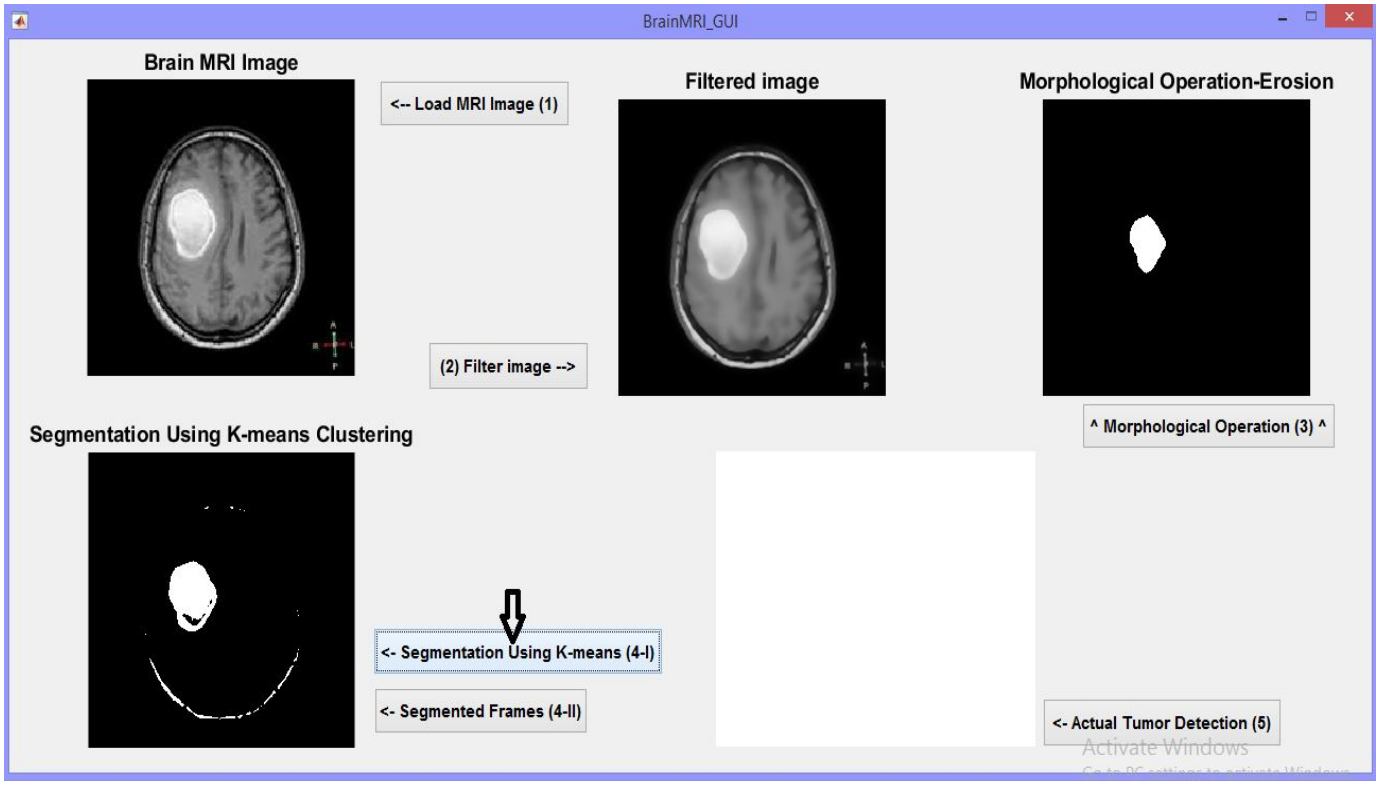

Fig: 13.5 Step 4-I Segmented Image

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a) Step 4-II: Clustering Frames.

Click on button segmented frames for seeing clustering using K-Means.

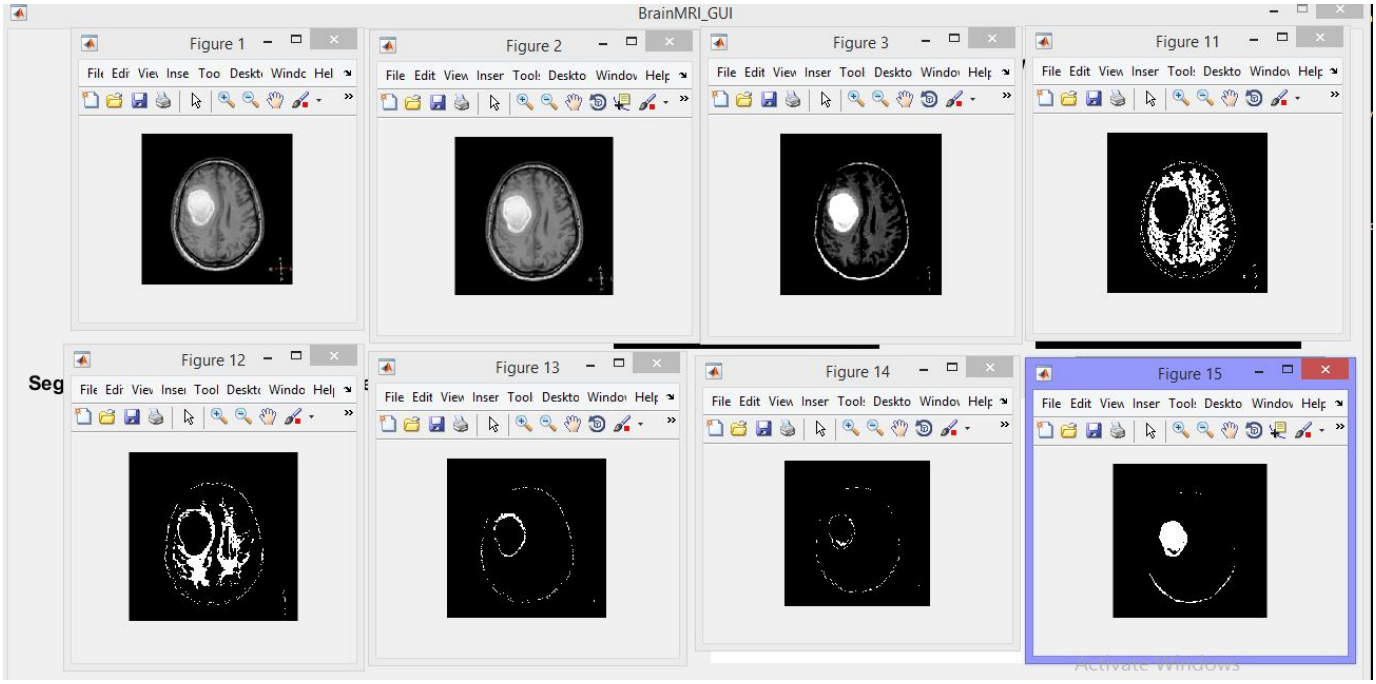

Fig: 13.6 Step 4-II Clustering Frames

5) Step 5: Actual tumor detection.

Click on button actual tumor detection for seeing tumor in bordered portion

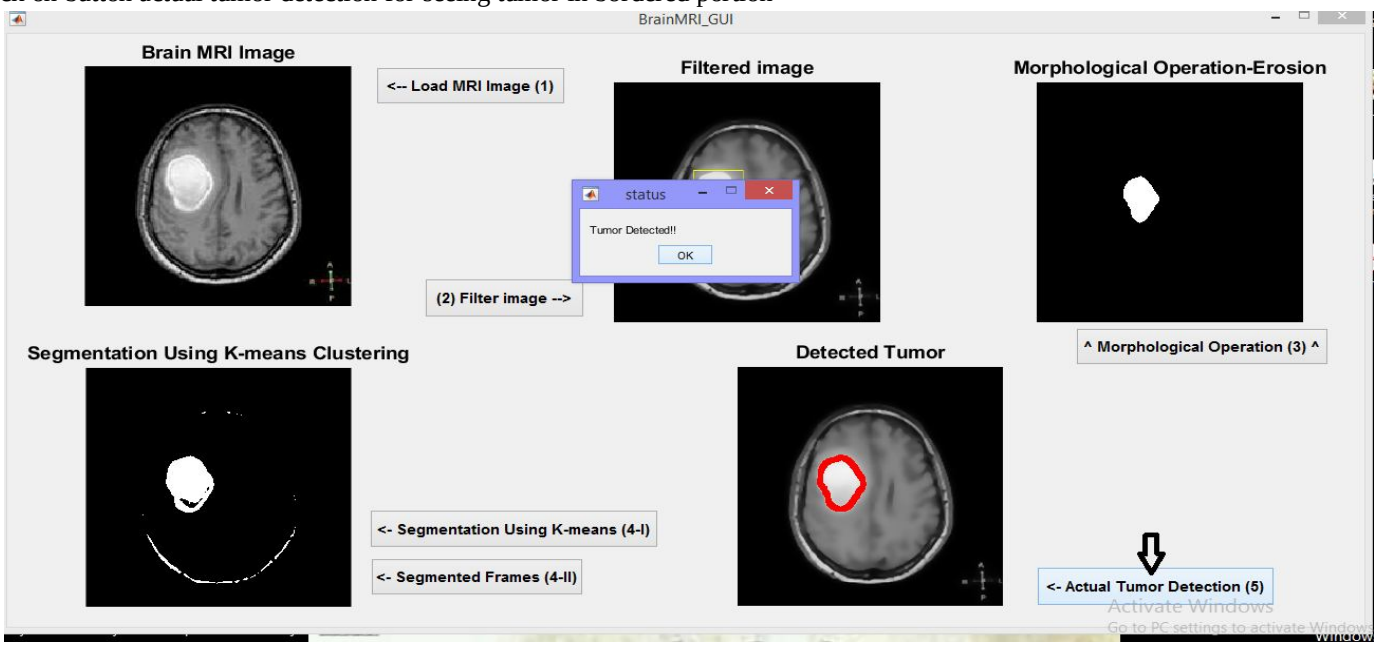

Fig:13.7 Step 5: Actual tumor detection.

XIV. CONCLUSION

The proposed algorithm is inputted with gray scale images of brain that contain tumous. The image is processed through various stages of morphological operations like filtering, erosion, etc. and segmentation using K-Means clustering through MATLAB programming. Hence, the tumour is outlined in the original image and clearly demarcated. A GUI is also developed which enables the above application with a user friendly interface.

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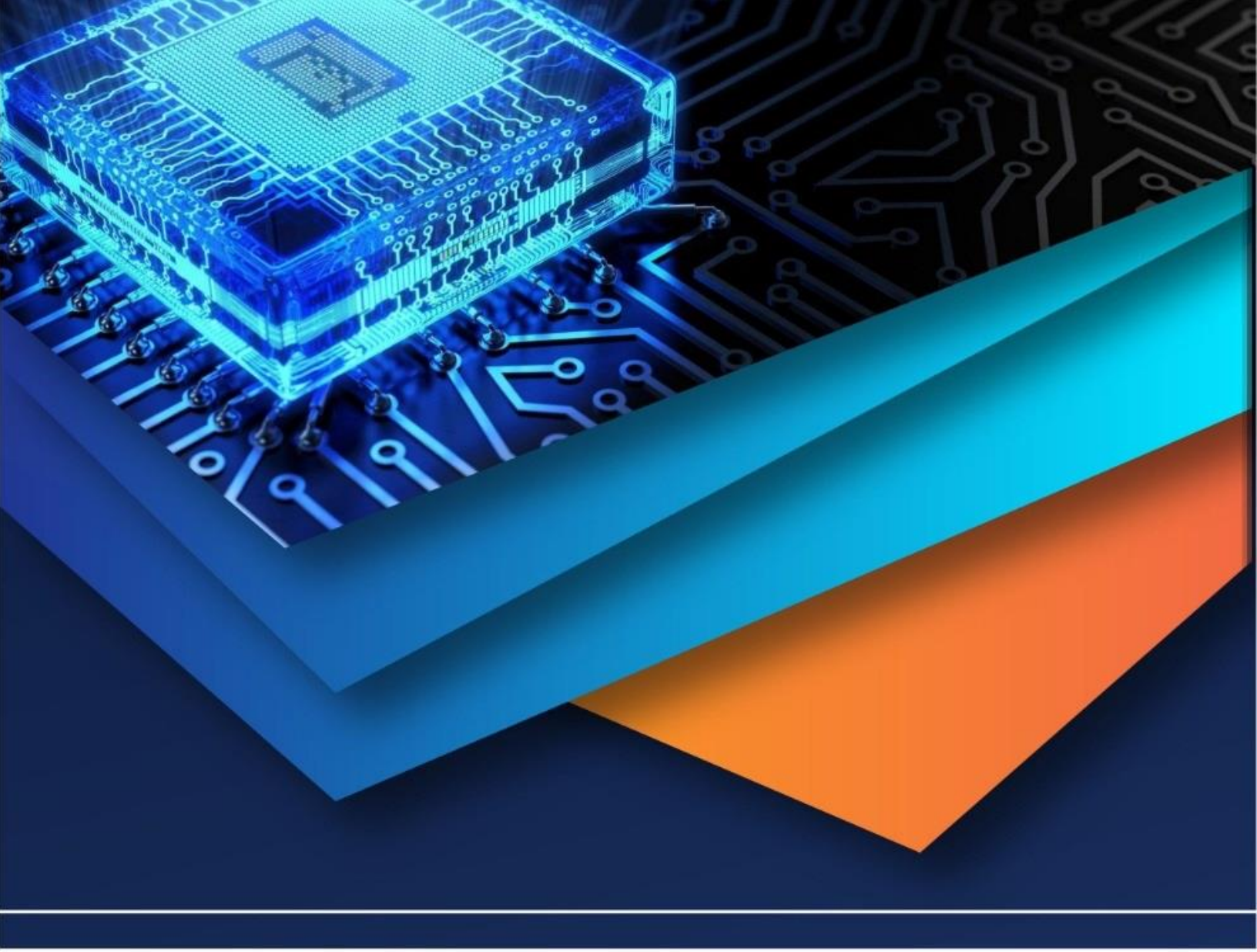

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