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# Brain Tumor Detection from Human Brain Magnetic Resonance Images using Image Mining Technique

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**Abstract**

Data mining deals with the extraction or mining knowledge from huge volumes of various kinds of data. A detailed study, analysis and extraction of relevant data are done using efficient data mining algorithms and tools. Image mining deals with the study and development of new technologies that allow easy analysis, representation and interpretation of the image data. Data mining and visualization make use of machine learning, statistical visualization, image processing, data manipulation and knowledge extraction techniques etc to mine useful information and visualize the required output. Medical images are available in different dimensions and in huge volumes. The availability of medical images through different formats is a huge resource for the health care related research. Research associated with storage, process and manipulation of medical image data by computers with minimal human intervention is the need of the time. One of the main goals of applying image-mining algorithms to medical images is that it can discover new relations among data and reveal new patterns with which experts can identify diseases, diagnose symptoms, or can prescribe treatments. The use of image mining technique will be a supplementary knowledge for a particular medical images analysis field and it help to represent medical images and the contained data in a focused and precise manner. This research approach is helpful in information retrieval from MRI images, using data mining techniques. Accuracy of tumour detection is increased.

**Keywords**: brain MRI, brain tumor, segmentation, SVM

## INTRODUCTION

Data contains information in an unordered format. Huge collection of different types of data is available in the universe. A systematic arrangement of knowledge will cut back the uncertainty regarding the data and provides a transparent illustration of the data for a given context. Data mining is the study and examination of large quantities of data. It is a multi-disciplinary research area. Data is examined with various algorithms or statistical methods to discover potentially useful data or data patterns. Image data contains vital information from the field of medicine, engineering, astronomy etc. Image mining is derived from data mining and in this the information mining is done from large image repositories. Relevant knowledge extraction is possible through mining algorithms and tools.

Medical imaging technology advanced and these medical images contains various information about the human body. The information is useful in various diagnosis and treatment of patients. Trained medical practitioners are required for analyse these medical images. Depending on the experience and expertise in the field, the medical practitioners give away the diagnosis reports. In order to avoid human interpretation errors, an automated system is suggested. In this research extraction of brain tumor from Magnetic Resonance Images (MRI) had done. The automated process is helpful in conducting timely surgical or other clinical therapy for any patient. Image processing software developments through hybrid models provide new progress in medical imaging research.

A computer system which is capable for browsing, searching, retrieving and processing the images from large databases is called as an image retrieval system [1]. New development in digital and medical technologies give birth to various types of medical images like X-rays, CT, MRI, ECG, fMRI etc and they are the standard for various diagnosis and treatment purposes [2].Image mining includes the extraction of knowledge or patterns or relationships, which are not directly stored in image format or in the images [3]. Image mining commonly use two methods. Latter approach mine knowledge from huge dataset which consist of only image data and the former approach, they mine the collective set of images along with their correlated data. In the paper of [4] mining of images and its associations have done using blobs. In the paper [5] has used rule mining to learn the associations between structures, size and role of human brain images. Use of different image compression methods help to condense the amount of data required to represent an image. The image compression method reduces the transmission requirements and storage space for a given input data [6].

Diagnosis of brain tumor from brain images in medical field can speed up with the help of CAD. The human analysis of CT-scan images for any diagnosis turn to be tedious and therefore it is inclined to human mistakes. CAD systems eliminate all most all common human errors and are recommended in hospitals and medical treatment

canters. To collect all the important objects from the images, the pre-processing is done. The pre-processing deals with noise reduction and enhancement of images. The pre-processing of the images was done with shape priori algorithm. It considered the curve shapes in the images and corrected the image following an iterative step. After the pre-processing the relevant features are extracted using association rule mining. Transactional database were used to store the extracted features. The decision tree classifier is used to classify the dataset objects as malignant, normal or benign. The CT-scan of brain images has used as a better way to detect the brain tumor. Accuracy when compared with other method was high for this method. In association rule-mining algorithm, according to the class labels, decision tree classifier was used to classify various rules. The outcome of classification result can give a support for the physicians [7].

The internal body structures of the human in different planes are able to visualize with the help of MRI images. Internal haemorrhage, ligament tear, fracture, brain abnormal testing etc can identify in an accurate way with high quality MRI images. The MRI image texture contains much information about the features like characterize brightness, colour, slope and size. The feature extraction of the data, dimension reduction and classification of the output using two classifiers are the major steps. MRI pre-processing includes steps like noise removal (de-noising), skull-stripping and intensity normalization [8]. Noise removal algorithms are useful to pre-process the MRI. The noise may acquire from imaging system at various stages like image acquisition, coding, saving and in transmission process. The noise produces undesirable effects like blurred objects, unseen lines or corners or unrealistic edges. The noise disturbs the background scenes of the images also. Good image denoising methods removes the unwanted noise from the MRI images to achieve a good quality image and preserve the edges of the images. Filter can perform sharpening, smoothing, and edge enhancement depending on the filtering algorithm. Generally, there are two types of filters known as linear filter and nonlinear filter. In linear filtering a linear combination of values are applied to the pixel values of original image. Linear filtering is easy to learn and compute. The nonlinear filters provide a smoothing effect to the image without blurring the edges [9]. For denoising the most popular methods applied in MRI includes wavelets [10] adaptive filtering [11], Non-Local Means [12-15], Anisotropic Diffusion Filtering, median filter [16,17] etc.

The segmentation of MR images is useful in various kinds of analysis, visualization and optimisations of diseases. The region growing is the simplest and most commonly in region-based segmentation extraction of similar pixel points will lead to the segmentation of connected regions [18,19] used a hybrid segmentation which combines edge detection, threshold segmentation, watershed segmentation, and morphological operators for attribute selection from images was introduced. In paper [20] the author has used Support Vector Machine (SVM) for Image classification. SVM is used in quite

a lot of researches which are related to knowledge discovery, prediction making, decision-making etc. SVM classifiers were successfully applied to real-world applications like recognition of face [21] handwriting digit recognition [22] spam categorization [23] financial research [24], gene and gender classification [25], early lung cancer detection [26] etc. From MRI, relevant features were extracted and these features were used as input to the K-NN and NN. The texture feature of the brain MRI's were given to neural network algorithm and k-nearest neighbour and classified as an abnormal or normal. The performance of the system was evaluated using confusion matrix, specificity, sensitivity and accuracy. The experimental results in achieved a 100% accuracy with K-NN classifier and 98.90% for NN classifier.

## METHODOLOGY

### 1. Tool: MATLAB

MATLAB (*Matrix Laboratory*) is a high-level programming language where the users can write their codes and can create Graphical User Interfaces (GUI). MATLAB is useful for analysing data that are in different formats, develop new algorithms, simulate complex models and create applications. MATLAB offers different toolboxes like aerospace toolbox, bio informatics toolbox, communication toolbox, image processing toolbox etc. These toolboxes are application specific. The Image Processing Toolbox consist of several built-in functions which can be used for analysis, process and visualization of images. It supports different forms of images and videos. Image processing toolbox works in most of the operating systems. Images in RGB, binary and grey scale can be taken as input for image.

### 2. Dataset

MRI images available in the following resources Osirix [28], ADNI [30], BIRN[31] were checked for initial study. Later this research work used real time data set of brain MRI of patients collected from Mediscan, Jubilee Mission Medical College Hospital and Research Institute campus, Cochin, India. Dataset contains total 245 patient's brain MRI images. Size of each image lies between 35 KB to 55 KB. T1 weighted and T2 weighted brain MRI images in DICOM format were used in this research. DICOM is Digital Imaging and Communications in Medicine [32]. It is the global standard for medical pictures and related data (ISO 12052). The X-ray, ultrasound, MRI and CT images are also available in DICOM format. DICOM store data and meta data about the patient in an invisible form. They are stored in. DCM

extension and contain patient information like date of image taken, age, gender, study description, modality, image type, size etc. Brain image for each patient has 20 to 50 MRI images.

## 3. Pre-process- Adaptive Filtering

Pre-processing is done to remove unwanted data from input images. Pre-processing of MRI used Adaptive Filtering algorithm to preserve all the edges and high-frequency parts of the image. The wiener2 functions available in MATLAB apply the wiener filter to an image adaptively and remove the Gaussian noise by tailoring itself to the local image variance. Depending upon the calculated variance the smoothing is performed. A comparative study of anisotropic and median filtering with adaptive filtering had done and identified that the performance of adaptive filtering is good for MRI. The results of comparative study with these filtering algorithms are shown in Figure 1. Filtering provide a high-quality image after removing the noise present in them.

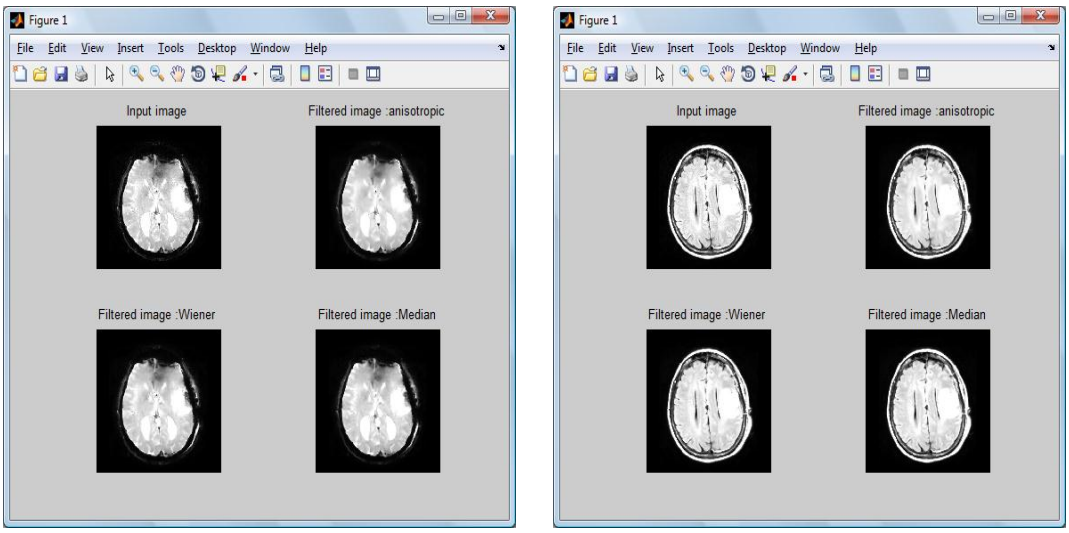



**Figure 1:** Comparative study of filtering algorithms using Anisotropic, wiener2 and median filter

In general, PSNR value indicates the reconstruction quality of digital images. Figure 7 gives graphical comparison of the filtering algorithm. PSNR value for adaptive wiener2 is 38.60 dB which is more when compared with other two algorithms. Median algorithm gives a PSNR value of 36.44dB and anisotropic filter give 36.91 dB. So here for the given MRI images, Wiener2 filtering give noise removed brain MRI with all relevant information stored in it. These filtered images are used for further segmentation process. Among these filtering algorithm wiener2 gave better performance measure than other algorithms.

**Table 1:** Performance Analysis of filtering algorithms with MSE and PSNR values

| Algorithm used | Performance Metrics | |
|---|---|---|
| | MSE(dB) | PSNR(dB) |
| Median filtering | 14.75 | 36.44 |
| Anisotropic | 13.24 | 36.91 |
| Adaptive-wiener2 | 12.2 | 38.6 |

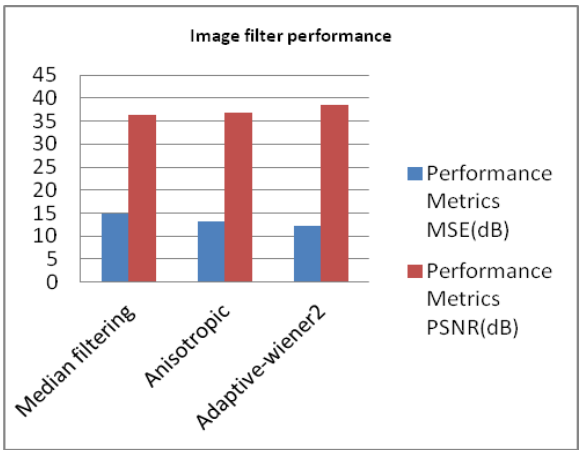



**Figure 7:** Algorithm comparison

## RESULT AND DISCUSSION

Brain tumours are caused by uncontrolled and uneven cell growth or cell division inside the brain. Accurate brain tumour detection is a challenging area in medical image processing. The manual identification of brain tumours from MRI images is a tedious process as each patient has so many images. During MRI scan procedure, a series of MRI images from different angle and plane will be taken and stored. Since the result has direct impact on patient's life, the accuracy of the result should be fast and high. The fast and successful detection of brain tumour will help the patients to get a better treatment in the form of surgery, radiation or chemo therapy. In this research, Brain tumor segmentation from MRI images is done in a GUI which was developed in MATLAB. The GUI with different image loading menu is shown in Figure 2. A series of files can be uploaded into GUI for further processing. Initial input images are taken and the unwanted text portion, noise and brightness balancing were done in pre-processing step.

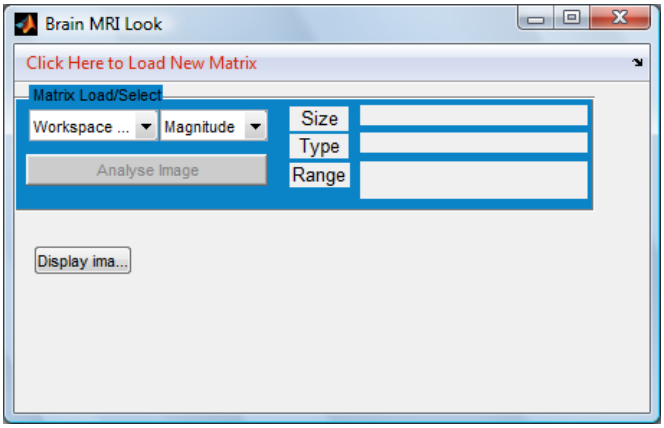



**Figure 2:** Brain MRI GUI

The input image can be accepted in DICOM, JPEG, NifTI and matrix format. The images which are loaded into the work space are also available for processing. For reading DICOM images special software is required. Loading of each MRI images one after another in this software is a tedious task. Matlab allows reading and storing of DICOM images in different formats. Loading the images in original DICOM format and matrix format is possible in this GUI. Images in DICOM format require more space. But if these images are converted into matrix and stored it for further processing will save the space requirement. Time for accessing matrix files are faster when compared with other file formats. This GUI is capable of converting DICOM images from. DCM format to matrix files as well. Hence the time for various processes and space requirement for storing the images reduces drastically. The size of the image with X and Y coordinate is also displayed. The cursor movement and the location or region of interest marking is possible for the image. If the images are available only in matrix format and not in image format, then also this GUI is able to perform various perform.

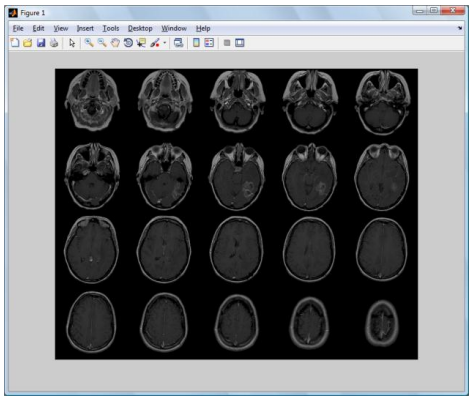


**Figure 3:** Patient data set view

The GUI is useful to read the entire set of images of a particular patient. There were twenty MRI images for a patient. A series of images available for this patient is read and displayed in a single window in Matlab as shown in Figure 3

Patient-1 has 20 different brain MRI. The dicomread() and dicomwrite() functions are available in MATLAB for reading and writing the DICOM images. Each image is read and stored in a matrix of size 256 x 256. Storing MRI images in the matrix format reduces the storage requirement. The matrix contains all the in formations of one particular patient and is able to load into the workstation whenever required. These matrices are used in information retrieval stages. Various MRI inputs with basic information is displayed in Figure 4.

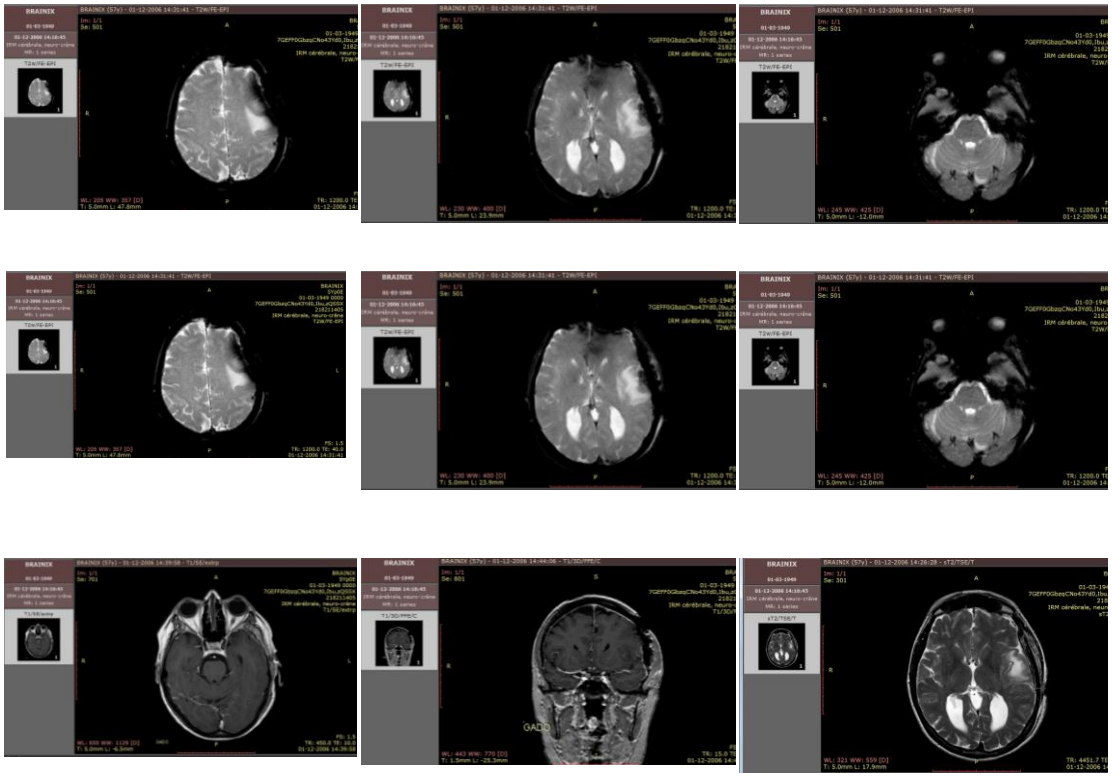


**Figure 4:** Input MRI images with different plane views

MRI images can be viewed as sagittal, axial or coronal. The different view of same MRI image in the same scene is useful for appropriate visualization and diagnosis.

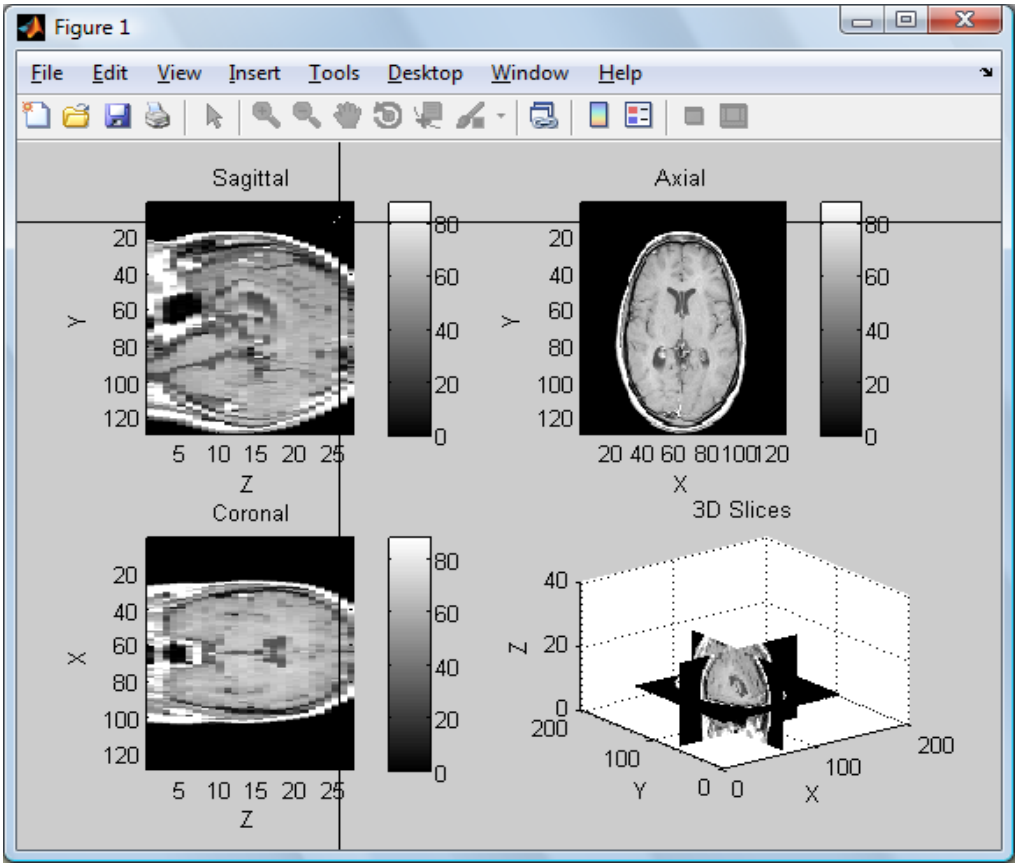
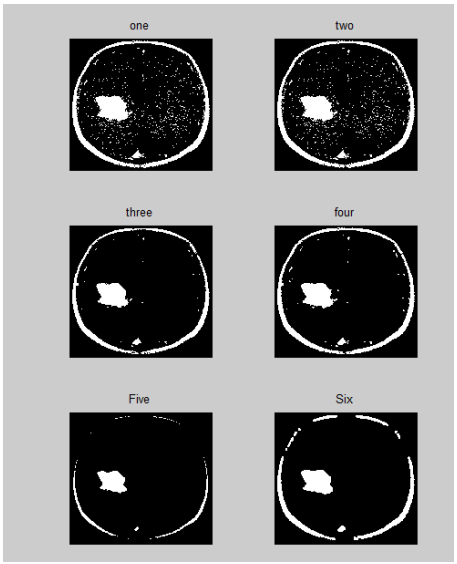



**Figure 5 :** Sagittal, axial or coronal view of MRI image

The slice cut of whole brain is also possible in this. By adjusting the X, Y and Z co-ordinate values, the slice and planes are adjustable like Figure5. Different plane and axial view of the image help the medical practitioner to serve in a better manner. The analysis time is reduced drastically when compared with manual system. In manual system, the medical practitioners will be taking each image separately and check for anomalies.

The SVM with RBF kernels were used for the segmentation of the pre-processed image. There is total of 242 patient images which were tested by this method. A step by step image segmentation process is shown in Figure 6. The segmentation is done to identify the tumor portions. After identifying the affected porting, it is segmented and extracted out. This is a step by step process. In sixth step the tumor portion is segmented out and displayed.



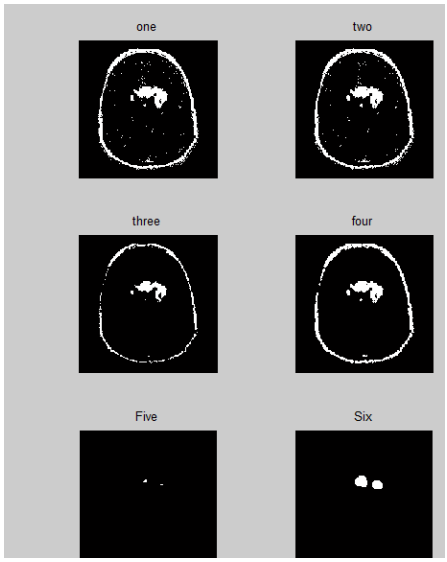




**Figure 6:** Tumor localization for Patient-1 Tumor localization for Patient-2

Figure 8 is the output screen for tumor extraction. The tumor is segmented and the tumor location is displayed with tumor area. Column one show the extracted tumor. Original image with filtered image and segmented out result is available in GUI. This provides a detailed analysis of tumor portion. The extracted portions are the region of interest for medical practitioners. The doctors can suggest for further treatment procedures. SVM is applied to the input image. The region of interest is marked separately. When the number of iterations increases the accuracy of ROI selection is also increased. ROI selection in different iterations are given in Figure 7.

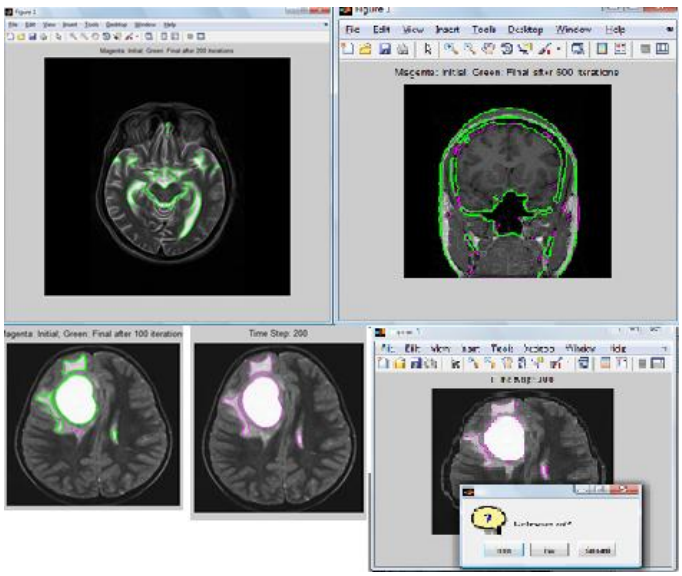


**Figure 7:** ROI identification in different iterations.

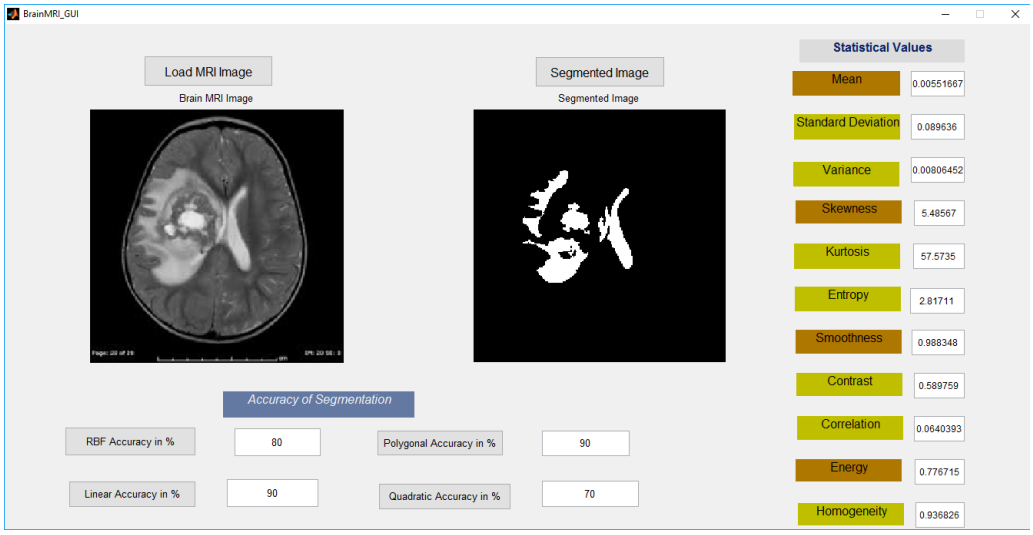
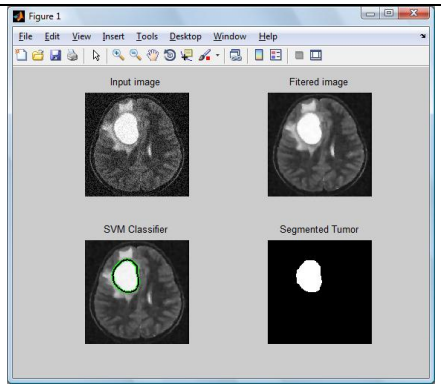
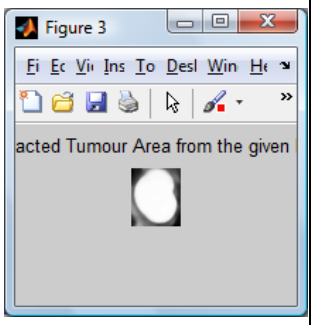
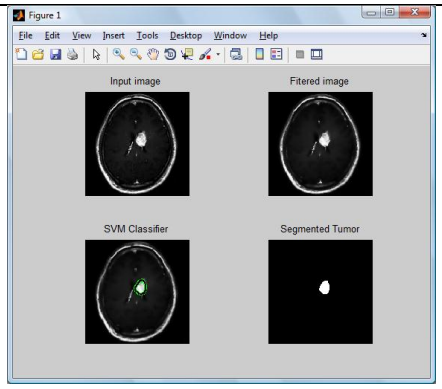
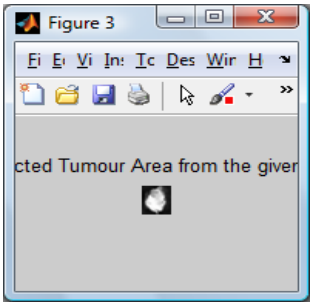



**Figure 8:** Tumor identification using RBF, Polynomial, Linear and Quadratic support vector machines are tested and the accuracy is listed.

The segmented brain tumor area from the given MRI is extracted shown separately. This gives an in-depth knowledge of the MRI to the medical practitioner. In figure 9 three different brain MRI is taken and tumor area is marked and segmented out.

| | | |
|---|---|---|
| Patient 1 MRI image<br>segmentation |  | Extracted Tumor Area<br>  |
| Patient 2 MRI image<br>segmentation |  |  |

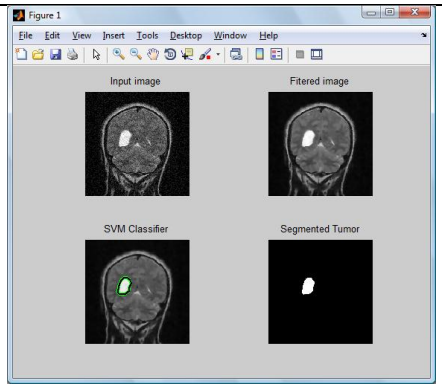
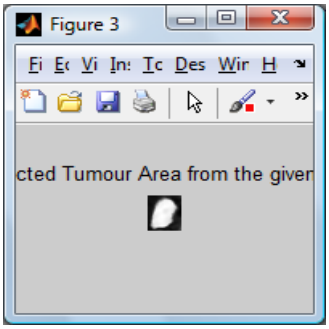
| | | |
|---|---|---|
| Patient 3 MRI image<br>segmentation |  |  |

**Figure 9 :** Tumor Extraction for different patients

The accuracy of the proposed system was tested with confusion matrix. A confusion matrix gives the visualization of number of correct and incorrect predictions made by the model compared with the actual classifications in the test data. The Dice Similarity Coefficients (DSC) is used to check the statistical validation of the data. The experience and expertise in the field help the medical practitioners to evaluate and conclude with a result. But the automated system with their experience will reduce the time of action for a particular patient. The medical practitioners are able to perform the same task in less time with an accurate result.

## CONCLUSION

Medical imaging is a field, where extensively research is happening in order to create or simulate human related and anatomically important images to identify, study or to retrieve potential information for the betterment of mankind. In this research work an approach to identify and locate the brain tumour was implemented on real time brain MRI dataset. Tumour detection from the images was done with an accuracy of 90.07%.

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