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Recognition of Tumors and Blood Clots in Human Cerebrum

R. Raja Sudharsan[1], C. Jasline Nivetha[2], O.S. Ashwini Seshma[3]

[1] Assistant Professor of Electronics and Communication Engineering
[2], [3] Department of Electronics and Communication Engineering
K.L.N. College of Information Technology, Sivagangai

***Abstract*---One of the challenging tasks in the medical field is brain tumor classification which involves the extraction of tumor regions from images. Generally, this task is being done manually by medical experts which is not always obvious due to the similarity between tumor and normal tissues and the high diversity in tumors' appearance. Thus, automating medical image segmentation remains a real challenge. In this paper, we will focus on clustering of Magnetic Resonance brain Images (MRI) by use of *k*-Nearest Neighbors algorithm. Our idea is to consider this problem as a classification problem where the aim is to distinguish between normal and abnormal pixels on the basis of several features, namely intensities and texture. More precisely, we propose to use Support Vector Machine (SVM) which is popular and well motivating classification methods. The experimental study will be carried on Gliomas dataset representing different tumor shapes, locations, sizes and image intensities and also to detect blood clots in the human brain.**

Keywords: **Support Vector Machine (SVM), Brain tumor, Brain tumor Segmentation, Gliomas, Magnetic Resonance Imaging**

I. INTRODUCTION

Tumor is a deathly disease. According to certain surveys there was an estimate that around 14.1 million cancer cases were reported in the world in 2012, out of which 7.4 million cases were in men and 6.7 million in women. This number is expected to increase to 24 million by 2035. Among different cancers brain tumor is most aggressive. The average survival rate of brain tumor is only 34.4%.The prognosis and early cure of brain tumor depends on the early detection and treatment. For early detection and effective treatment of the brain tumor a precise and reliable method for tumor detection is needed. So, in this paper we use an automatic segmentation method. In this method we use Convolutional Neural Network and Support Vector Machine for the segmentation and classification of tumors.

Tumors can be benign or malignant, can occur in different parts of the brain, and may be primary or secondary. A primary brain tumor is one that has started in the brain, as opposed to a metastatic tumor, which is something that has spread to the brain from another part of the body. The incidence of metastatic tumors is more prevalent than primary tumors by 4:1 ratio. Tumors may or may not be symptomatic: some tumors are discovered because the patient has symptoms, others show up incidentally on an imaging scan, or at an autopsy. A glioma is a type of tumor that starts in the brain or spine. It is called a glioma because it arises from glial cells. The most common site of gliomas is the brain. Gliomas make up about 30% of all brain tumors and central nervous system tumors and 80% of all malignant brain tumors.

The most common primary brain tumor is meningioma with 34%, however glioma, a broad term including tumors arising from the gluey or supportive tissue of the brain (30% of all brain tumors), represents 80% of malignant tumors making it the most common primary brain tumor causing death. The most common and aggressive glioma is glioblastoma multiform (GBM) representing 54% of all gliomas. This type of tumor is accompanied by rapid infiltrative growth and very poor prognosis with one year average survival time after diagnosis. The survival time is affected by extensive treatment such as chemo- and radiotherapy and surgical resection. This work is particularly focused on the automatic processing of volumes with the most common malignant tumor - glioma - in low and high grades.

In common clinical routines, the evaluation of acquired images is currently performed manually based on quantitative criteria or measures such as the largest visible diameter in axial slice. Therefore, highly accurate methods being able to automatically analyze scans of brain tumor would have an enormous potential for diagnosis and therapy planning. However, it was shown that even manual annotation performed by expert raters showed significant variations in areas where intensity gradients between tumorous structures and surrounding tissues are smooth or obscured by bias field artifacts or the partial volume effect. Moreover, brain tumor lesions are only defined by relative intensity changes to healthy tissues, and their shape, size and location are individual for each patient, which makes the use of common pattern recognition algorithms impossible. Due to the increasing number of patients, the number of acquired data increase, too. Therefore, there is an increasing necessity of algorithms that are able to process the data automatically, which is the main motivation for this work.

Image processing methods are becoming increasingly sophisticated and the tendency is to develop as much automation as possible. A common goal of image processing techniques applied to neuroimaging is to improve detection of abnormal brain tissue, including abnormalities that may not be readily

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recognizable by visual analysis alone. The main advantage of digital image processing is its versatility, repeatability, and the preservation of the originality of the data.

This technique proposes an algorithm that groups up the tumerous and non-tumerous tissues separately by use of *k*-Nearest Neighbors algorithm which helps in the identification and classification of different types of tumors and blood clots. This classification is achieved with the help of Support Vector Machine(SVM) Algorithm.

Generalized Brain Tumor Detection System :

The structure of any brain tumor detection system mainly consists of five sections as following:

• *Image Acquisition:* Acquisition of the image is the first step of image processing. Brain MRI images can be acquired from publicly available databases.

• *Image Pre-processing*: In this step, we segment the required image into its constituent regions. The main goal of the image pre-processing is to improve the image data and reduce the effect of noise.

• *Feature Reduction*: Excessive features increases computation times and storage memory. They sometimes make classification more complicated.

• *Classification*: It's the categorization process by which we assign the class level to the data and further test if any new data comes to the assigned class level of data.

• *Accuracy assessment*: By applying different methods/algorithms we can find the accuracy of the different class of data.

II. METHODOLOGY

The figure 1.1 represents the overview of this proposed technique. There are three main stages : Pre-processing, Segmentation and Classification.

Pre-Processing :

Image pre-processing is the name for operations on images at the lowest level of abstraction whose aim is an improvement of the image data that suppresses undesired distortions or enhances some image features important for further processing. It does not increase image information content. Image pre-processing uses the redundancy in images.

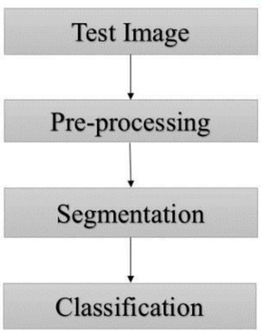

Fig 1.1 : Overview of Proposed Method

In pre-processing , median filtering technique is used. The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pattern of neighbors is called the "window", which slides, pixel by pixel over the entire image 2 pixel, over the entire image.

The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

Median filtering is one kind of smoothing technique, as is linear Gaussian filtering. All smoothing techniques are effective at removing noise in smooth patches or smooth regions of a signal, but adversely affect edges. Often though, at the same time as reducing the noise in a signal, it is important to preserve the edges.

Edges are of critical importance to the visual appearance of images, for example. For small to moderate levels of (Gaussian) noise, the median filter is demonstrably better than Gaussian blur at removing noise whilst preserving edges for a given, fixed window size. However, its performance is not that much better than Gaussian blur for high levels of noise, whereas, for speckle noise and impulsive noise, it is particularly effective. Because of this, median filtering is very widely used in digital image processing.

Clustering :

Clustering is done to differentiate between normal and abnormal in the human cerebrum. *k*-Nearest Neighbors algorithm is used for clustering. The goal of this clustering method is to simply seperate the data based on the assumed similarties between various classes.

k-Nearest Neighbors is one of the most basic yet essential classification algorithms in Machine Learning. It belongs to the supervised learning domain and finds intense application in pattern recognition, data mining and intrusion detection.

It is widely disposable in real-life scenarios since it is non-parametric, meaning, it does not make any underlying assumptions about the distribution of data.

The test sample label is derived from its k-nearest neighbors from the training set in the feature space. The distance may be measured by e.g. Euclidean, Mahalanobis, or Minkowski distance depending on the implementation.

It is difficult to accurately differentiate a partially affected tissue. By use of *k*-Nearest Neighbors it is possible to group the approximate values.

Segmentation :

Image segmentation is the process of partitioning a digital image into multiple segments (set of pixels also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.

Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

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The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as colour, intensity,
or texture. Adjacent regions are significantly different with respect to the same characteristics. In this project image is segmented using support vector machine algorithm.

"Support Vector Machine" (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiate the two classes very well. Support Vectors are simply the co-ordinates of individual observation. Support Vector Machine is a frontier which best segregates the two classes (hyper-plane/ line).

Support Vector Machines are based on the concept of decision planes that define decision boundaries. A decision plane is one that separates between a set of objects having different class Memberships.

Linear SVM is the newest extremely fast machine learning algorithm for solving multiclass classification problems from ultra large data sets that implements an original proprietary version of a cutting plane algorithm for designing a linear support vector machine. Linear SVM is a linearly scalable routine meaning that it creates an SVM model in a CPU time which scales linearly with the size of the training data set. Our comparisons with other known SVM models clearly show its superior performance when high accuracy is required.

Role of Kernel Functions in SVM : To select a proper classification algorithm for image is really a tedious task. The linear SVM classifier takes an input data from feature set and classifies into two possible classes. That's why the nonlinear SVM works in a good way on high dimensional feature sets. To increase the margin of the classification, kernel functions are used. There are many kernels used in support vector machine such as Radial Basis Function (RBF), linear, polynomial etc. Kernel SVM gives the clear understanding of the classification and very easy to use in practical image processing. In this paper some of its methods like RBF, linear, and polygonal are used to find the segmented image. Several features of the data set have been considered like Mean, Standard Deviation, Entropy, RMS, Variance, Smoothness, Kurtosis, Skewness, IDM, Contrast, Correlation, Energy, Homogeneity etc. for the classification methods.

III. EXPERIMENTAL SETUP AND RESULT ANALYSIS

All MRI data was provided by the 2015 MICCAI BraTS Challenge, which consists of approximately 250 high-grade glioma cases and 50 low-grade cases. The MRI of brain is segmented and classified using Support Vector Machine with 4 kernel functions. RBF accuracy, Linear accuracy, Polygonal accuracy, Quadratic accuracy are calculated in the following images.

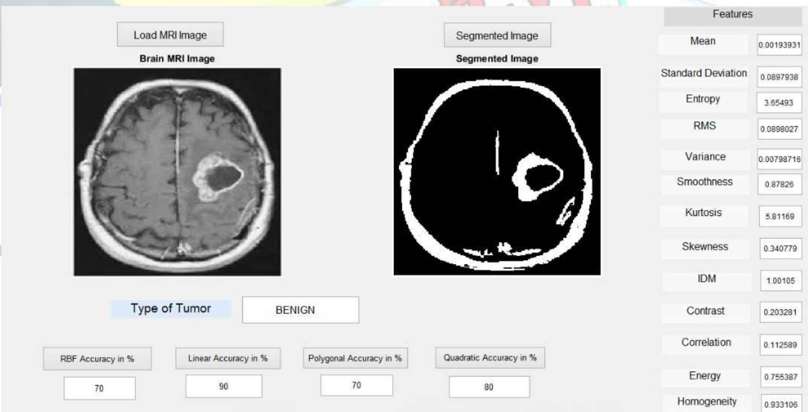

Figure 1.2 : Segmented Image of Benign Data

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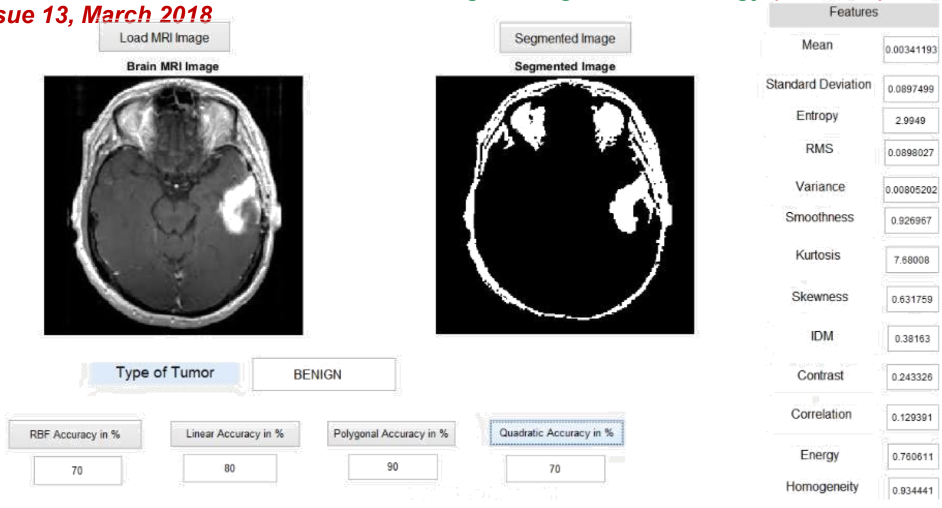

Figure 1.3 : Segmented Image of Benign Data

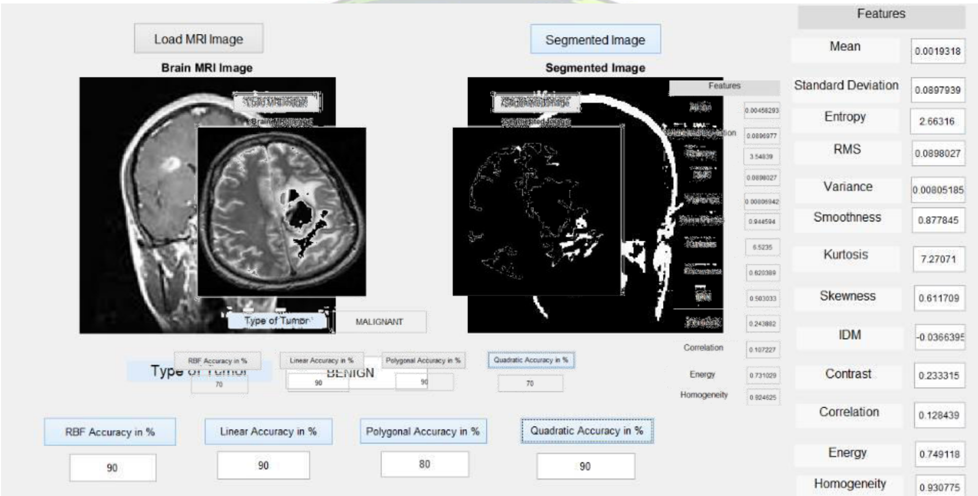

Figure 1.4 : Segmented Image of Benign Data

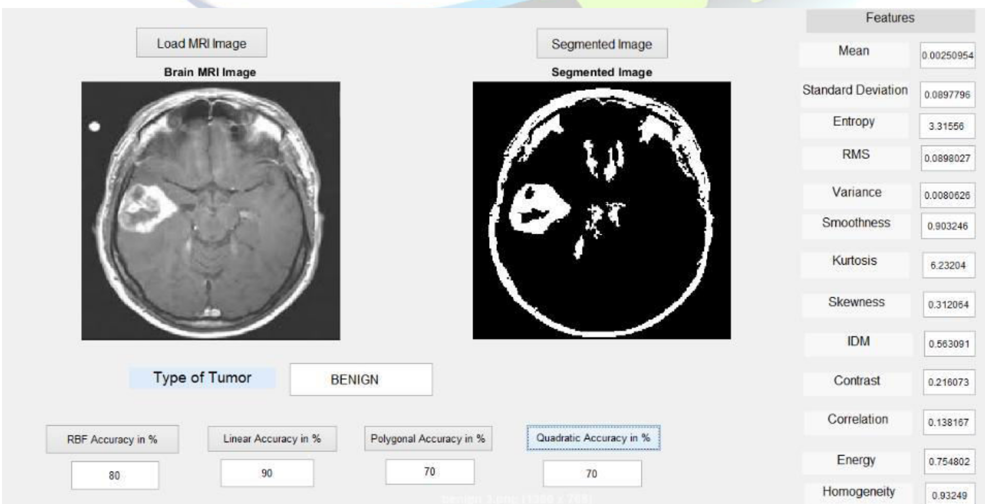

Figure 1.5 : Segmented Image of Benign Data

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Figure 1.6 : Segmented Image of Benign Data

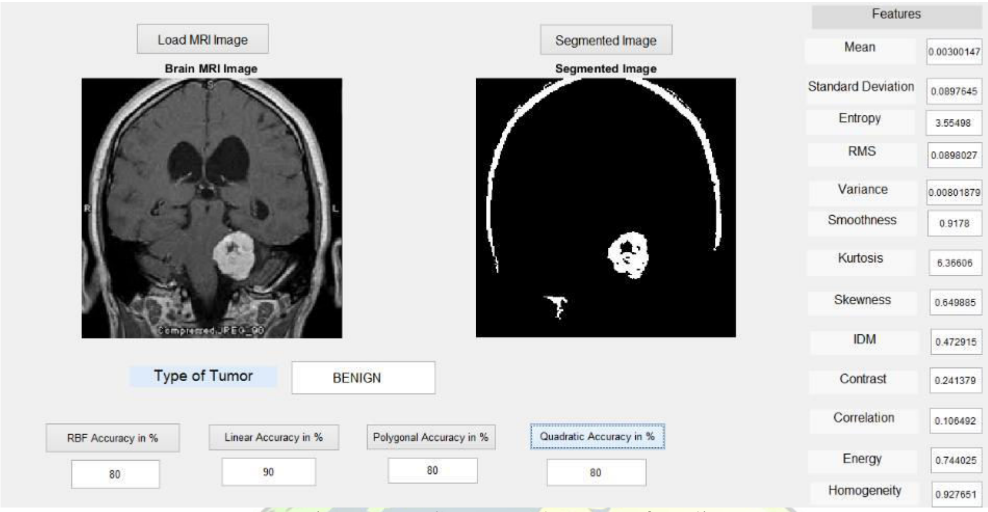

Figure 1.7 : Segmented Image of Malignant Data

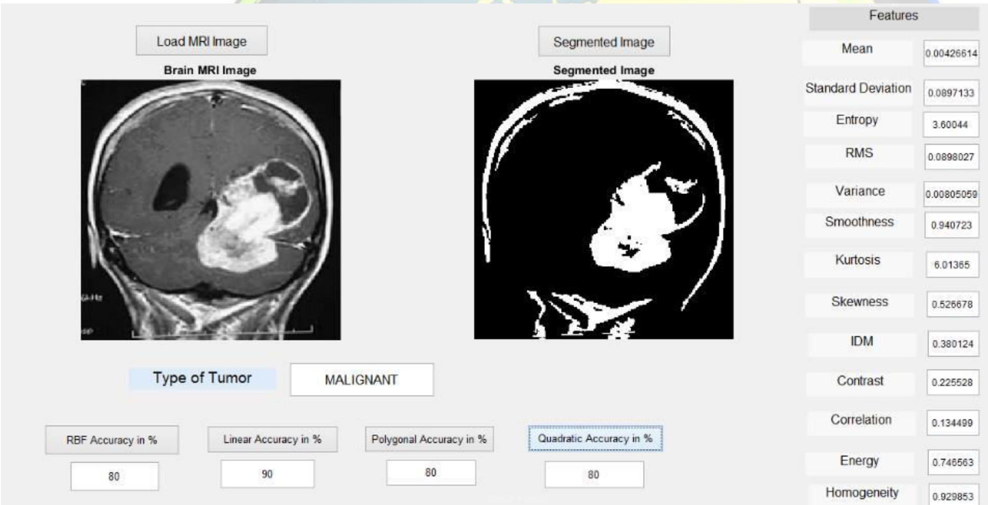

Figure 1.8 : Segmented Image of Malignant Data

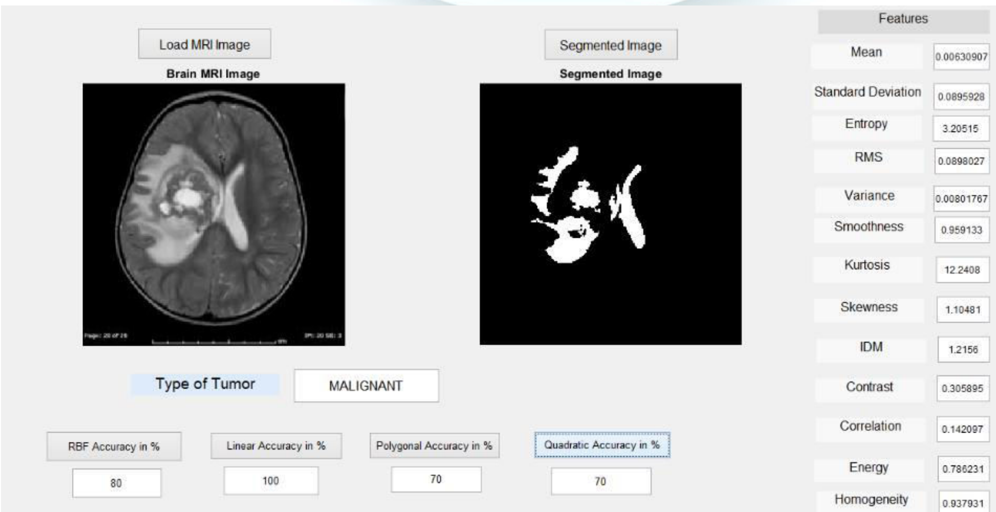

Figure 1.9 : Segmented Image of Malignant Data

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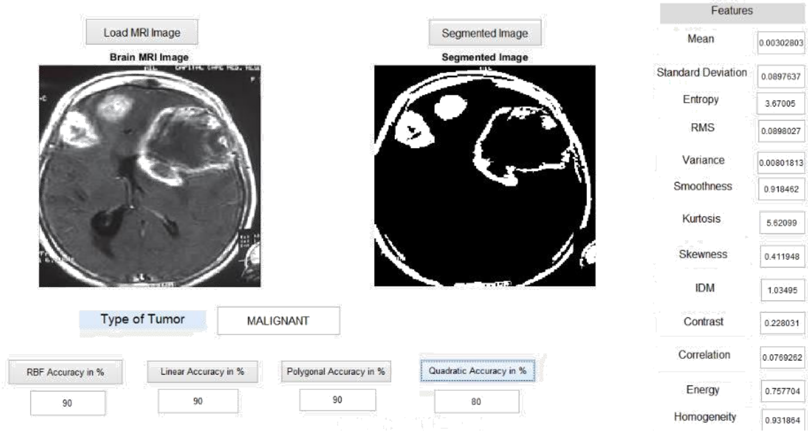

Figure 1.10 : Segmented Image of Malignant Data

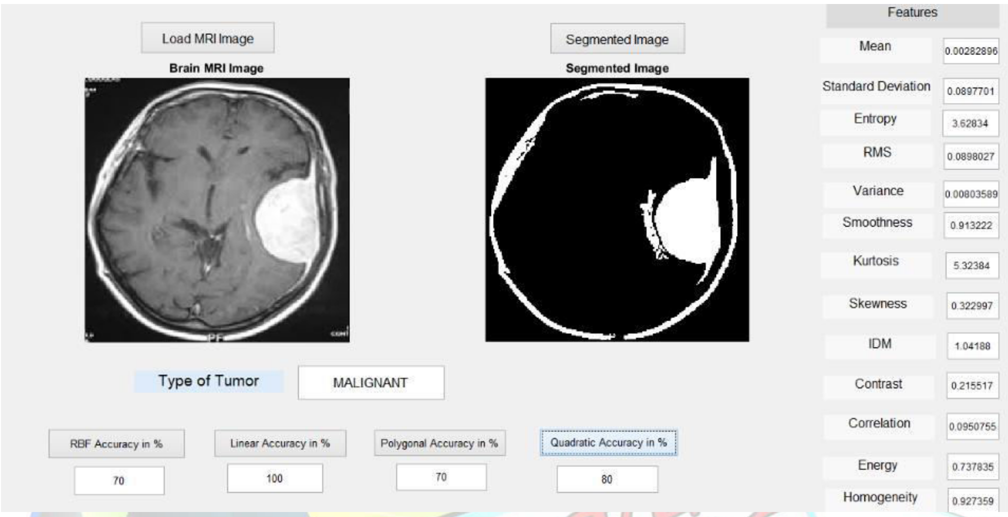

Figure 1.11 : Segmented Image of Malignant Data

IV. CONCLUSION

The MRI of brain is segmented and classified using Support Vector Machine. In particular, we have analysed and compared four of the kernel functions of SVM with a standard brain MRI data. In future we can use others feature reduction method and can compare and find the accuracy. The researcher can also use various hybridized learning algorithms with variety of datasets.

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