

Prediction of Brain Tumor Image Segmentation using MRG and GLCM Algorithms

A.Srinivasa Reddy, P. Chenna Reddy

Abstract: The challenging unusual jobs in medical image processing are Brain tumor removal and its examination. Moreover, segmentation plays vital function in the handling of medical images, where the brain tumor MRI images were gathered and the tumor part is segmented efficiently from the original brain MRI images. In this paper, using our new proposed algorithm i.e. Modified Region Growing (MRG), the performance is evaluated where the whole anticipated method is implemented in the platform of MATLAB and the result analysis is done. Our new algorithm is compared with the existing K-Means and FCM methods using different parameters like PSNR, MSE, and SSIM. The results are shown using the comparison between input images and output images. Next, we can use GLCM (Gray Level Co Occurrence Matrix) for assessing the accuracy of brain tumor images. In this paper, we analyze all these methods in brief and try to understand how these methods will help us to go for better segmentation.

Index Terms: Brain Tumor, Segmentation, MRI, Region Growing, K-Mean, FCM, GLCM.

I. INTRODUCTION

Brain considered to be a complex structure is a kernel part of the body. Nature had wrapped the mind inside a skull that blocks the investigation of its capacity. Brain mainly consists of 3 major parts namely Cerebellum, brain stem and Cerebrum [3,4,5,8]. The Cerebrum is the vital and most foremost piece of the mind situated in the front zone of the skull and comprising of two halves of the globe, left and right, isolated by a split. It is in charge of the combination of complex tactile and neural capacities and the inception and coordination of willful action in the body. Nature has solidly wrapped the cerebrum inside the skull that makes the investigation of its capacity extremely troublesome and it makes the examination of its sicknesses much more perplexing. The Brain tumor is cerebrum illness that can be influenced by the strange development of the cells that progressions its ordinary configuration and conduct.

The cerebellum assumes a critical job in engine control, and it might likewise be associated with some psychological capacities, for example, consideration and language just as in directing anxiety and delight reactions, however its development related capacities are the most emphatically settled [1,8,9].

The cerebellum of human does not start development, yet adds to coordination, exactness, and precise planning: it gets

contribution from tangible frameworks of the spinal string and from different parts of the mind and incorporates these contributions to adjust engine action. Cerebella harm produces issue in fine development, harmony, stance and engine learning in people.

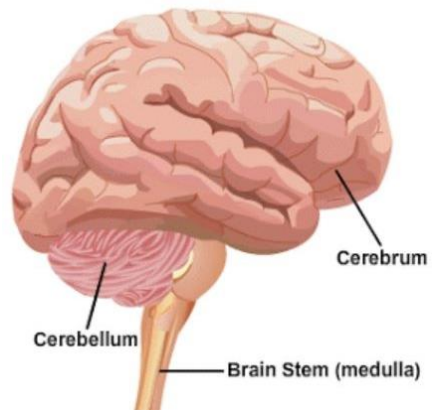


Fig. 1: Brain image

The brain stem gives the fundamental engine and tangible innervations to the face and neck by means of the cranial nerves. Though small, this is an enormously vital part of the brain as the nerve associations of the engine and tangible frameworks from the principle part of the mind to whatever stays of the body experience cerebrum stem. This joins the corticospinal tract (motor), the back segment average lemniscuses pathway (fine touch, vibration, and sensation), and the turn thalamic tract (torment, temperature, tingle, and rough touch). The cerebrum stem additionally assumes an essential job in the control of cardiovascular and respiratory capacity. It likewise controls the focal sensory system and is significant in keeping up cognizance and directing the rest cycle. The brain stem has numerous essential capacities including pulse, breathing, dozing, and eating [7,8].

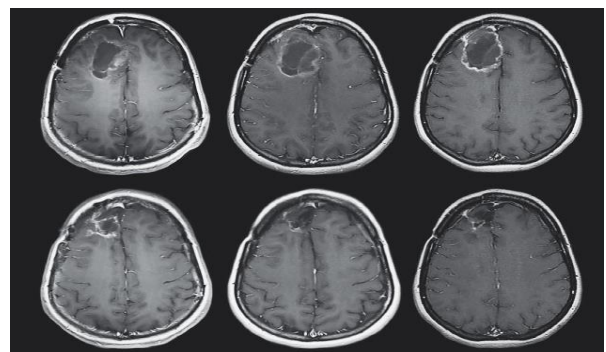


Fig. 2: Brain Tumor images

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Brain tumors can start in your cerebrum (essential Brain tumors), or malignancy can start in different parts of your body and spread to your Brain (optional, or metastatic, cerebrum tumors). The principal objective of cerebrum tumor imaging investigation is to separate the patient unequivocal clinical data and their indicative highlights. This data installed inside the multi-dimensional picture information and consequently aides and screen intercessions after illness identification and causes the master radiologists to cure the infection with a precise conclusion and legitimate drug.

II. IMAGE SEGMENTATION

Segmentation of image is a procedure of separating the original image or picture into noteworthy sub-areas dependent on the properties as intensity, texture and color of the picture. Digital image Segmentation alludes to the isolating the advanced picture into subparts dependent on properties of irregularity and closeness. The picture can be fragmented either by recognizing edges or limits or gathering the pixel utilizing predefined condition [5,6].

Segmenting the Brain Tumor can be done using several methods namely watershed segmentation, level set segmentation, Region Growing and snakes segmentation. In this paper, we mainly focus on Region Growing approach and its modified algorithm for better image segmentation. The mainly used 2 methods are explained below.

A. Watershed Segmentation

Watershed is a change characterized on a grayscale picture. This method separates adjacent drainage basins. The watershed change treats the image it works upon like a topographic guide, with the magnificence of each point talking to its stature, and finds the lines that keep running along the tops of ridges. When we pour water on a flat surface, it is going to divide the surface by making some regions with non-uniform boundaries based water flow direction. There are different technical definitions of a watershed. In graphs, lines of watershed might be characterized on hubs, on edges, or cross breed lines on the two hubs and edges.

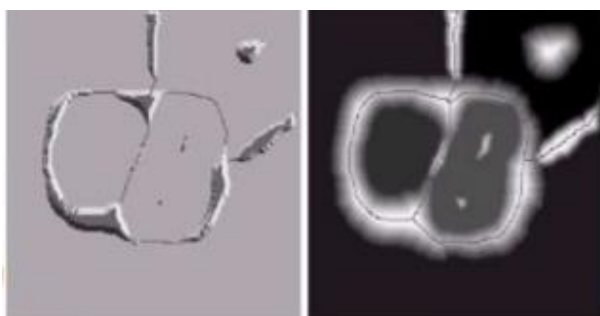


Fig. 3: Watershed segmentation

Watersheds may likewise be characterized in the persistent space and are utilized in picture preparing basically for the division of work and the noticeable one is Meyer's flooding calculation. This calculation chips away at a grayscale picture. In the midst of the dynamic flooding of the diminish regard help, watersheds with close-by catchment bowls are manufactured. This flooding procedure is performed on the

angle picture, for example the bowls ought to develop along the edges. Ordinarily this will prompt an over-division of the picture, particularly for uproarious picture material, e.g. medical CT data. Either the picture must be pre-handled or the areas must be converged based on a similitude basis thereafter.

B. Region Growing

Region growing which is pixel-based picture division technique is a methodology that gathering's pixels or sub-areas into bigger districts dependent on predefined criteria for development. The essential methodology is to begin with a lot of 'seed' focuses and from these develop locales by adding to each seed those adjoining pixels that have predefined properties like the seed, for example, explicit scopes of dark dimension or shading [2,9].

An extensive part of the territory creating methodologies recognize the seed point physically which incorporate human coordinated effort and require before information about the image.

The initial phase in Region developing is to choose a lot of seed points. Seed point determination depends on some client basis. The underlying area starts as the definite area of these seeds. The locales are then developed from these seed focuses to neighboring focuses relying upon an area participation standard. The measure could be, for example, pixel control, grayscale surface, or shading. Since the areas are created dependent on the measure, the image information itself is basic.

The Region growing is similar to Merge sort where we divide the whole data sets into individual ones where a further division is not possible, then we are going to merge them based some Threshold criteria.

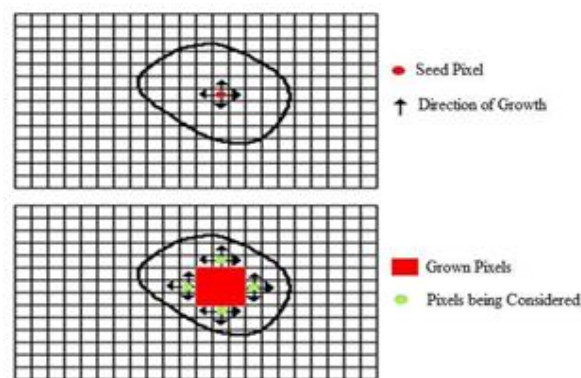


Fig. 4: Region growing segmentation

III. GRAY LEVEL CO-OCCURRENCE MATRIX

GLCM is a statistical process of investigating texture that considers spatial relationship among pixels in images. GLCM essentially used in pattern recognition and determines the variation in intensity at the pixel of intrigue. GLCM surface considers the connection between two pixels at any given moment, called the reference and the neighbor pixel.

GLCM set of highlights can be utilized to mirror the general normal for level of connection between's sets of pixels in various angles as far as homogeneity, consistency, and so forth. One of the principle factors the influences the segregation abilities of GLCM is the division remove between pixels. When you take the separation 1, it prompts mirror the level of relationship between's adjoining pixels (i.e., short range neighborhood network). While, expanding the separation esteem leads to reflect the degree of correlation between distant pixels.

A co-occurrence matrix, also referred to as a co-occurrence distribution is characterized over a picture to be the conveyance of co-happening esteems at a given balance or speaks to the separation and precise spatial relationship over a picture sub-area of explicit size.

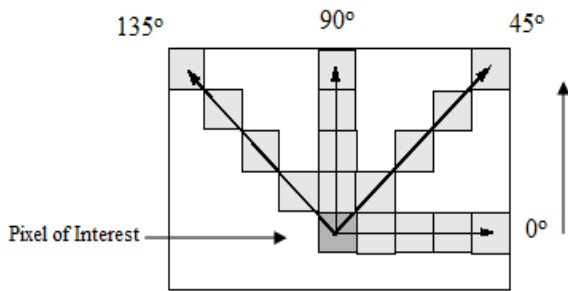


Fig. 5: GLCM pixel of interest

The GLCM is made from a dim scale picture. The GLCM is figures how regularly a pixel with dim dimension (grayscale force or Tone) esteem I happens on a level plane, vertically, or corner to corner to nearby pixels with the esteem j. Where I and j are the dim dimension esteems (tone) in the picture. This is situated in the goals of the picture (for example does the picture have 8 dark tones or 256). GLCM analyses an image in 4 directions which is shown in above figure 1.

A factual methodology sees a picture surface as a quantitative proportion of the plan of powers in an area since regular surfaces are made of examples of sporadic sub-components. The co-event framework catches numerical highlights of a surface utilizing spatial relations of comparable dim tones. Numerical highlights figured from the co-event lattice can be utilized to speak to, analyze, and characterize surfaces. Coming up next are a subset of standard highlights resultant from a standardized co-event grid or co-occurrence matrix:

A. GLCM Feature Set

1. Contrast:

It gauges the neighborhood varieties in the gray dimension co-occurrence matrix.

$$Contrast = \sum_{i=1}^{Ng} \sum_{j=1}^{Ng} n^2 p[i, j], \text{ where } n = |i - j|$$

Where $p[i, j]$ is the $[i, j]$ th entry in a gray-tone spatial reliance matrix, and Ng is the no. of distinct gray-levels in

the quantized image.

2. Correlation:

It gauges the joint likelihood event of the specified pixel pairs.

$$Correlation = \frac{\sum_{i=1}^{Ng} \sum_{j=1}^{Ng} p[i, j](i - \mu_i)(j - \mu_j)}{\sigma_i \sigma_j}$$

$$mean \mu = \frac{1}{n} \sum_{i=1}^n x_i$$

$$Standard \ Deviation \ \sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \mu)^2}$$

3. Energy:

It gives the total of squared components in the GLCM and furthermore gives deliberateness of pixels. It is otherwise called consistency or angular second moment.

$$Energy = \sqrt{\sum_{i,j=1}^n (p[i, j])^2}$$

4. Homogeneity:

It quantifies the closeness of the dispersion of components in the GLCM to the GLCM diagonal.

$$Homogeneity = \sum_{i,j=1}^n \frac{p[i, j]}{1 + |i - j|}$$

5. Entropy:

Entropy is a proportion of picture data content, which is translated as the normal vulnerability or randomness of information source.

$$Entropy = - \sum_{i,j=1}^n p[i, j] * \ln(p[i, j])$$

B. Aid of SVM for Prediction

A Support Vector Machine (SVM) was designed to locate optimal hyperplane which separates classes with insufficient data.



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SVM or Support Vector Machine is a straight model for grouping and relapse issues. The possibility of SVM is straightforward: The calculation makes a line or a hyperplane which isolates the information into classes. As such, given named preparing information (supervised or managed learning), the calculation yields an ideal hyperplane which sorts new precedents.

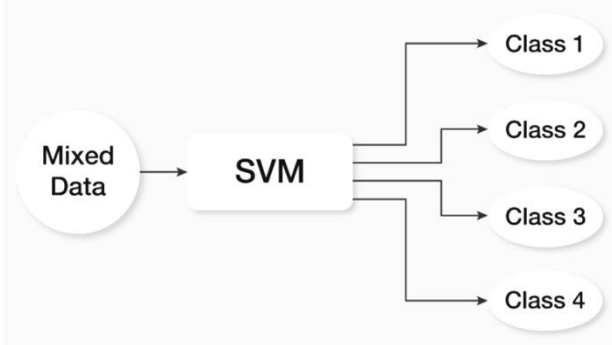


Fig. 6: SVM Architecture

As indicated by the SVM calculation we discover the focuses nearest to the line from both the classes. These focuses are called bolster vectors. Presently, we process the separation between the line and the help vectors. This separation is known as the edge. We will likely expand the edge. The hyperplane for which we got the greatest edge will be the ideal hyperplane. The target of the help vector machine calculation is to discover a hyperplane in a N-dimensional space (N-the number of highlights) that unmistakably arranges the information focuses.

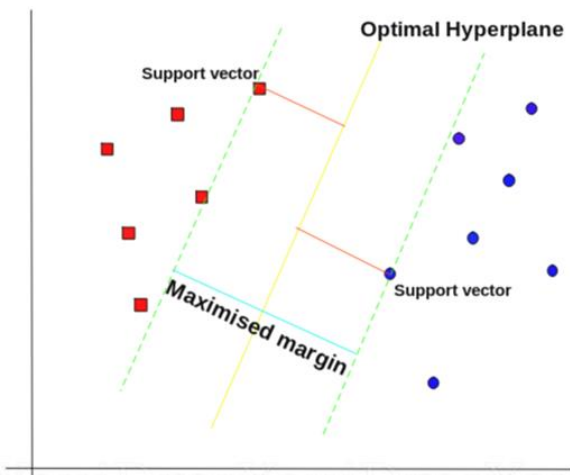


Fig. 7: Data Classification using SVM

For this sort of SVM, preparing includes the minimization of the blunder work:

$$\frac{1}{2} w^T w + C \sum_{i=1}^N \xi_i$$

Subject to conditions:

$$y_i(w^T \phi(x_i) + b) \geq 1 - \xi_i \text{ and } \xi_i \geq 0, i = 1, 2, \dots, N$$

Where C is the limit consistent, w is the vector of

coefficients, b is a steady, and speaks to parameters for dealing with nonseparable information (inputs). The record I name the N preparing cases.

IV. PROPOSED METHODOLOGY

Segmenting the Brain Tumor can be done using several methods namely Region Growing method, Watershed segmentation, Level set segmentation and Snakes segmentation.

In this paper, we mainly focus on Region Growing approach and its modified algorithm for better image segmentation which helps the radiologists to identify exact tumor portions and thus providing better medication. In our proposed method an inventive system for the division and forecast of tumor parcel inside the MRI pictures is presented. At first, the MRI pictures accumulated from the database were changed into HSV shading space. At that point, the sole choice of V channel is done, as the V channel relates to the shine/power data of a picture. After the subjecting of the pictures to pre-preparing evacuates the loud substance inside the pictures and for the division of the tumor parcel, the skull part of the MRI brain images was expelled. Further, the tumor bit of the picture is divided utilizing Modified Region Growing technique [2,8,9].

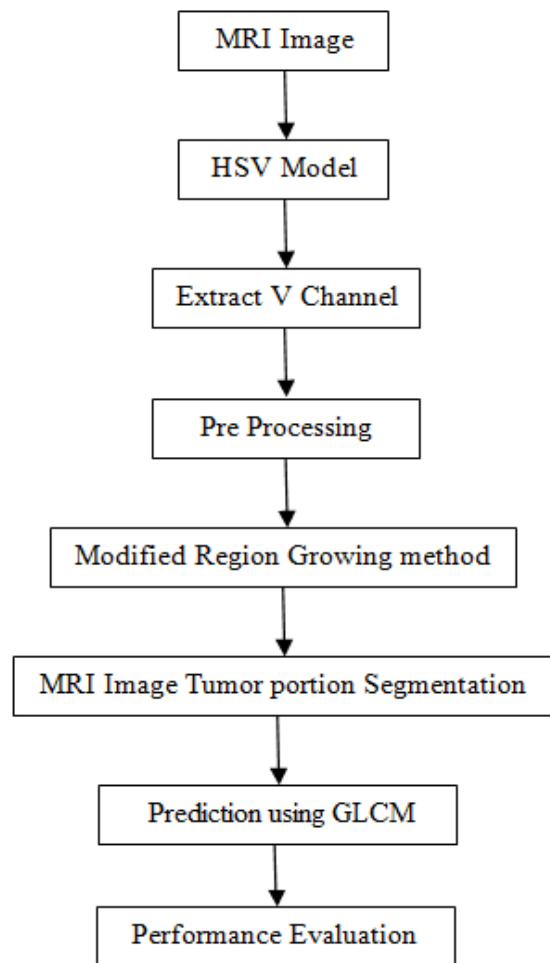


Fig. 8: Flow chart of proposed method



Brain well thought-out to be a complex organization and it is an essential part of the body. The Brain tumor is brain sickness that can be influenced by the irregular development of the cells that changes its typical structure and conduct. A mind tumor happens when unordinary cells shape inside the cerebrum.

A. RGB to HSV Conversion

The input RGB picture change is done to the HSV shading space. The RGB display incorporates the three essential shading segments i.e. Red, Green, and Blue. The components of the HSV shading space incorporate the Hue, Saturation, and Value (intensity). Here, every component is disconnected from each other. Consequently, the HSV shading space is favored more in picture preparing than the RGB shading model. The components of HSV are clarified in the accompanying areas. The main objective of RGB to HSV conversion corresponds to Grey and White maters of the brain.

Hue refers to the likeness of pure color. Saturation describes the whiteness of the color. The Value which is also known as lightness or intensity describes how the dark the color is. We are going to extract V value from HSV components.

B. Pre Processing

In this step, we are going to remove the noisy content from the input images using the median filter which is frequently used one.

The Median Filter is a nonlinear advanced separating strategy, normally used to remove issue from an image or banner. Such noise diminishment is a typical pre-preparing venture to enhance the aftereffects of later handling (for instance, edge recognition on a picture). Median filtering is all around extensively utilized in computerized picture preparing on the grounds that under certain condition, it jam edges while evacuating clamor or noise.

C. MRG Method

The Region growing is a segmentation method, where the seed point is initially set. A region is grown around the seed point from the neighbor pixels based on the intensity constraints. For this purpose, a threshold value will be predefined. Moreover, the region is grown around the seed point from the neighbor pixels satisfying the threshold. But the normal region growing method that utilizes the intensity constraint has some disadvantages.

- Due to noise addition or any variation of intensity values may result in over segmentation or holes.
- The shading of the real image is difficult to decide.
- Moreover, it is difficult to distinguish the shading of actual images.

The modified region growing is similar to normal region growing method with the only difference being, an additional constraint called “orientation”. This method which is taken in the modified region growing, two thresholds were to be set and the region growing is to be made with the neighbor pixels satisfying both the constraints.

The major steps in Modified Region growing (MRG) are affirmed as below.

1. Grid splitting
2. Seed point choice
3. Region Growing

Step 1: Grid Splitting

In this progression, the input picture is changed over into various lattices by drawing an imaginary line of correspondent space and the imaginary lines were drawn on a level plane and vertically finished the picture. The frameworks are shaped to make precise estimations. In view of the necessity, a number of matrices can be made. The quantity of matrices regularly made incorporates 4, 18 and 24 frameworks. Here, the 3x3 frameworks were made for investigation and each piece is dealt with independently.

Step 2: Seed Point choice

After the process of grid splitting, a seed point is selected initially for each block of the grids. The selection of seed point is based on the histogram analysis. The probabilistic selection of reoccurring histogram values is more probable to be selected as the seed points.

Step 3: Region Growing

The process of region growing is performed by growing up in the cluster by taking the neighborhood pixels around the selected seed point.

MRG Algorithm:

1. Begin
2. Calculate the gradient value at x and y axes
3. Determine angle vector by coordinating the slopes at the two axes. The slope vector is resolved through the accompanying condition as,

$$G(x, y) = \frac{1}{1 + (I_x^2 + I_y^2)}$$
4. Change the gradient vector $G(x, y)$ in radians to degrees.
5. Constructing $gr(i)$ grids by splitting the input pre-processed image.
6. Set orientation and intensity thresholds as T_0 and T_1 respectively.
7. For each grid $gr(i)$,
 - a. Calculate Histogram for each pixel within the grid $gr(i)$
 - b. Calculate the frequently occurring histogram $f(H)$

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- c. Select any of the frequently occurring histogram $f(H)$ as seed point with intensity $f_{(i)}$ and orientation $f_{(o)}$
 - d. Check conditions
 - Condition 1: Orientation

$$\|f_{(o)} - Neigh_{(o)}\| \leq T_o$$
 - Condition 2: Intensity

$$\|f_{(i)} - Neigh_{(i)}\| \leq T_i$$
 - e. If the adjacent pixel with orientation $Neigh_{(o)}$ and intensity $Neigh_{(i)}$ satisfies both conditions, Then consider that adjacent pixel for inclusion.
 - f. Region has to be grown towards the neighbor pixel
8. End

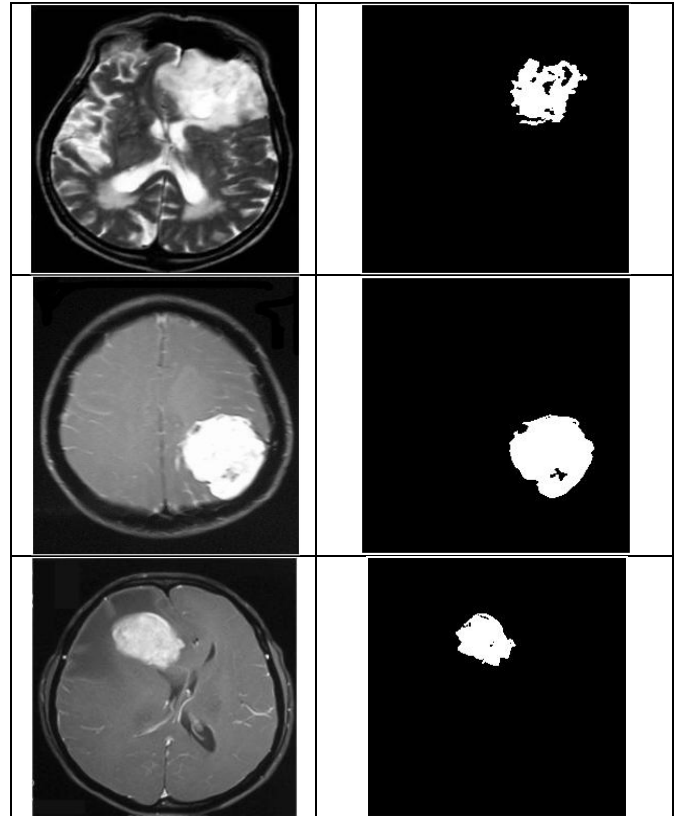
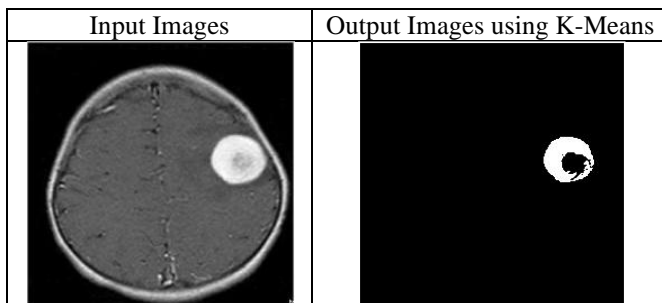
V. RESULTS AND DISCUSSION

The proposed method is implemented in MATLAB. After the original brain MRI images are taken, brain tumor MRI images are collected and the tumor part is segmented efficiently from the obtained original brain MRI images. These MRI images are modified into RGB color MRI images. This is then converted to HSV color space followed by a pre-processing process. Pre-processing process helps to remove the noisy contents after the removal of the skull portion of the image. With the help of Modified Region Growing technique, the tumor part is segmented.

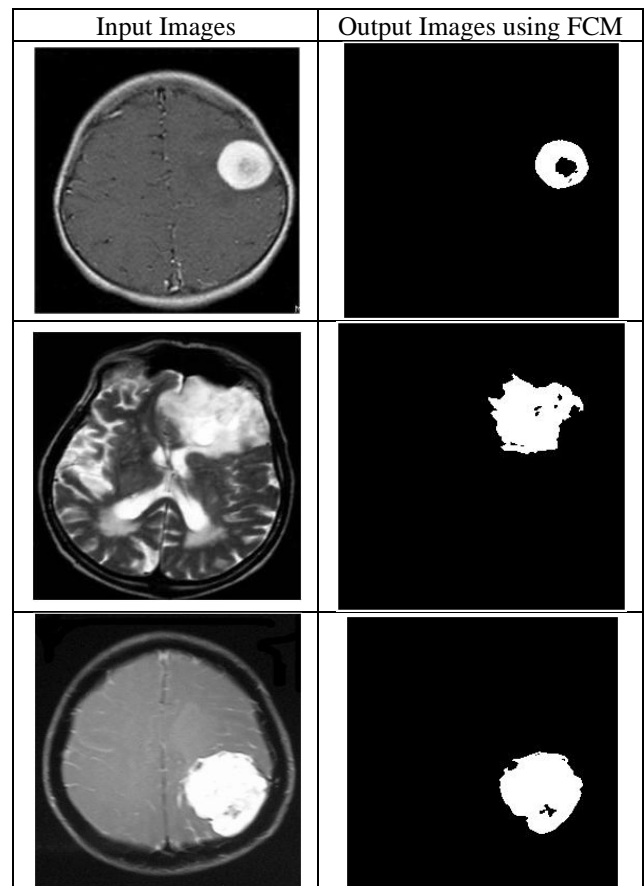
In this article, we anticipated new algorithm which is based on normal region growing approach and this method is compared with existing K-means and FCM algorithms and different parameters are tested using for these three methods using MATLAB and Results are displayed. Clearly, our new method is better than the existing methods.

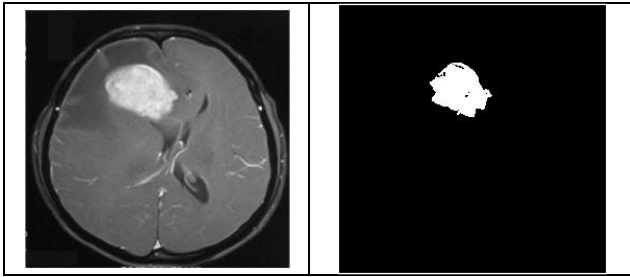
At next level, we had applied the GLCM and SVM techniques to predict the tumor level in the brain.

A. Output using K-Means



B. Output using FCM





C. Output using Modified Region Growing

Input Images	Output Images using MRG

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