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Comparative Analysis of Segmentation Algorithms for Brain Tumor Detection in MR Images

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Abstract- Tumors can occur in any parts of the body. A brain tumor can be considered as one of the genuine and hazardous tumors. It is really made either by the strange and uncontrolled cell division inside the brain or from diseases essentially display in different parts of the body. By and large, tumors are characterized in light of the area of their cause and its threat. We proposed to set up a no holds barred examination of three brain tumor division procedures. We are displaying correlation of district developing, split and union and K-Means cerebrum tumor division methods. From our research work we concluded that region growing stands to be best technique for brain tumor segmentation on the basis of parameters derived. The parameters derived are Area, Region of Interest mean color (ROImean), Rest mean color (Restmean), Region of Interest Standard Deviation (ROIstD), Rest Standard Deviation (ReststD), Region of Interest Peak to Mean Ratio (ROIPMR), Rest Peak to Mean Ratio (RestPMR), Convex Area (ConArea), and Aspect Ratio (AsRatio).

Keywords- *Brain Tumor Segmentation, Region Growing, Split & Merge, K-means.*

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I. INTRODUCTION

Digital Image Processing:

Digital Image Processing is the utilization of PC calculations to perform image handling on computerized images. As a subcategory or field of advanced flag handling, computerized image preparing has many points of interest over simple image handling. It permits a considerably more extensive scope of calculations to be connected to the info information and can evade issues, for example, the development of commotion and flag twisting amid handling. Since images are characterized more than two measurements (maybe more) computerized image handling might be displayed as multidimensional frameworks.

Applications of Digital Image Processing:

Some of the major fields in which digital image processing is widely used are mentioned below:

- Image sharpening and restoration
- Medical field
- Remote sensing
- Transmission and encoding
- Machine/Robot vision
- Color processing
- Pattern Recognition
- Video processing
- Microscopic Imaging
- Others

Tumor:

The word tumor is an equivalent word for a word neoplasm which is framed by an anomalous development of cells. The tumor is something very surprising from malignancy. A cerebrum tumor is an unusual development of the cells inside the brain, which can be harmful or not malignant. It is for the most part caused by strange and uncontrolled cell division. Cerebrum tumors are of two sorts: essential and auxiliary. Essential brain tumor incorporates any tumor that begins in the cerebrum [13].

Essential brain tumors are delegated favorable, premalignant and threatening.

A) Benign tumor:

Benign tumors can be evacuated and the from time to time become back. Considerate tumors more often than not have an outskirt or an edge. They don't spread to different parts of the body

B) Pre-Malignant tumor:

Premalignant Tumor is a precancerous stage, considered as an infection, if not legitimately treated it might prompt growth.

C) Malignant tumor:

Malignant brain tumors are for the most part more genuine and frequently are a risk to life. They develop quickly in the group and attack the adjacent solid tissue. Growth cells may split far from a harmful cerebrum tumor and spread to alternate parts of the brain or to the spinal line yet it infrequently spread to different parts of the body. Any cerebrum tumor is naturally genuine and perilous due to its intrusive and infiltrative character in the restricted space of the intracranial depression. Be that as it may, its danger level relies upon the blend of variables like the sort of tumor, its area, its size and its condition of advancement. Since the brain is all around ensured by the skull, the early discovery of a cerebrum tumor happens just when indicative apparatuses are coordinated at the intracranial cavity. For the most part, discovery happens in cutting edge stages when the nearness of the tumor has caused unexplained side effects. Attractive reverberation imaging (MRI) is a medicinal imaging method utilized as a part of radiology to explore the life systems and physiology of the body in both wellbeing and infection. X-ray scanners utilize attractive fields and radio waves to shape

 ISSN: 2454-4248
093 – 100

images of the body. The system is generally utilized as a part of doctor's facilities for therapeutic finding, organizing of sickness and for follow-up without presentation to ionizing radiation. X-ray has an extensive variety of uses in therapeutic conclusion and more than 25,000 scanners are evaluated to be being used around the world. X-ray affects conclusion and treatment in numerous claims to fame in spite of the fact that the impact on enhanced wellbeing results is questionable. Since MRI does not utilize any ionizing radiation, its utilization is for the most part supported in inclination to CT when either methodology could yield a similar data. X-ray is, by and large, a protected procedure however the quantity of episodes causing quiet mischief has risen. Contraindications to MRI incorporate most cochlear inserts and heart pacemakers, shrapnel and metallic remote bodies in the circles [13].

Brain Tumor:

A brain tumor is characterized as unusual development of cells inside the brain or focal spinal waterway. A few tumors can be destructive along these lines they should be distinguished and cured in time. The correct reason for brain tumors is not clear nor is correct arrangement of manifestations characterized, in this way, individuals might be experiencing it without understanding the peril. Essential brain tumors can be either dangerous (contain disease cells) or amiable (don't contain growth cells) [9].

Brain tumor happened when the cells were separating and developing anomalous. It seems, by all accounts, to be a strong mass when it determined to have symptomatic medicinal imaging strategies. There are two sorts of brain tumor which are an essential cerebrum tumor and metastatic brain tumor. An essential cerebrum tumor is a condition when the tumor is shaped in the brain and tended to remain there while the metastatic brain tumor is the tumor that is framed somewhere else in the body and spread to the brain [8].

The side effect has a brain tumor relies upon the area, size, and sort of the tumor. It happens when the tumor compacting the encompassing cells and gives out weight. Moreover, it additionally happens when the tumor obstructs the liquid that streams all through the cerebrum. The regular indications are having migraine, queasiness, and regurgitating, and having an issue with adjusting and strolling. A cerebrum tumor can be identified by the analytic imaging modalities, for example, CT sweep and MRI. Both of the modalities have favorable circumstances in identifying relying upon the area sort and the motivation behind examination required. In this paper, we want to utilize the CT images since it is anything but difficult to inspect and gives out exact calcification and outside mass area [8].

The CT image procured from the CT machine give two measurement cross sectional of the cerebrum. In any case, the image obtained did not remove the tumor from the image. Accordingly, the image preparing is expected to decide the seriousness of the tumor relies upon the size [8].

The explanations behind choosing CT images upon MRI images are as per the following:

1. CT is considerably quicker than MRI, settling on it the investigation of decision in instances of injury and other intense neurological crises. CT can be gotten at impressively less cost than MRI.
2. CT can be gotten at impressively less cost than MRI.
3. CT is less delicate to understanding movement amid the examination.
4. The imaging can be performed considerably more quickly, so CT might be less demanding to perform in claustrophobic or overwhelming patients.
5. CT can be performed at no hazard to the patient with implantable therapeutic gadgets, for example, heart pacemakers, ferromagnetic vascular clasps, and nerve stimulators.

The concentration of this venture is CT cerebrum images' tumor extraction and its portrayal in a less difficult frame to such an extent that it is reasonable by everybody. People have a tendency to comprehend shaded images superior to anything highly contrasting images, in this manner, we are utilizing hues to make the portrayal less sufficiently difficult to be comprehended by the patient alongside the therapeutic staff. Shape plot and c-name of the tumor and its limit are customized to give 3D representation from the 2D image utilizing distinctive hues for various levels of force. An easy to understand GUI is likewise made which causes therapeutic staff to accomplish the above target without getting into the code.

Region Growing:

Region growing [10] is a method for separating an area of the image that is associated in view of some predefined criteria. This standard in view of force data. Area developing is a way to deal with image division in which neighboring pixels are analyzed and added to a locale class of no edges are recognized. This procedure is iterated for every limit pixel in the district. On the off chance that adjoining areas are discovered, a district blending calculation is utilized as a part of which frail edges are disintegrated and solid edges are left in place.

Another area developing calculation is proposed in this paper in light of the vector point shading closeness measure. The area developing calculation as-

1. Select seed pixels inside the image
2. From each seed pixel grows area:
   - 2.1 Set the locale model to be seed pixel;
   - 2.2 Calculate the likeness between the locale model and the competitor pixel;
   - 2.3 Calculate the likeness between the competitor and its closest neighbor in the district;
   - 2.4 Include the hopeful pixel if both similitude measures are higher than analyze every set limit;
   - 2.5 Update the locale model by computing the new main segment;
   - 2.6 Go to the following pixel to be analyzed.

This algorithm introduces a few focal points over other shading image division calculations. Locale developing methodology is basic. The fringe of locales found by area developing is superbly thin and associated. The calculation is likewise extremely stable as for commotion. The constraint is that it requires a seed point, which for the most part implies

 ISSN: 2454-4248
093 – 100

manual association. Accordingly, every district to be fragmented, a seed point is required.

Region Splitting and Merging:
Split and merge technique is the inverse of the district developing. This strategy deals with the entire image. Locale part is a best down approach. It starts with an entire image and partitions it up to such an extent that the isolated parts are more homogenous than the entirety. Consequently, a consolidating stage after the part is constantly attractive, which is named as the part and-union calculation. Any locale can be part into sub districts, and the proper areas can be converged into a district. As opposed to picking seed focuses, the client can separate a image into an arrangement of subjective detached locales and afterward blend the areas [11]-[12] trying to fulfill the states of sensible image division. Locale part and blending are typically actualized with a hypothesis in light of quad tree information.

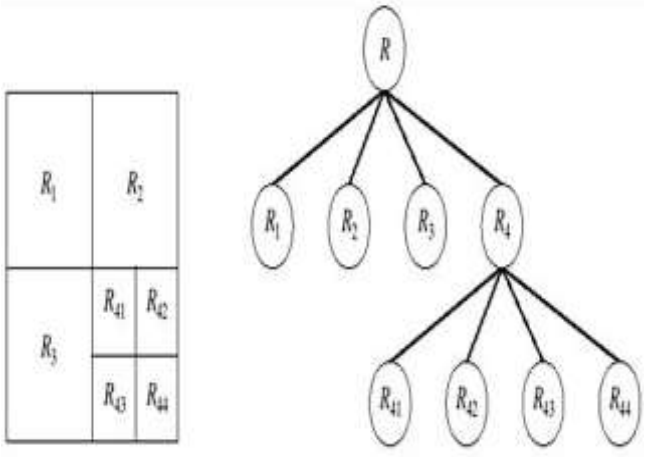

Fig 1: Quad tree

Region splitting and merging are a image division strategy that contemplates spatial data. The locale part and blending technique are as per the following:

Region splitting Method:
1. Let R represent the entire image. Select a predicate P.
2. Split or subdivide the image successively into smaller and smaller quadrant regions.

The splitting technique has a helpful portrayal as a structure called a quad tree appeared in figure 1.10. In a quad tree, the base of the tree compares to the whole image and every hub relates to the subdivision.

Region Merging Method:
Merge any contiguous regions that are sufficiently comparative. The method for split and merge is given.
1. Begin with the entire image.
2. In the event that the difference is too expansive, break it into quadrants.
3. Union any neighboring districts that are sufficiently comparable.
4. Rehash step (2) and (3) iteratively until the point when not any more part or combining happens.

This method requires the info information to be sorted out into a pyramidal matrix structure of areas, with every locale composed in gatherings of four on account of 2D, and of eight on account of 3D.

K-Means Clustering Algorithm:
Clustering is a technique to isolate an arrangement of information into a particular number of gatherings. It's one of the well-known techniques is k-implies grouping. In k-implies bunching, it parcels a gathering of information into a k number gathering of information [14], [15]. It orders a given arrangement of information into k number of disjoint bunch. K-implies calculation comprises of two separate stages. In the principal stage it computes the k centroid and in the second stage, it takes each point to the bunch which has the closest centroid from the separate information point. There are diverse techniques to characterize the separation of the closest centroid and a standout amongst the most utilized strategies is Euclidean separation. Once the gathering is done it recalculate the new centroid of each group and in view of that centroid, another Euclidean separation is ascertained between each middle and every information point and allots the focuses in the bunch which have least Euclidean separation. Each group in the parcel is characterized by its part questions and by its centroid. The centroid for each group is the point to which the entirety of separations from every one of the articles in that bunch is limited. So K-implies is an iterative calculation in which it limits the whole of separations from each protest its bunch centroid, over all groups.

II. LITERATURE REVIEW

Garima Singh et.al in [1] proposed for fruitful distinguishing proof of the brain tumor utilizing standardized histogram and division utilizing K-implies bunching calculation. Effective arrangement of the MRIs is finished utilizing Naïve Bayes Classifier and Support Vector Machine (SVM) in order to give precise forecast and grouping.

Rasel Ahmmed et.al in [2] presented a strong division strategy which is the incorporation of Template based K-implies and altered Fuzzy C-implies (TKFCM) grouping calculation that, diminishes administrators and gear mistake. In this strategy, the layout is chosen in light of convolution between dim level force in a little bit of cerebrum image, and brain tumor image. K-implies calculation is to accentuated beginning division through the best possible determination of a layout. Refreshed enrollment is gotten through separations from bunch centroid to group information indicates until the point that it achieves its best. This Euclidian separation relies on the distinctive components i.e. power, entropy, complexity, disparity and homogeneity of the coarse image, which was depended just on similitude in customary FCM. At that point, on the premise of refreshed enrollment and programmed group determination, a sharp fragmented image is acquired with a red checked tumor from changed FCM procedure. The little deviation of dark level power of ordinary and anomalous tissue is identified through TKFCM. The exhibitions of the TKFCM strategy is investigated through neural system give a superior relapse and slightest mistake. The execution parameters demonstrate significant outcomes which are

 ISSN: 2454-4248
093 – 100

powerful in identifying a tumor in different force based brain MRI image.

J. Vijay et.al in [3] described a productive strategy for programmed cerebrum tumor division for the extraction of tumor tissues from MR images. In this strategy, division is done utilizing K-implies bunching calculation for better execution. This upgrades the tumor limits increasingly and is quick when contrasted with numerous other grouping calculations. The proposed procedure produces grateful outcomes.

Ming-Ni Wu et.al in [4] proposed a shading based division strategy that uses the K-implies grouping system to track tumor questions in attractive reverberation (MR) cerebrum images. The key idea in this shading based division calculation with K-implies is to change over a given dark level MR image into a shading space image and after that different the position of tumor objects from different things of a MR image by utilizing K-implies grouping and histogram-bunching. Investigations exhibit that the technique can effectively accomplish division for MR cerebrum images to enable pathologists to recognize precisely injury size and locale.

D. Haritha et.al in [5] proposed algorithm is separated into two sections: pre-preparing and division. For preprocessing the Brain MRI images utilized nearby twofold example. For division of the Brain, MRI images utilized distinctive methods like K-implies, edge identification and Morphological operations like disintegration and expansion. Further, every one of these strategies are consolidated and watched for the division comes about. Dimensionality diminishment was accomplished by utilizing K-implies calculation.

Heena Hooda et.al in [6] discussed about the execution investigation of image division systems, viz., K-Means Clustering, Fuzzy C-Means Clustering and Region Growing for identification of brain tumor from test MRI images of the cerebrum. The execution assessment of the previously mentioned procedures is done on the premise of mistake rate when contrasted with ground truth. The continuous database is taken from Rajiv Gandhi Cancer Institute and Research Center, Delhi, India (RGCI&RC).

S. Charutha et.al in [7] proposed a robotized and effective brain tumor location system executing on Magnetic Resonance Imaging (MRI) images, which coordinates two image division techniques, for example, adjusted surface based district developing and cell automata edge identification. Recreation of the proposed work is done in MATLAB. Despite the fact that the adjusted surface based district developing and cell automata edge location are effective systems, joining of both upgrades the productivity of cerebrum tumor recognition. The execution of the proposed procedure is broke down by making distinctive correlations. Results demonstrate that the proposed technique is more proficient than altered surface based division and cell automata edge discovery. From the outcomes, it is obvious that the discovery by the proposed technique is nearer to that of the manual division when it is taken as the ground truth and more tried and true contrasted with manual division. It is likewise comprehended that the changed surface based division coordinated with the cell automata edge discovery is better when contrasted with the one with the fuse of established edge recognition strategies. Every one of these focal points make the proposed strategy productive in the treatment of cerebrum tumors and furthermore in surgical evacuation of tumors if necessary.

III. PROBLEM FORMULATION

Brain Tumor is the outcome of abnormal and uncontrolled division of the cells present in the brain. Commonly, the cells present in brain or other body parts decease with age and are replaced with the new cells. But, with cancer and other tumors, this normal process is disrupted and the tumor cells go on increasing, even when not needed by the body. The abnormal cells, when created in the brain, it is called brain tumor. Tumors can directly damage the healthy brain cells as well as indirectly by clustering around the other healthy tissues of the brain [39-40]. Brain is damaged with tumor because of rising pressure in the brain, shifting it towards the skull, and penetrating them into the healthy brain tissues. Brain tumor is further divided into primary and metastatic tumors. Primary tumors arise in the brain itself whereas metastatic tumors emerge in other organs of body and then, spread to the brain via blood cells or through adjacent tissues [41]. The various techniques used for detection of abnormalities in brain incorporate Magnetic Resonance Imaging (MRI), Magnetic Resonance Spectroscopy (MRS), Computed Tomography (CT), Positron Emission Tomography (PET) and Electroencephalogram (EEG). MRI is the standard imaging technique for detecting the abnormalities in brain. It takes the images from diverse planes that create a three-dimensional image of the brain. It observes the signals that are emitted from a healthy and tumor affected tissues present in the brain. It is necessary to detect brain tumor timely for better cure and treatment. We propose to compare different brain tumor segmentation and detection techniques on the basis of comparison of various parameters.

ISSN: 2454-4248
093 – 100

IV. PROPOSED METHODOLOGY

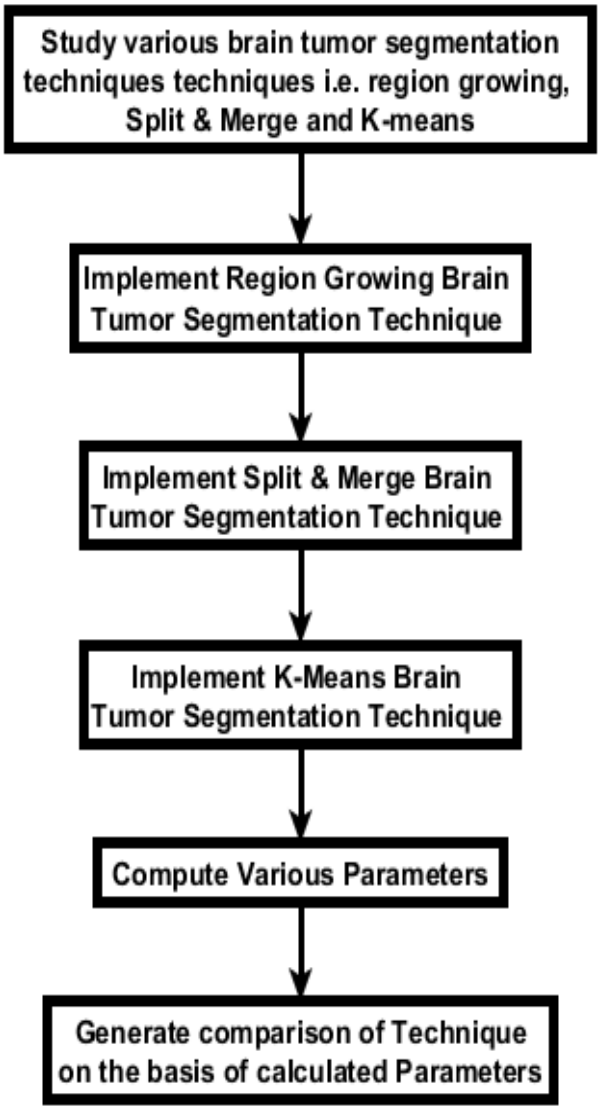

Fig 2: Proposed Research Methodology

V. SIMULATION AND EXPERIMENTAL RESULTS

We proposed to compare the various brain tumor segmentation techniques on the basis of various parameters. We have chosen region growing, split & merge and K-means technique for our research work. The parameters selected, on the basis of which comparison of techniques will be performed are Area, Region of Interest means color (ROImean), Rest mean color (Restmean), Region of Interest Standard Deviation (ROIstD), Rest Standard Deviation (ReststD), Region of Interest Peak to Mean Ratio (ROIPMR), Rest Peak to Mean Ratio (RestPMR), Convex Area (ConArea), and Aspect Ratio (AsRatio).

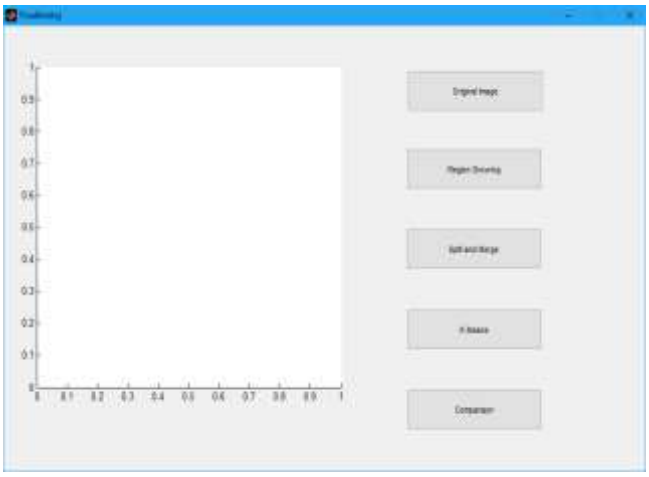

Fig. 3: Graphical User Interface (GUI) of Proposed Research Work

The graphical user interface designed specifically for the proposed research work is shown in figure 3. The interface designed having five buttons i.e. original image (to choose the image from data set to perform brain tumor detection), region growing (to perform region growing technique for brain tumor detection), split and merge (to perform split and merge technique for brain tumor detection), K-means (to perform K-means technique for brain tumor detection) and last button is for comparison to generate comparison table with values of parameters for different techniques.

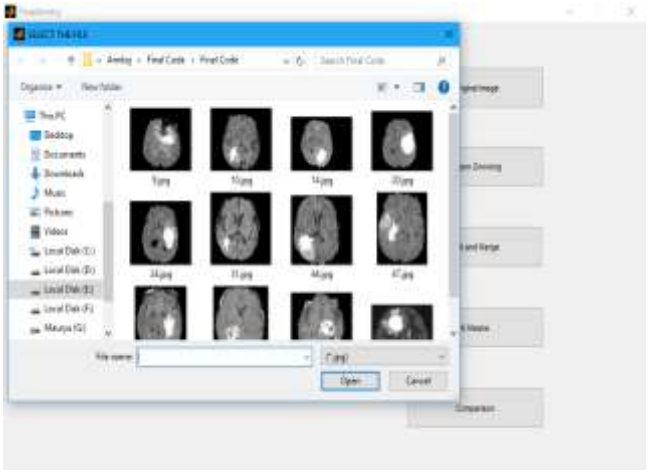

Fig. 4: Selection of image for analysis

The selection of animage for analysis is shown in figure 4. When we press button original image, a window pop-up which shows us data set images available for analysis, we have to select one image and click on button open.

 ISSN: 2454-4248
093 – 100

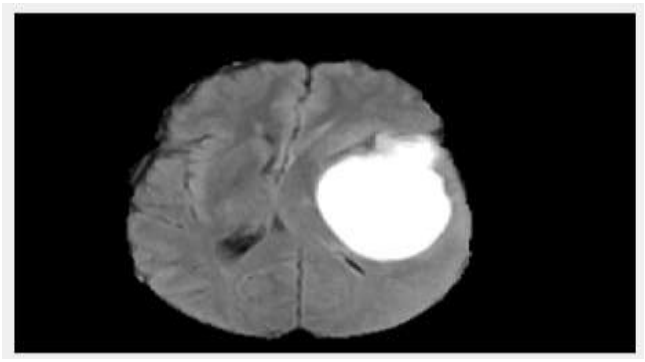

Fig. 5: Selected original image for analysis

The selected image from provided data set is shown in figure 5. After selection of anoriginalimage, the next step will be to perform brain tumor segmentation.

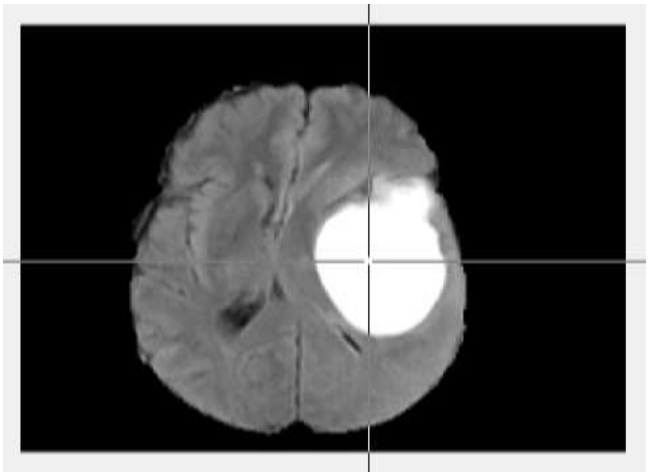

Fig. 6: Performing Region Growing Method

The region growing method performed after selection of theoriginal image is shown in figure 6. In region growing method we have to select seed pixels within the image to perform the brain tumor segmentation.

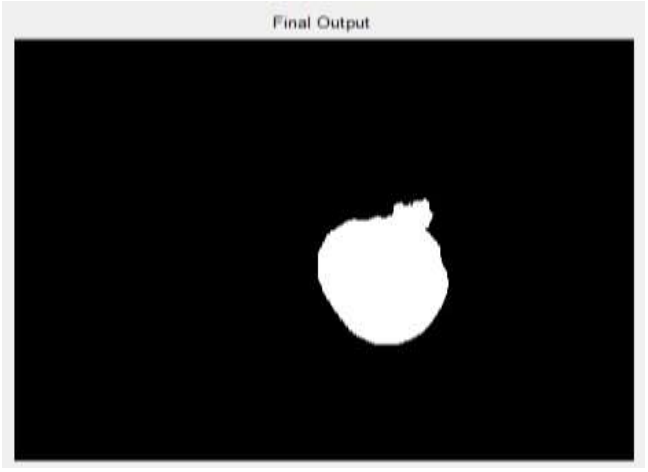

Fig. 7: Final Output of Region Growing Method

The final output of region growing method is shown in figure 7. The extracted brain tumor region is marked with white color.

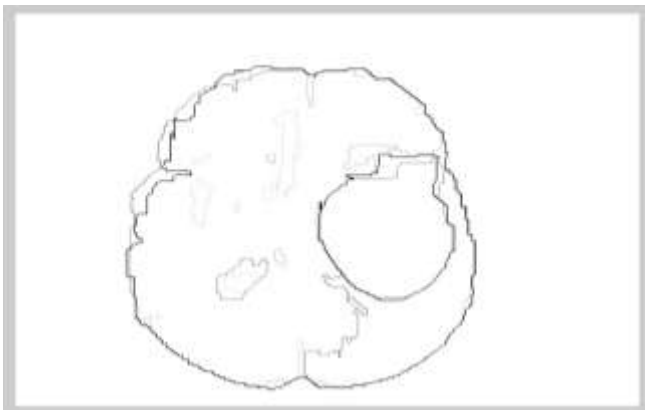

Fig. 8: Segregated Output of Split & Merge Method

The segregated output of Split & Merge method is shown in figure 8. The original image selected is segregated into parts when button split and merge is pressed.

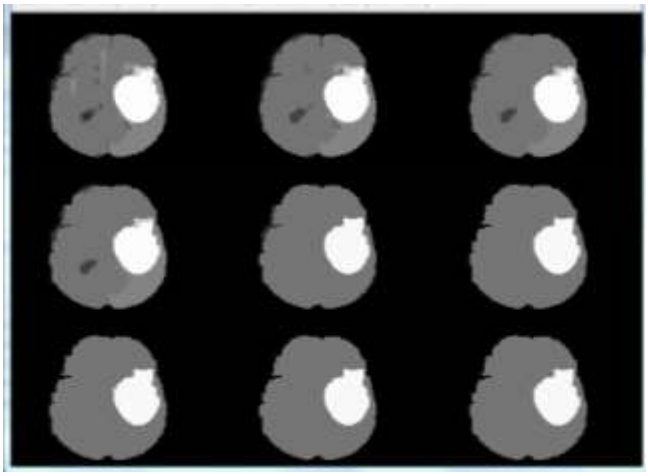

Fig. 9: BW steps output of Split & Merge Method

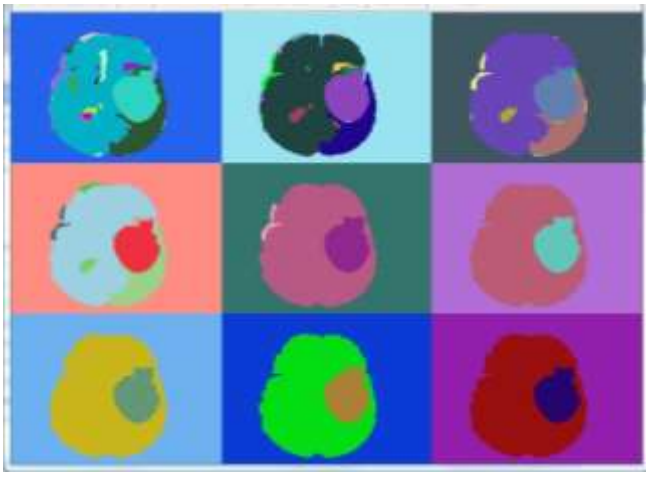

Fig. 10: Colored steps output of Split & Merge Method

 ISSN: 2454-4248
093 – 100

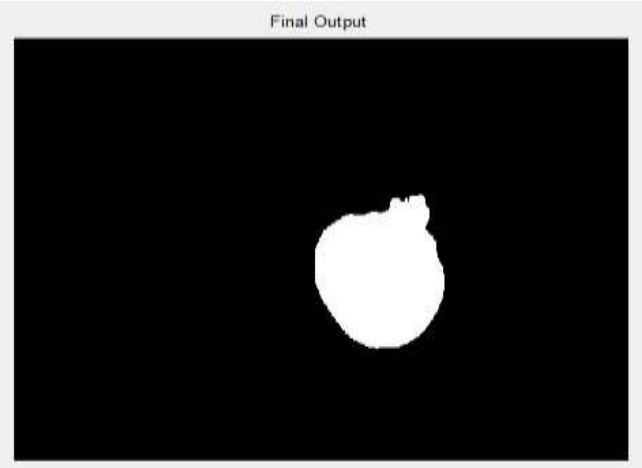

Fig. 11: Final Output of Split & Merge Method

The final output of Split & Merge method is shown in figure 11. The extracted brain tumor region is marked with white color.

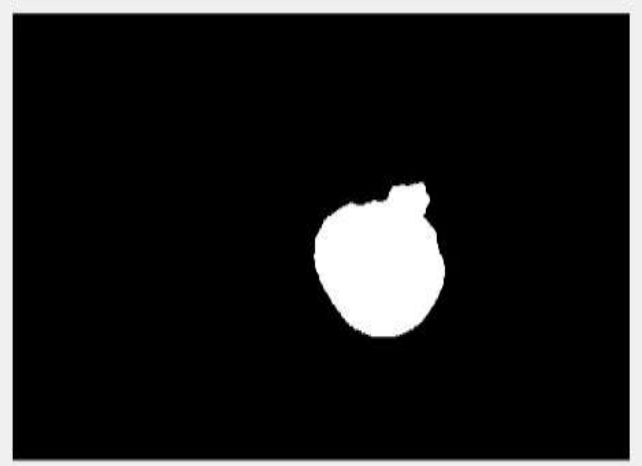

Fig. 12: Final Output of K-means Method

The final output of K-means method is shown in figure 12. The extracted brain tumor region is marked with white color.

	Area	ROImean	Restmean	ROIstD	ReststD	ROIPMR	RestPMR	ConArea	AsRatio
Original	15216	252.9301	39.8008	0.8945	13.0029	0.0035	0.3267	21000	0.7246
RgnGrowing	15382	254.6961	39.6551	1.5360	13.0127	0.0060	0.3281	21250	0.7239
SpnMrge	16700	250.9074	38.6714	4.4641	13.0876	0.0178	0.3384	22500	0.7422
Kmeans	15574	252.9301	39.4900	3.2193	13.0211	0.0127	0.3297	22050	0.7063

Fig. 13: Comparison of parameter values

The values of parameters for comparison are shown in figure 13. The figure shows the values of parameters of theoriginal image, region growing method, split and merge method and K-means method of brain tumor segmentation.

TABLE I. Comparison Table of Proposed Techniques

Parameters	Original	Region Growing	Split & Merge	K-means
Area	15216	15382	16700	15574
ROImean	252.9301	254.6961	250.9074	252.9301
Restmean	39.8008	39.6551	38.6714	39.4900
ROIstD	0.8945	1.5360	4.4641	3.2193
ReststD	13.0029	13.0127	13.0876	13.0211
ROIPMR	0.0035	0.0060	0.0178	0.0127
RestPMR	0.3267	0.3281	0.3384	0.3297
ConArea	21000	21250	22500	22050
AsRatio	0.7246	0.7239	0.7422	0.7063

From the above Table I. Comparison Table of Proposed Techniques, we can easily conclude that region growing technique is best suited for brain tumor detection from the taken parameters.

VI. CONCLUSION AND FUTURE SCOPE

Tumors can happen in any parts of the body. Brain tumor can be considered as one of the serious and perilous tumors. It is actually created either by the anomalous and uncontrolled cell division inside the brain or from growths essentially display in different parts of the body. For the most part, tumors are ordered in view of the area of their origin and its malignancy. We proposed to prepare a head to head analysis of three brain tumor segmentation techniques. We are presenting comparison of region growing, split & merge and K-Means brain tumor segmentation techniques. We have performed all our analysis and simulations using MATLAB R2013B. From our research work we concluded that region growing stands to be best technique for brain tumor segmentation on the basis of parameters derived. The parameters derived are Area, Region of Interest mean color (ROImean), Rest mean color (Restmean), Region of Interest Standard Deviation (ROIstD), Rest Standard Deviation (ReststD), Region of Interest Peak to Mean Ratio (ROIPMR), Rest Peak to Mean Ratio (RestPMR), Convex Area (ConArea), and Aspect Ratio (AsRatio).

The future scope of the proposed work is to cross the limit of three techniques comparison and implement it with other new and existing techniques, which will be very useful and beneficial for further enhancements in the method of detecting brain tumors..

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