Independent Study Final report

Level 3

Brain Tumor Identification Using Image Processing Techniques

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Supervisor

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Abstract – Brain is the controlling unit in human body. It regulates the functions such as memory, vision, hearing, knowledge, personality, problem solving, etc. The main reason for brain tumors is the uncontrolled development of brain cells. Many health organizations have identified brain tumor as the second major issue that causes a large number of human deaths all around the world. Identification of brain tumor at an early stage offers a possibility of successful medical treatment. Use of Magnetic Resonance Imaging images have been recognized as more precise and more reliable images when compared to Computed Tomography images. There are various techniques to diagnose brain tumors or neoplasms. The most efficient and effective algorithms are discussed in this paper after studying a number of relevant research papers. Preprocessing brain images, segmenting them, feature extraction and detection of the tumor are the approaches in most researches. These techniques, limitations and the advantages with further expansion are discussed extensively in the paper.

Keywords: *Tumor, Magnetic Resonance Imaging, Computed Tomography, preprocessing, segmentation, feature extraction, detection*

I. INTRODUCTION

Brain regulates all the functions of human body including memory, vision, hearing, knowledge, personality, problem solving etc. But the genuine functioning of the brain is severely disturbed by a tumor inside the brain [1]. Severe headache, nausea, dizziness are most common symptoms of brain tumors, but these symptoms differ among various individuals depending on the location of the tumor in the central nervous system.

Magnetic Resonance images (MR images) are used most of the time in the approaches of detecting brain tumors because it has been recognized as a more accurate imaging technique than Computed Tomography (CT) imaging [1]. A strong magnetic field that uses radio waves is used in MRI scanning. This helps to investigate various human body parts and their structures. Apart from MRI and CT images, Positron Emission Tomography (PET) images, Single Photon Emission Computed Tomography (SPECT) images can also be used in brain tumor identification [2].

A concretion of cells that divide and grow in an unguided and unregulated manner is a brain tumor. It increases the pressure inside the brain and damages gray matter, white matter and cerebrospinal fluid [3]. Brain tumors have been categorized into four grades according to their severity. Grade I and grade II consist of slowly growing cells while grade III and grade IV consist of rapidly dividing cells. Slowly growing tumors are considered as less dangerous but rapidly growing tumors affect the functionalities of human brain in a shorter period hence considered as more dangerous [4].

Brain tumor detection is a difficult task and the situation becomes more difficult when using manual processes. Manual processes need the expertise of experienced oncologists and the shortage of these oncologists create complex situations that disrupt patients with brain tumors from getting successful treatments. These manual methods consume a lot of time and the final results may not be reliable. To overcome this issue, automated approaches to detect brain tumors at early stages have been implemented by various groups of researchers all around the world. When detected in an early stage, brain tumors can be successfully treated [5]. This intensifies the need of developing methods to automatically detect brain tumors in a shorter period. It is also needed to raise the awareness among communities about these tumor detection approaches in order to tempt them for early treatments.

The two types of brain tumors are primary tumors and secondary tumors. Tumors that do not have the ability to spread to other body parts are known as Primary Tumors. Tumors that spread through cancerous cells in particular body areas can be recognized as Secondary Tumors. In many situations, lung cancers and breast cancers rapidly spread to brain causing tumors. Primary tumors have two types as Benign and Malignant [6]. Benign generally does not harm human life, but if it occurs in a vital area, it too can be life threatening. Benign grows slowly inside the brain and does not spread. Gliomas and Meningiomas come under Benign. Malignant is a dangerous type of tumor because it grows rapidly. It can spread within brain and spine hence known as Brain Cancer [7]. Glioblastoma and Astrocytoma are Malignant [8].

Next chapters of the review paper are organized according to the following arrangement. Overview of techniques used for brain tumor detection is discussed in section II. Section III presents a comparison of similar methodology used in brain tumor identification. Section IV and V present discussion and conclusion respectively. The acknowledgement and list of references are presented at the end of the paper.

II. OVERVIEW OF IMAGE PROCESSING TECHNIQUES

Brain tumor identification is mainly executed using MRI images. Some methods use CT images in the process, but it is identified that the outcome is not accurate when compared to the procedures that use MRI images.
Preprocessing the MR image, segmentation of it, feature extraction and classification are the key strategies discussed in most of the mechanisms [2]. Using MRI in detection of brain tumors has a variety of MRIs to be used. T1-weighted MRI, T2-weighted MRI, Fluid-Attenuated Inversion Recovery (FLAIR) weighted MRI, Proton Density MRI are the categories of MRIs used in this field [9].

a. Preprocessing

Preprocessing is the initial step in every procedure that ultimately identify brain tumors. In the preprocessing step, noise and other artefacts are removed from the image with the purpose of obtaining a clearer image and highlighting the tumor from background. With noise, the results obtained deviate in large values from accurate values. When the images include colors, they are converted into Gray Scale that contains images only in two colors; black and white [10, 11, 12]. Gray scaling is an important step in preprocessing because the output of this step gives accurate information regarding colors [12, 13].
The equation to convert a color image into a gray scale image is;
$0.2989 * R + 0.5870 * G + 0.1140 * B$ [5].
In preprocessing step several filters can be used according to the situation.

i) Median filter

Median filter provides a perfect noise reduction for some noise types. It is also used to smoothen and preserve the edges. This is the most common non-linear denoising technique [1, 14]. Gray scale images consist of Salt and Pepper noise. In order to detach this noise, Median filter is effective rather than other filters. In brief, the median filter performs movements from pixel to pixel in an image and replaces pixel values by the median value of the next pixel [2, 15, 16].
Figure 1 shows an image which has the effect of Salt and Pepper noise (a) and after applying median filter to the image (b).

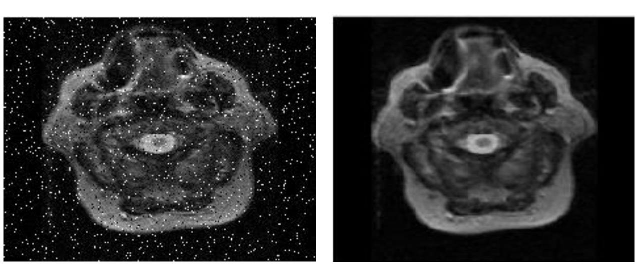


Figure 1 :- (a) Salt & Pepper Noise (b) Median Filter
Source :- Adapted from [17]

ii) Anisotropic diffusion filter

Anisotropic filter is an iterative method used to detach surrounding noise that is connected with high frequencies from images. It also preserves intensity of edges [18]. Edge-stopping function (ESF) is used to smoothen the noise when using this filter. But if noise level is more than 3% of maximum intensity, blurred edges are resulted when detaching noise [19, 20].
Figure 2 below shows a brain MR image with Salt and Pepper noise (a) and resulted image after Anisotropic filtering (b).

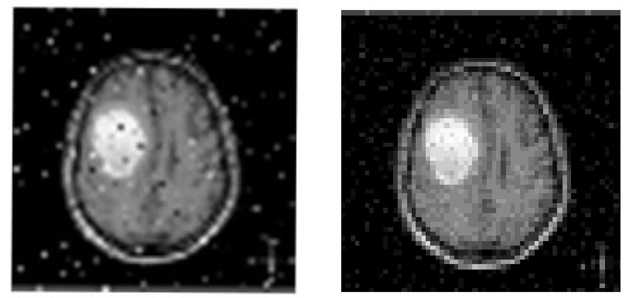


Figure 2 :- (a) Salt & Pepper Noise (b) the Anisotropic filter
Source :- Adapted from [21]

iii) Wavelet based de-noising

Wavelet based de-noising is identified as a method that separates image signals from noisy signals while removing noise. This filter preserves important features of images when de-noising. It also analyzes the image signal according to various frequencies with various resolutions [18].

iv) Gaussian filter

Gaussian filter is also used to eliminate noise in MR images but most of the time image brightness preservation does not happen when using this filter. To detach Salt and Pepper noise occur in images, this filter is not advantageous but to smooth images, this filter has proven to be more beneficial and advantageous [4].
Figure 3 shows an image after using the Gaussian filter (a) and the same image after using the Average filter (b).

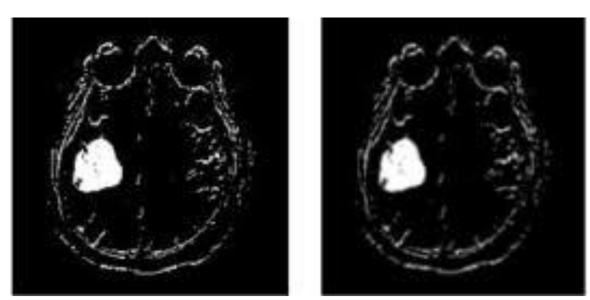


Figure 3 :- (a) Gaussian Filter (b) Average Filter
Source :- Adapted from [22]

v) High Pass filter

Edge detection is implemented by High Pass filter. It indicates images sharper and highlights the image details. High pass filter normally raises the luminescence in the middle pixel when compared to the surrounding pixels and this increases the sharpness of the image [11, 15].

After preprocessing there is a technique that can be applied to get clearer images known as skull stripping. It allows better segmentation of MR images and therefore increases the accuracy of diagnosing brain tumors and other brain diseases [23]. The main purpose of skull stripping is to remove non-brain tissues and speed up the segmentation process.
Figure 4 below shows the resulted MR brain image after skull stripping for an original image.

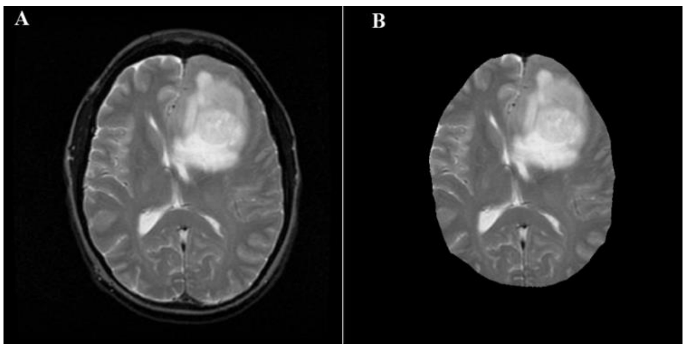


Figure 4 :- (a) Original MR image (b) Skull Stripping
Source :- Adapted from [24]

Basically, there are five methods in skull stripping. They are as follows.

(A) Method based on Morphology

This method separates the skull from brain using methods for edge detection and thresholding techniques combined together. But this method is highly based on shape and size of the image, hence not effective in the process [23].

(B) Method based on Intensity

Function of intensity distribution of images is used in this method to differentiate brain regions from non-brain regions. The main drawback of this method is that it is sensitive to low contrast, imaging artifacts, low resolution etc. [23].

(C) Method based on Deformable Surface

In this method, after considering selected characteristics of images, a dynamic curve which reaches boundaries of objects is known as an Active Contour in this method. Deformation methods detect inner boundaries as well as outer boundaries of objects. Limitation here is that the method is sensitive for noise in the images [23].

(D) Method based on Atlas/Template

To separate brain and the skull, in this method, an Atlas/Template is fit on MR images. Method based on Atlas/Template is able to identify brain regions when intensities of pixel in images and regions are not defined [23].

After the skull stripping, segmentation can be executed accurately and therefore skull stripping is becoming popular in brain tumor identification approaches.

b) Segmentation

Segmentation is a difficult step in medical imaging because the images are too complex. In segmenting process, the image is divided into several partitions according to their color, intensity etc. [4, 10]. This helps to observe and analyze the details of the images and provide accurate results [2]. There are several segmentation methods.

i) Threshold segmentation / Boundary approach

Optimal thresholding, adaptive thresholding, mixture thresholding and P-tile thresholding are the types of thresholding. This strategy has been identified as the simplest and the easiest strategy in segmentation [3]. Gray Scale image to Binary image conversion is the most important purpose of Thresholding method which depends on a value which is known as the Threshold value or clip-value [7, 15]. In this method, a specific level is assigned for all the pixels in an image considering similar characteristics of visuals [15].

ii) Edge detection approach

Edge detection identifies the boundaries of various objects in an image. An edge is a boundary that separates two correspondent areas. This type of segmentation does not provide direct boundaries normally. Roberts algorithm, Canny algorithm, Prewitt algorithm, Sobel algorithm, Laplacian of Gaussian etc. are known as edge detection algorithms [3, 16]. Using these algorithms, unnecessary data in an image is removed and the main properties of the image are preserved. A variety of gray levels also can be identified using edge detection approaches [8, 16].

1) Canny Algorithm

This is the standard method in edge detection approach which is mainly used in industry. In this algorithm, first the image is smoothen using 2D Gaussian. Then the gradient of the image is considered to identify the intensity changes. Edges are occurred when the gradient maximizes. Other points which do not have maximum gradient are suppressed by computing magnitude and gradient of pixels [8, 25].

2) Prewitt Algorithm

This algorithm is considered as an algorithm with inexpensive computations. Prewitt operator convolutes images with a little filter that bears integer values in X and Y directions [8].

3) Sobel Algorithm

In this algorithm, all the edges in an image are extracted regardless the directions. Sobel algorithm is beneficial in giving smooth and different effects for images. The output is displayed as a layout in the initial image [8].

4) Roberts Algorithm

This is an easy and quickly computable algorithm that provides gradient values of an image. 2*2 kernels that can be applied to images are used in the method. When a kernel is rotated by 90°, the other kernel can be obtained. The two kernels are heading perpendicular directions [8].

Figure 5 below explains how different edge detection approaches affect the MR images of brain.

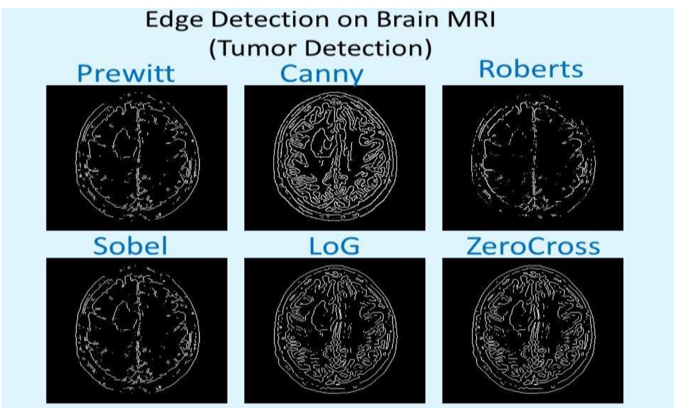


Figure 5 :- Edge detection approaches
Source :- [26]

iii) Region approach

In this approach, a pixel is compared with its surrounding pixels [18]. There are several region-approaches in segmentation. They are,

1) K-mean segmentation

K mean approach does not provide precise results when there are overlapping clusters. In this segmenting method, segments with similar characteristics are grouped together. There are K number of clusters and at least one item is present in each cluster [10, 27, 28]. Performance of segmentation can be evaluated using K-means clustering. In a mass of tissues, using only K-means clustering, brain tumor can be identified [28].

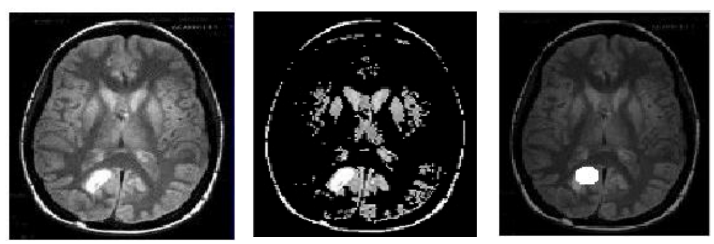
2) Fuzzy C-mean segmentation (FCM)

FCM, also known as soft clustering, is associated with various clusters, hence provide more accurate results. This algorithm is an extension of Hard C-means clustering. FCM effectively detects boundaries of images using distances between different points in the input data set. There is a cluster center between various data points. To use this method, an object may include within a single cluster or many clusters [18, 27, 29].

3) *Mathematical Morphological operation*

Issues with FCM approach can be solved using mathematical morphological operations and gives the results in a least time [30, 14]. This includes dilation and erosion. In dilation, vector addition is used to combine two data sets while erosion combines two sets with vector subtraction [3, 4, 5]. Morphological operations are usually non-linear. The shape of the image structure decides the most appropriate operation to be used in the process. Relative position of pixels, ordering of them etc. are used in morphological operations rather than the numeric data when processing the binary image [16, 20]. MATLAB software has been used for mathematical operations in most of the procedures.

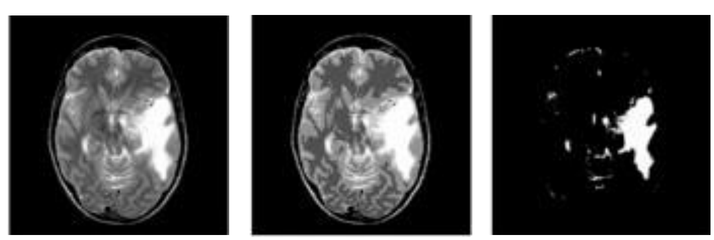
Figure 6 given below compares the original brain MR image (a) with the result after K-means clustering (b) and Morphological Operation (c).



(a) (b) (c)

Figure 6 :- (a) Original Image (b) K-means Clustering (c) Morphological Operator
Source :- Adapted from [31]

Figure 7 shows an original MR image (a), segmented image using FCM technique (b) and segmented tumor using FCM technique (c).



(a) (b) (c)

Figure 7 :- (a) Original image (b) Segmented image using FCM (c) Segmented tumor using FCM
Source :- Adapted from [32]

4) *Watershed Segmentation*

The fundamental concept of Watershed segmentation was built from geography. If rain falls to an area where all the water gets collected into one place, Watershed line is recognized as a margin that separates two basins as in figure 8. Water falls on any direction of a watershed line drains to same place. This is the concept that lies behind image processing to provide solutions for problems [33, 34].

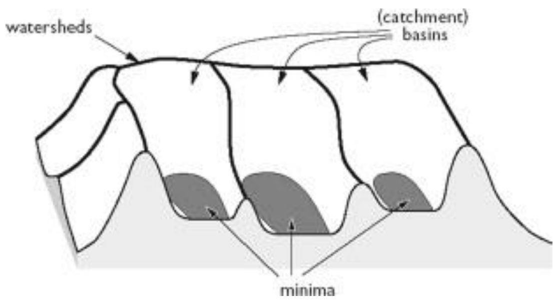


Figure 8 :- Watershed Segmentation
Source :- Adapted from [34]

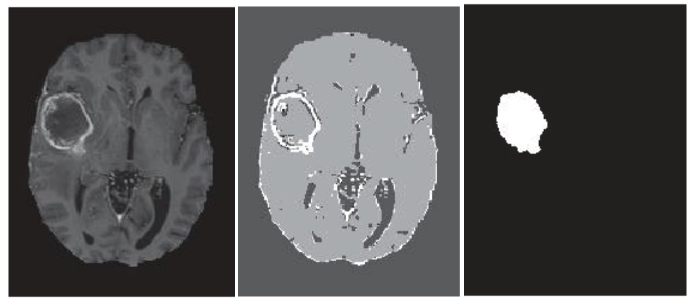
After segmentation, the output undergoes with feature extraction to identify the brain tumor according to its different stages.

c. Feature Extraction

Feature extraction detects the tumor size and reveals the stage of tumor whether it is in the stage I, II, III or IV. Specific criterions are examined in this step to identify stages. They are size, shape, location etc. [18].
There are conditions that are fixed by the medical practitioners when detecting tumors. They are as follows.

- If the area of the tumor is less than 7mm, it is considered as a First Stage Tumor.
- If the area is between 7mm to 14mm, a Second Stage Tumor.
- If the tumor has spread to 14mm to 21mm, it is at the Third Stage.
- The critical stage is when the area of the tumor is greater than 21mm [10].

Feature extraction is mainly executed by applying a technique known as the Gray Level Co-occurrence Matrix (GLCM) method. It detects the position of tumors by indicating pixels of the same gray values. GLCM method has the ability of identifying differences, mean, standard deviation (for homogeneity), correlation, entropy, energy, cluster shade, directional moment, cluster prominence, highest probability etc. [2, 35]. Structural irregularities of various brain tissues can be detected easily in this step.
Some approaches use Discrete Wavelet Transform (DWT) in this purpose which is recognized as a powerful approach. In this method coefficient of wavelets obtained from MR images of brain is extracted [35, 36].
As it is difficult to define a universal method for feature extraction, various other methods to accomplish the purpose have been implemented. Genetic Algorithm, Independent Component Analysis etc. have also been experimented [40].
Figure 9 displays an original brain MR image (a), segmented image (b) and the detected tumor (c).



(a) (b) (c)
Figure 9 :- (a) Original image (b) Segmented image
(c) Extracted tumor
Source :- Adapted from [37]

d. Classification

Classification is executed using a binary image which represents data in 0s and 1s [10]. Support Vector Machine (SVM) is the mostly utilized technique of diagnosing whether the images indicate normal brain tissues or abnormal brain tissues [2, 19, 20]. Decision planes are the base of this step. Linear SVM or non-linear SVM is applied according to the relevance. The issue with this step is the difficulty in discovering the most suitable hyperplane [11, 29].
K-nearest Neighbor (KNN) is an advanced technique used for classifying Brain MR images. It is mainly used for recognizing patterns and classifying them in a statistical basis. KNN is a Euclidian distance-based method. KNN has been identified as a simple algorithm since it has a non-parametric approach which is beneficial in most of the situations when classifying real world scenarios. In a situation where there are continuous values, different *k* values are applied to measure and calculate distances between those values. In a such scenario values from 1 to 9 are considered [26, 36].

III. COMPARISON OF SIMILAR METHODOLOGY

Professor A.Raut et al. [1] have proposed a mechanism to detect brain tumors by using thresholding, morphological operations and extracting tumor region of the brain for extra investigations. They have introduced a *T* constant that can be implemented to the MR image. If constant is employed to the whole image, it is called Global Thresholding and if the constant has changed values over an image, it is called Variable Thresholding. In this approach, MR images have gone through shrinking to reduce the number of pixels which may affect to reduce unwanted details like noise.

S.Suhag and M.Saini [2] in their system highlighted approaches with image processing. Histogram equalization, enhancing image, segmenting image etc. are some of the mostly used approaches. They have developed the system user friendly by using the tool MATLAB. In this process, knowledgebase is used to store collected data. The researchers have identified clustering method as more effective in segmenting images. The most important discovery in the process is that it is unable to identify the tumor and the edges of the brain separately because the tumor tissues appear darker at the edges. This issue affects the identification of tumor at the edges. To overcome this problem, Fuzzy C-means segmentation has been used.

S.Kaushal [3] has also developed a process to identify brain tumors using segmentation of MRI images. According to him, MRI is an enhanced technique when compared to CT. In this process, Optimal Thresholding has been used because it assists to clearly recognize the shape and the position of tumor. As a result, the proposed approach has become an advanced process than Professor Raut's process. This method also detects the tumor tissue volume. By using these data, growth of the tumor can be measured. For this measuring the researchers have used performance metrices such as Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE).

P.M.Jijith and T.M.Nitha [4] in their research have used Histogram Thresholding and Artificial Neural Network for identification of brain tumors. They obtained two histograms for two uniform halves of the brain and by observing these histograms, decisions have been made. If the two halves are symmetric along the central axis, decision is made as a tumor has not occurred. If an asymmetric pattern is recognized, that can be a brain tumor according to the researchers. In the segmentation step, this method also uses the Thresholding techniques as most of the methods discussed here.

Professor P.Charles and S.Tripathi [7] introduced an approach to detect brain tumors that used Magnetic Resonance Spectroscopy (MRS) technique to encounter the composition of the brain. Although most of the methods use several MRIs, this method uses only a single MRI for detecting the tumor. The specialty of this method is that that the researchers were able to identify the functional areas of brain that are responsible for speech and muscle movement. It allows the surgeons not to harm functional parts of the brain while operating the tumor. This method also has the ability of differentiating dead tumor tissues and new tumor tissue.

N.B.Bahadure et al. [9] presented a method that uses a different technique in the process to detect brain tumors. After the preprocessing step, they have executed a step known as skull stripping. It has been identified as a major step of analyzing biomedical images. In skull stripping, all the tissues which are not brain tissues have been detached from the images. It is also beneficial to detach other brain tissues such as fatty tissues, skin tissues and skull. Another new technique Berkley Wavelet Transform (BWT) is used in this approach for image processing. BWT converts data. It is a productive procedure for image transforming. This approach also uses morphological operations to extract boundaries similar to many other approaches.

M.Pallavi and his fellow researchers [10] introduced an algorithm for brain tumor identification and area calculation. For segmenting they have used K mean and FCM both. Clearer boundaries were detected when using FCM. Thresholding is used in feature extraction. The tumor is shown at the FCM output. This method enables the researchers to recognize stage and scale of the tumor which helps doctors to commence proper treatments. Approximate reasoning is a step in this method. In this step the result is printed, and it allows the patients to obtain the results as their wish. This method also uses MATLAB programming for fast mathematical computations.

S.R.Telrandhe et al. [11] were enthusiastic in implementing an algorithm to obtain a detailed diagnosis while identifying the region affected by the tumor. A range from 0 to 255 has been used in this algorithm to separate a region from the image surrounding. It is called the Region of Interest (ROI). Object Labelling algorithm and K means algorithm have been used in the process for more accurate results. Object labeling is a special step that can be seen in this method. After segmenting the image, object labeling is performed. The researchers have identified that object labeling gives reliable results for detecting tumors. They have also used color images when segmenting because human eye can clearly identify colors rather than gray scale images.

The methodology proposed by T.Sudhakar et al. [18] comprise of eight components for brain tumor detection. This process automatically detects brain tumors with a high accuracy level. Canny edge detection technique has been used in this mechanism to obtain smooth edges in the step of detecting edges. This edge detection technique uses gradient of images. To identify horizontal and vertical edges, an approach known as Prewitt edge detection has been used in the system. A gradient based operator known as Robert edge detection has been used to compute the magnitude and direction of gradient component. Hence this process has used three edge detection methods. The researchers also have used Morphological Reconstruction for image constructing using small components. It preserves the object shapes in the MR image.

B.Devkota et al. [30] implemented an algorithm that also used MRI images. Using the Median filter, noise and other artefacts have been removed in the images. They have obtained an accuracy level of 92% by applying 19 brain images in the approach. But this algorithm is unable to categorize the tumors under several levels as level I, II, III and IV. This method includes Mathematical Morphological Operations with few steps that only consume several seconds for segmenting images, hence the computation time is less than other methods. Global Thresholding is used in the process as the method introduced by professor Ashok Raut.

S.E.Amin et al. [38] introduced a mechanism using Artificial Neural Networks for identifying brain tumors. Segmentation of

MRIs is also executed in this approach like the other approaches. Supervised Neural Networks as well as unsupervised Neural Networks have been applied in this method. Principal Component Analysis (PCA) which is a method for feature extraction has been executed for unsupervised Neural Networks. For supervised Neural Networks, the researchers have used back-propagation networks to classify the extracted features from images. Image size and network weight have been used in two matrices in this approach. Preprocessing has been done in three acts in the approach. Cutting the image is the first act. Enhancing the image and normalizing image size are the second and third steps respectively. The Paintshop software has been used in this in these steps. This method has recorded a less time consumption than the other similar methods for brain tumor identification.

A summary of the above discussed brain tumor identifying approaches is attached to the discussion for easy reference.

IV. DISCUSSION

Irregularities in the brain that prevent ideal functioning of the brain are identified as brain tumors. A person at any age can be diagnosed by brain tumor and the danger is that the impact of tumor on different individual may differ. Although the tumor is in primary stage or secondary stage, it is hard to detect tumors manually because it consumes lot of time and the results are less reliable and less accurate. This fact intensifies the need of developing automated algorithms and approaches to detect brain tumors in a shorter period of time with a high reliability.
Figure 10 below displays some of the mostly used procedures in image processing to identify brain tumors.

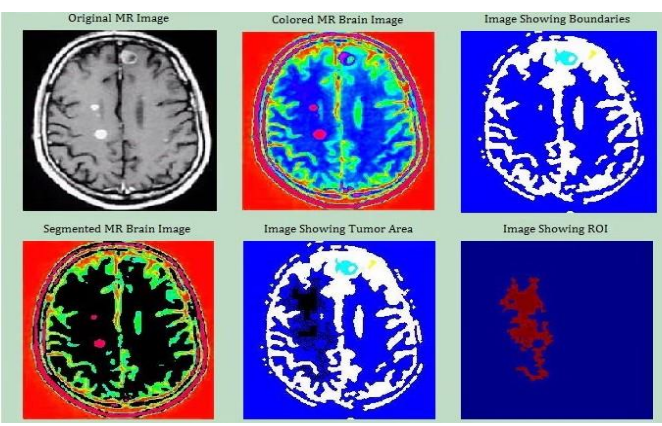


Figure 10 :- Procedural summary of image processing
Source :- [39]

Various number of approaches have been developed to detect brain tumors by various researchers because it is essential to detect it in an early stage. As a result, to detect size, volume, location and stage of the tumor, many procedures have been developed. Image processing, machine learning, artificial neural networks, probabilistic neural networks are widely used to effectively detect brain tumors. It is crucial to accurately detect these parameters because the success of surgeries mostly depend on the accuracy of these parameters. Early detection of brain tumors allows oncologists to successfully treat the tumor, otherwise it could be fatal and cause death.
MRIs have been used in most image processing approaches to detect brain tumors because it is scientifically proved to be more accurate when compared to CT images. In tumor detecting approaches, a single MRI or several MRIs can be used, but when considering the effectiveness of the approach, it is better to use several images because by using several images faults in the approach can be diminished.
Based on tumor location in brain, patients may have language controlling and understanding issues, issues in thinking as well as personality, abnormal movements in the body, vision problems, problems in limbs coordination etc.
In detecting brain tumors, preprocessing of MR images is the step that removes unnecessary details in images and strengthen the image quality. Median filter is used frequently in this pace because it removes Salt and Pepper noise effectively mainly from Gray scale images. Other filters such as Anisotropic diffusion filter, Wavelet based denoising, High pass filter, Gaussian filter have their own pros and cons which may sometimes affect the effectiveness of the process. It may be more accurate to use a combination of two of these filters because the drawbacks of one filter can be reduced by another filter and hence can provide a better result. As an example, Median filter can be combined with High pass filter. This combination can produce an output of a noiseless image with sharpened edges. Median filter eliminates Salt and Pepper noise while High pass filter highlights the edges of the image.
The approach by N.B.Bahadure et al. uses skull stripping methods for analyzing MR images. This method is able to provide a higher effectiveness in removing other tissues like skin, fatty tissues, skull etc. in brain MR images. Skull stripping can be executed using various techniques like segmentation, histogram analysis etc. This can also be done automatically with the use of image contour.
Segmentation of medical images has to be done with more care. It is in this stage the tumor is separated from normal brain tissues and a small mistake can affect the whole outcome. Some approaches use K-means algorithm for segmentation while other approaches use Fuzzy C-means segmentation or both. These algorithms come under region detection approach.
Other approaches for segmentation are boundary approach and edge detection approach that are recognized as less efficient than region detection approach. Mathematical Morphological operations are used in segmentation to obtain faster results. For mathematical computations used in most of the approaches, MATLAB software has been used because it usually performs mathematical calculations in a least time with a high accuracy. To detect the tumor and its details such as stage, location, size etc. feature extraction is used. It checks various brain tissues and identify necessary details. Linear or non-linear Support Vector Machine classifies images further to recognize normal brain tissues from tumor tissue.

Below is a table with comparisons of different types of brain tumor detection approaches executed by various researchers. Important facts about these researches have been included in section III.

Table 1 – Comparison table for studied researches

Ref.	Advantages	Drawbacks	Future Expansion
[1]	Morphological operations remove noise and make the images clearer and more accurate. Histograms can be drawn according to the results to display frequencies. It helps to compare results on different occasions and to make decisions. Intensities are used in Thresholding to indicate information.	Images are not in the exact size; hence the images have to be re-sized which may result in inaccuracy. Calculation of the area of tumor depends on the accuracy of pixel information obtained from Gray scale imaging.	Develop the algorithm to identify the type of the tumor and use color images in the process.
[2]	The system can be developed to calculate the area of the tumor and its size using enhanced algorithms.	Preprocessing is essential for noise removal.	Develop algorithm to detect area and thickness of the tumor. Use feature extraction to get accurate results.
[3]	Easy to develop algorithms in detecting and segmenting tumors.Easy to handle information. Easy to do feature extraction. Clearly identifies the tumor and its boundaries.	Unable to remove or extract noise that associate with edges.	Enhance preprocessing techniques to remove edge-associated noise.
[4]	Categorize MRI brain images into malignant, benign or normal categories. Probabilistic Neural Network has been used for more productivity. Most accurate results have been obtained. Adjustable as instantaneous information can be obtained by PNN. Automatically detects tumors with high accuracy.	The data set consisted of 50 images; 40 tumor-images and 10 normal images. To evaluate the method with an increased accuracy, it is better the data set to be larger.	Develop Probabilistic Neural Networks to achieve more reliable results.
[5]	Automated brain tumor detection algorithm is developed. Indicates the tumor affected area as a portion.	Conversion of RGB to Gray may create inaccurate results.	Use density-based clustering to detect the tumor effectively.
[6]	Overcomes the shortcomings of Fuzzy C-mean algorithm. Segmenting results do not depend on the initial values. Less computational time is used (10 times faster than	Not effective in differentiating large masses. Computational cost is high. Accuracy is less.	Enhanced Mathematical Morphological Operations will be used to lessen computational cost.

	normal methods).		
[7]	Images can be split progressively. Can be used for a single MRI image. Mean or the variance can be used for image splitting. According to the splitting criteria, merging criteria can be selected.	As a single MRI image is used in the approach, if there had been a mistake in the image, the result may be inaccurate.	Enhanced Mathematical Morphological Operations to obtain more reliable results.
[9]	Detects the exact location of the tumor with a higher accuracy. Can be integrated with clinical decision support systems.	The used cases are less realistic and less clinically bounded.	Combine several classification and feature extraction techniques for more accuracy.
[11]	According to data, technologies can be selected. Faster results.	Discovering the best hyperplane is difficult at the stage SVM.	Evaluate tumor size, type and location using a 3D image.
[38]	Accurately detects Acoustic Neuroma, Astrocytoma, Optical Glioma.	With increase of features, norm error increases.	Utilize neurosurgeries by using advanced image-guided technologies.

Table 1 gives a precise description about different approaches made to recognize brain tumors effectively using image processing methodologies. But each approach contains drawbacks regarding the techniques. By identifying those drawbacks, the researchers will be able to develop more accurate and reliable approaches for brain tumor identification. Neural networks and Machine Learning are trending techniques in this field nowadays. They will be developed to achieve more effectiveness in the near future.

V. CONCLUSION

This paper is a survey of various techniques, steps and comparison of them when identifying brain tumors using medical image processing. These techniques can be grouped into many categories according to the preferences of different researchers, but when considering most effective and efficient approaches, preprocessing the MR image, segmentation the MR image, feature extraction and classification are the steps that have been recognized as most suitable and beneficial stages in detecting brain tumors. Among them, segmentation has become the most crucial step because at this step tumor tissues are separated from normal brain tissues. This paper presents a collective knowledge base on different preprocessing methods, segmentation methods, methods of feature extracting and classifying methods after studying research papers on the topic.

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