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## Detection of Brain Tumor-A Proposed Method

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**Abstract:** The segmentation of brain tumors in magnetic resonance images (MRI) is a challenging and difficult task because of the variety of their possible shapes, locations, image intensities. In this Review paper, it is intended to summarize and compare the methods of automatic detection of brain tumor through Magnetic Resonance Image (MRI) used in different stages of Computer Aided Detection System (CAD). Brain Image classification techniques are studied. Existing methods are classically divided into region based and contour based methods. These are usually dedicated to full enhanced tumors or specific types of tumors. The amount of resources required to describe large set of data is simplified and selected in for tissue segmentation.

**Keywords:** Magnetic Resonance Image (MRI), Brain Tumor Images. Classification of Brain Image

### INTRODUCTION

Brain cancer is a very serious type of malignancy that occurs when there is an uncontrolled growth of cancer cells in the brain. Brain cancer is caused by a malignant brain tumor. Not all brain tumors are malignant (cancerous). Some types of brain tumors are benign (non-cancerous). Brain cancer is also called glioma and meningioma.

Brain cancer is one of the leading causes of death from cancer. There are two main types of brain cancer. They include primary brain cancer, in which the brain cancer originates in the brain itself. Primary brain cancer is the rarest type of brain cancer. It can spread and invade healthy tissues on the brain and spinal cord but rarely spreads to other parts of the body.

Secondary brain cancer is more common and is caused by a cancer that has begun in another part of the body, such as lung cancer or breast cancer that spreads to the brain. Secondary brain cancer is also called metastatic brain cancer.

Brain cancer is most treatable and curable if caught in the earliest stages of the disease. Untreated and/or advanced brain cancer can only spread inward because the skull will not let the brain tumor expand outward. This puts excessive pressure on the brain (increased intracranial pressure) and can cause permanent brain damage and eventually death. This process results in symptoms, such as headache, and other neurological problems. For more details on other key symptoms and complications, refer to symptoms of brain cancer.

People at risk for developing brain cancer include people with a family history of brain cancer and people who have had radiation therapy of the head.

Diagnosing brain cancer begins with taking a thorough personal and family medical history, including

symptoms and risk factors for brain cancer. The diagnostic process also includes completing a thorough physical and neurological exam. A neurological helps to evaluate the brain and nervous system and such functions as reflexes, sensation, movement, balance, alertness, coordination, vision, and hearing.

A diagnosis of brain cancer is generally made by a specialist called a neurologist. Imaging tests that may be performed include MRI and/or CT scan which use computer technology to create detailed pictures of the brain.

A procedure called a brain angiogram may also be done to illuminate blood vessels in the brain that feed blood to a brain tumor. Another procedure that may be performed is a spinal tap or lumbar puncture. In this procedure, a small sample of spinal fluid is removed from the spinal cord and examined under a microscope for the presence of cancer cells.

Diagnostic testing also includes a biopsy. In a biopsy a sample of cells or tissues are taken from the brain during surgery performed on a brain tumor. The sample of brain tissue is examined under a microscope for the presence of brain cancer cells or abnormal changes in brain tissue that can lead to cancer. This will determine if a brain tumor is cancerous or benign.

A diagnosis of brain cancer can be missed or delayed because some symptoms of brain cancer are similar to symptoms of other conditions. For more information about other diseases, disorders and conditions that can mimic brain cancer, refer to misdiagnosis of brain cancer.

### ANATOMY OF BRAIN TUMOR, SYMPTOMS AND IDENTIFICATION

The symptoms of brain tumors depend on tumor size, type, and location. Symptoms may be caused when a tumor presses on a nerve or damages a certain area of the brain. They also may be caused when the brain swells or fluid builds up within the skull. Brain tumors are composed of cells that exhibit unrestrained growth in the brain.

Brain tumor diagnosis is a very crucial task. This system provides an efficient and fast way for diagnosis of the brain tumor. Proposed system consists of multiple phases. First phase consists of texture feature extraction from brain MR images. Second phase classify brain images on the bases of these texture feature using ensemble base classifier. After classification tumor region is extracted from those images which are classified as malignant using two stage segmentation process. Segmentation consists of skull removal and tumor extraction phases.

Brain tumor pathologies are the most common fatality in the current scenario of health care society. Hence, accurate detection of the type of the brain abnormality is highly essential for treatment planning which can minimize the fatal results. Accurate results can be obtained only through computer aided automated systems. Besides being accurate, these techniques must converge quickly in order to apply them for real time applications. Even though several automated methods are available with these desirable performance measures, there is no clear differentiation between these techniques about the suitability for various applications. Many reports claim its work to be superior but a complete comparative analysis is lacking in these works.

The major areas of the brain have one or more specific functions.

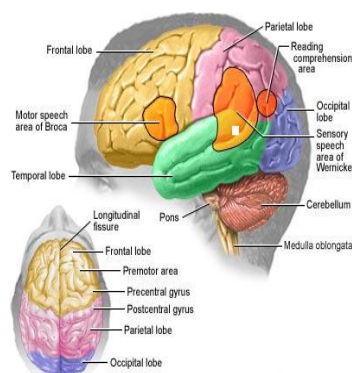


Figure 1: Basic Anatomy of Brain

These are the most common symptoms of brain tumors:

Headaches are a common initial symptom. Typical "brain tumor headaches" are often described as worse in the morning, with improvement gradually during the day. They may rouse the person from sleep. Sometimes, upon awakening, the person vomits then feels better. These headaches may worsen with coughing, exercise, or with a change in position such as bending or kneeling. They also do not typically respond to the usual headache remedies.

- Headaches (usually worse in the morning)
- Nausea or vomiting
- Changes in speech, vision, or hearing
- Problems balancing or walking
- Changes in mood, personality, or ability to concentrate
- Problems with memory
- Muscle jerking or twitching (seizures or convulsions)
- Numbness or tingling in the arms or legs

These symptoms are not sure signs of a brain tumor. Other conditions also could cause these problems. Anyone with these symptoms should see a doctor as soon as possible. Only a doctor can diagnose and treat the problem. If a person has symptoms that suggest a brain tumor, the doctor may perform one or more of the following procedures:

- Physical exam - The doctor checks general signs of health.
- Neurologic exam - The doctor checks for alertness, muscle strength, coordination, reflexes, and response to pain. The doctor also examines the eyes to look for swelling caused by a tumor pressing on the nerve that connects the eye and brain.
- CT scan - An x-ray machine linked to a computer takes a series of detailed pictures of the head. The patient may

receive an injection of a special dye so the brain shows up clearly in the pictures. The pictures can show tumors in the brain.

- MRI - A powerful magnet linked to a computer makes detailed pictures of areas inside the body. These pictures are viewed on a monitor and can also be printed. Sometimes a special dye is injected to help show differences in the tissues of the brain. The pictures can show a tumor or other problem in the brain.

The doctor may ask for other tests:

- Angiogram - Dye injected into the bloodstream flows into the blood vessels in the brain to make them show up on an x-ray. If a tumor is present, the doctor may be able to see it on the x-ray.

- Skull x-ray - Some types of brain tumors cause calcium deposits in the brain or changes in the bones of the skull. With an x-ray, the doctor can check for these changes.

- Spinal tap - The doctor may remove a sample of cerebrospinal fluid (the fluid that fills the spaces in and around the brain and spinal cord). This procedure is performed with local anesthesia. The doctor uses a long, thin needle to remove fluid from the spinal column. A spinal tap takes about 30 minutes. The patient must lie flat for several hours afterward to keep from getting a headache. A laboratory checks the fluid for cancer cells or other signs of problems.

- Myelogram - This is an x-ray of the spine. A spinal tap is performed to inject a special dye into the cerebrospinal fluid. The patient is tilted to allow the dye to mix with the fluid. This test helps the doctor detect a tumor in the spinal cord.

- Biopsy - The removal of tissue to look for tumor cells is called a biopsy. A pathologist looks at the cells under a microscope to check for abnormal cells. A biopsy can show cancer, tissue changes that may lead to cancer, and other conditions. A biopsy is the only sure way to diagnose a brain tumor.

- Surgeons can obtain tissue to look for tumor cells in three ways:

- Needle biopsy - The surgeon makes a small incision in the scalp and drills a small hole into the skull. This is called a burr hole. The doctor passes a needle through the burr hole and removes a sample of tissue from the brain tumor.

- Stereotactic biopsy - An imaging device, such as CT or MRI, guides the needle through the burr hole to the location of the tumor. The surgeon withdraws a sample of tissue with the needle.

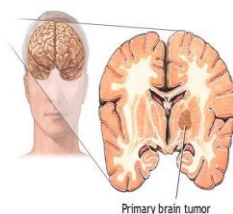
- Biopsy at the same time as treatment - Sometimes the surgeon takes a tissue sample when the patient has surgery to remove the tumor.

They can be *benign* (noncancerous, meaning that they do not spread elsewhere or invade surrounding tissue) or *malignant* (cancerous).

Cancerous brain tumors are further classified as either primary or secondary tumors.

Primary tumors start in the brain, whereas secondary tumors spread to the brain from another site such as the breast or lung. Benign tumors represent half of all primary brain tumors. Their cells look relatively normal, grow slowly, and do not spread (metastasize) to other sites in the body or invade brain tissue. Benign tumors can still be serious and even life-threatening if they are in vital areas in the brain where they exert pressure on sensitive nerve tissue or if they increase pressure within the brain. While some benign brain tumors may pose a health risk, including risk of disability and death, most are usually successfully treated with techniques such as surgery.

Figure 2: Indication Brain Tumor



A primary malignant brain tumor is one that originates in the brain itself. Although primary brain tumors often shed cancerous cells to other sites in the central nervous system (the brain or spine), they rarely spread to other parts of the body.

Brain tumors are generally named and classified according to the following:

- The type of brain cells from which they originate, or

- The location in which the cancer develops

The biologic diversity of these tumors, however, makes classification difficult.

A secondary (metastatic) brain tumor occurs when cancer cells spread to the brain from a primary cancer in another part of the body. Secondary tumors are about three times more common than primary tumors of the brain. Usually, multiple tumors develop. Solitary metastasized brain cancers may occur but are less common. Most often, cancers that spread to the brain to cause secondary brain tumors originate in the lung, breast, kidney, or from melanomas in the skin. All metastatic brain tumors are malignant. This report discusses primary malignant brain tumors.

About 80% of malignant primary brain tumors are known collectively as *gliomas*. Gliomas are not a specific type of cancer but are a term used to describe tumors that originate in glial cells. Glial cells are the building-block cells of the connective, or supportive, tissue in the central nervous system.

Gliomas are classified into four grades that reflect the degree of malignancy. Grades I and II are considered low-grade and grades III and IV are considered high-grade. Grade I and II are the slowest-growing and least malignant; grade I tumors are generally considered borderline between benign and malignant. Grade III tumors are considered malignant and grow at a moderate rate. Grade IV tumors, such as glioblastoma multiforme, are the fastest-growing and most malignant primary brain tumors.

There are several glial cell types from which gliomas form. The names of these gliomas and their cell types are:

Astrocytomas are primary brain tumors derived from astrocytes, which are star-shaped glial cells. Astrocytomas account for about 60% of all malignant primary brain tumors. Astrocytoma tumor types by grade include:

- Grade I. Pilocytic astrocytoma is one of the most common types of glioma in children
- Grade II. Diffuse astrocytoma (also called low-grade astrocytoma) typically occurs in men and women ages 20 - 60

- Grade III. Anaplastic astrocytoma typically occurs in adults ages 30 - 60 and is more common among men than women.

- Grade IV. Glioblastoma multiforme (GBM) accounts for about 50% of all astrocytomas. These highly malignant aggressive tumors are most common in older adults (50s - 70s), particularly men. Only about 10% of childhood brain tumors are glioblastomas.

Oligodendrogliomas develop from oligodendrocyte glial cells, which form the protective coatings around nerve cells. Oligodendrogliomas are classified as either low-grade (grade II) or anaplastic (grade III). Pure oligodendrogliomas, however, are rare. In most cases they occur in mixed gliomas. Oligodendrogliomas usually occur in younger and middle-aged adults.

Ependymomas are derived from ependymal cells, which line the ventricles (fluid-filled cavities) in the lower part of the brain and the central canal of the spinal cord. They are one of the most common type of brain tumor in children. They can also occur in adults in their 40s and 50s. Ependymomas are divided into four categories: Myxopapillary ependymomas (grade I), subependymomas (grade I), ependymomas (grade II), and anaplastic ependymomas (grades III and IV).

*Mixed gliomas* contain a mixture of malignant gliomas. About half of these tumors contain cancerous oligodendrocytes and astrocytes.

Gliomas may also contain cancer cells derived from brain cells other than glial cells.

Brain tumor pathologies are the most common fatality in the current scenario of health care society.

Hence, accurate detection of the type of the brain abnormality is highly essential for treatment planning which can minimize the fatal results. Accurate results can be obtained only through computer aided automated systems. Besides being accurate, these techniques must converge quickly in order to apply them for real time applications. Even though several automated methods are available with these desirable performance measures, there is no clear differentiation between these techniques about the suitability for various applications.

Many reports claim its work to be superior but a complete comparative analysis is lacking in these works. In this survey paper, an extensive comparative analysis is performed to illustrate the

merits and demerits of various available techniques.

## COMPUTER AIDED DIAGNOSIS OF BRAIN TUMOR

Computer Aided Diagnosis is gaining significant importance in the day-to-day life. Specifically, the usage of the computer aided systems for computational biomedical applications has been explored to a higher extent. Medical image analysis is an important biomedical application which is highly computational in nature and requires the aid of the automated systems. These image analysis techniques are often used to detect the abnormalities in the human bodies through scan images.

Automated brain disorder diagnosis with MR images is one of the specific medical image analysis methodologies. The automated diagnosis involves two major steps: (a) Image classification & (b) Image segmentation. Image classification is the technique of categorizing the abnormal input images into different tumor groups (brain tumors are of many types) based on some similarity measures. The accuracy of this abnormality detection technique must be significantly high since the treatment planning is based on this identification. The second step is image segmentation which is used to extract the abnormal tumor portion which is essential for volumetric analysis. This volumetric analysis determines the effect of the treatment on the patient which can be judged from the extracted size and shape of the abnormal portion.

## REVIEW PAPERS ON BRAIN CLASSIFICATION TECHNIQUES

The important process in the automated system is brain image classification. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. Several conventional classifiers are available for categorization but most of the earlier works depend on Artificial Intelligence (AI) techniques which yield highly accurate results than the conventional classifiers. The usage of Artificial Neural Networks (ANN) to improve the accuracy of the classifiers is illustrated by [4].

This report was based on head and neck carcinoma detection and a comparative analysis was performed with the Linear Discriminant Classifier (LDA) to show the superior nature of neural networks. An interactive tool to classify the healthy and the tumorous MR brain images is proposed by [5]. But the accuracy proposed in this system is very low compared to the AI techniques. Though this approach claimed a faster convergence rate, it may not be much useful because of its low accuracy. This report mainly concentrated on improving the convergence rate only. The application of various

ANN for image classification is analysed by [6]. The lack of faster convergence rate of the conventional neural networks is also explained in the report. This lay an emphasis on the requirement of modified neural networks with superior convergence rate for image classification applications.

The four different types of tumor is classified using LDA technique by [7]. But the classification accuracy reported in the paper is in the order of 80% which is relatively low. This work also suggested the various reasons for misclassifications.

Support Vector Machine based classification of various levels of MR glioma images is performed by [8]. This method claimed to be better than rule based systems but the accuracy reported in the paper is low. This work dealt with only glioma images and thus the lack of generalizing capability of this work is another drawback of this system. The application of Kohonen neural networks for image classification is explored by [9]. Some modifications of the conventional Kohonen neural network are also implemented in this work which proved to be much superior to the conventional neural networks. A hybrid approach such as combination of wavelets and Support Vector Machine (SVM) for classifying the abnormal and the normal images is used by [10]. This report revealed that the hybrid SVM is better than the Kohonen neural networks in terms of performance measures. But the major drawback of this system is the small size of the dataset used for implementation.

The classification accuracy results may reduce when the size of the dataset is increased. A modification of conventional SVM such as Least Square SVM (LS-SVM) for brain tumor recognition is proposed by [11]. Both bi-level classification and multiclass classification are performed in this work to show the superior nature of the proposed method over the conventional classifiers. This report also specified an important note that the differences between various algorithms increase when the number of classes increase. Thus, this work suggested the necessity for multiclass classification techniques than bi-level classification techniques. Another version of LSSVM is proposed and successfully implemented by [12].

An extensive comparative analysis is performed between the SVM, neural classifier and the statistical classifiers. Results suggested the advantages of SVM in terms of classification accuracy. Only bi-level classification is performed in this work which is inadequate for judging the nature of the automated system. The modified Probabilistic Neural Network for tumor image classification is used by [13]. Abnormal images such as metastase, glioma and meningioma are differentiated using the least square feature transformation based PNN. A comparative analysis is also performed with SVM. This work inferred that the transform based PNN is superior to the SVM in terms of classification accuracy.

The different grades of abnormal images are categorized using artificial neural networks by [14]. This report suggested a practical method for selection of database. The training of ANN is dependent on input data and hence a wide variety of pattern is desirable for high accuracy. This report also highlighted the difficulty in collecting a large dataset of different uncommon patterns and hence concluded that the automated system can be tested with the images of common abnormalities.

A time efficient neural network such as PNN is used by for pattern classification problems [59]. Emphasis was given for convergence time than the classification accuracy. The results concluded that the PNN is superior over conventional neural networks in terms of training time period. A computer aided system for discriminating the primary and secondary tumors is developed by [15]. Probabilistic Neural classifier is used in this work. Though the report records high classification accuracy, the size of the dataset is significantly small. Statistical classifiers are used for classifying different tumor types and one such work is reported by [16]. This classification is performed on proton Magnetic Resonance Spectroscopy images. A comparative analysis with neural classifier is also reported in this work. This report concluded that a combined statistical and neural classifier increased the accuracy to higher extent.

An enhanced ART neural network for classification applications is implemented by [17]. This employed the GA approach to select the order of training patterns to enhance the classification performance. This experiment is conducted on various datasets. But the classification accuracy results are different for different datasets which is one of the drawbacks of this approach.

A self-organizing neural network based automated system for glioma detection is implemented by [18]. The main disadvantages of this system are the low classification accuracy and the lack of multiclass analysis. RBF kernel based SVM for brain tumor detection is used by [64]. The results of SVM are compared with AdaBoost, a machine learning algorithm. Experimental results illustrated the superior nature of SVM over the other classifiers. Image classification based on fuzzy approach using the pattern discovery algorithm is demonstrated by [19].

Experiments are conducted on various real-world datasets and the results concluded that the proposed algorithm yield good results when compared with the other classifiers. A hybrid approach for pattern classification is reported by [20]. The combination of SVM and fuzzy rules is experimented in this work. The results revealed that the proposed hybrid approach is accurate, fast and robust.

## PROPOSED METHOD

Body is made of many cells. Each cell has specific duty. The cells growth in the body and are divided to

reproduce other cells. These divisions are very vital for correct functions of the body. When each cell loses the ability of controlling its growth, these divisions is done with any limitation and tumor emerges. Tumors, their self, are divided to tow classes: benign and malignant. According to a statistical report published by the Central Brain Tumor Registry of the United States (*CBTRUS*), approximately 39,550 people were newly diagnosed with primary benign and primary malignant brain tumors in 2002 [1-3].

Images usually contain one or more type of noise and artifact. Pre-processing is done to remove seeds from images and increase contrast between normal and abnormal brain tissues. The method used here are Histogram equalization, using Median filter, using Un sharp mask, thresholding and using from Mean filter respectively for each image.

According to upon statistics, it is clear that medical imaging has strong function to increase the yield and accuracy of tumor diagnosis in short time. Medical imaging is divided to two classes of anatomical and physiological. The anatomical imaging contains *CT*, Ultrasound and *MRI*.

In this research paper we have proposed a new enhancement and isolation process applied on MRI images for classification of tumors in the image. In this process, the medical image is treated as an array of pixel data. First step of the process is to determine the dimension of the image and determine the middle position of image array. We then take a maximum difference threshold (MDT) value, which is constant threshold determine by observation. We start checking this value with the image data by horizontally scanning from left of the array to the right. If result of any subtraction is greater than the MDT, the array will be divided into two equal subsets along middle position and the first and last positions of the two subsets will be pushed to stack. Otherwise, the mode value of subset will be propagated to all other position after modifying value using uniform color quantization technique in color space breaking in sixteen level scales. The process will be continued recursively, popping the start and end position subset array from the stack and repeat the aforesaid process. The process will be continued until the stack is empty.

The same process will be repeated by scanning the image vertically from top to bottom followed by uniform colour quantization technique in colour space breaking in sixteen level scales.

In Figure 1 one normal and abnormal input image has been showed and Figure 2 showed the proposed method.



(a)

(b) Figure 1: input image a) abnormal b) normal

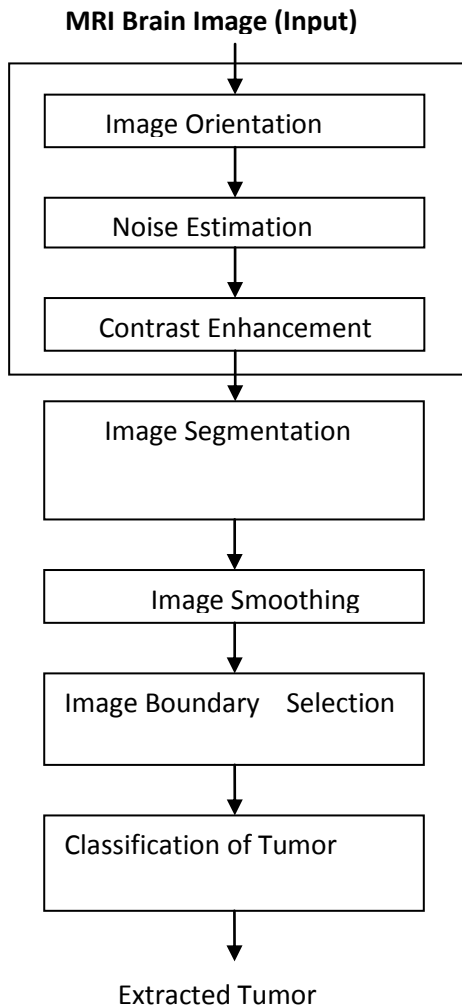
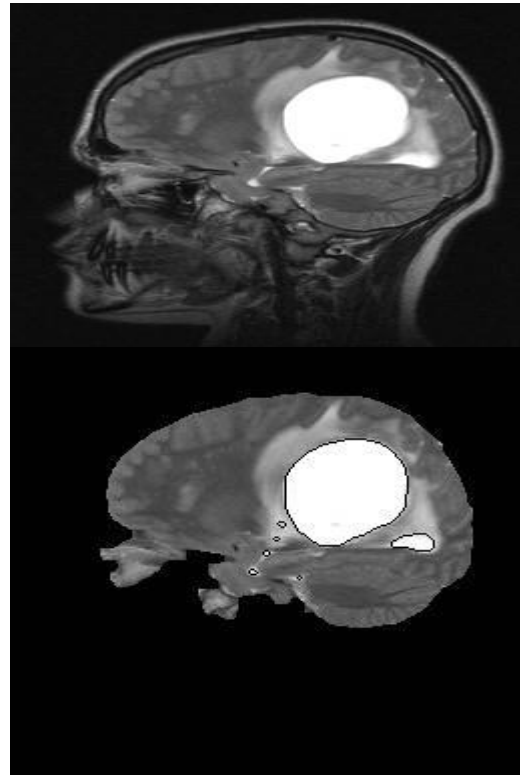
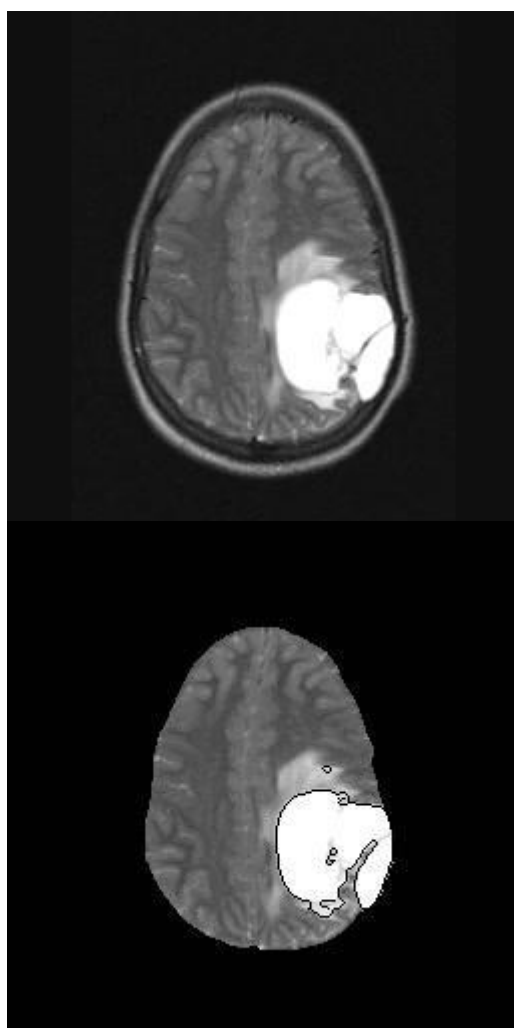


Figure 2: Entire process for Classification

Classification phase provides the images which are malignant to the segmentation phase as input. Classification phase of the proposed system quite accurately extract the tumor region from these malignant brain images. Figure 3 shows the results of classification phase. All images show that tumor region which is very high in contrast is quite accurately identified and extracted by the proposed system.



a.Original MR Image  
b. Tumor Extracted Region



c. Original MR Image  
d. Tumor Extracted Region

Figure 3 Tumor region is extracted from the original malignant brain MR image

### CONCLUSIONS

The paper proposes a method for classification of tumor in a brain image. The main objective of this step is to differentiate the different abnormal brain images based on the optimal feature set. This classification is performed on proton Magnetic Resonance Spectroscopy images. But the classification accuracy results are different for different datasets which is one of the drawbacks of this approach. Experiments are conducted on various real-world datasets and the results concluded that the proposed algorithm yield good results when compared with the other classifiers. The results revealed that the proposed hybrid approach is accurate, fast and robust.

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