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A Study the Brain Tumor detection by using Artificial Neural Networksand Classification of Brain Tumors

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Abstract- Brain tumor is a life threatening disease and its early detection is very important to save life. A brain tumor is an abnormal collection of cells that forms in the brain. Tumors of the brain are referred to by their place of origin, the brain. Tumors are masses of abnormal tissue that develop inside the skull as a result of unchecked cell division. Brain tumors may also develop as a result of metastasis from cancer originating in other parts of the body. In cases when tumors are located in the posterior fossa of the skull, the largest ones tend to be found in the cerebral hemispheres. Some brain tumors are harmless while others are malignant. Tissue involvement, tumor location, and other factors all play a role in the categorization process. Brain MRI segmentation can be utilized to find the tumor region. Systems for medical imaging are essential for getting images of the human body.

Keywords - Human brain,Brain tumor, brain structure, brain tumor categorization

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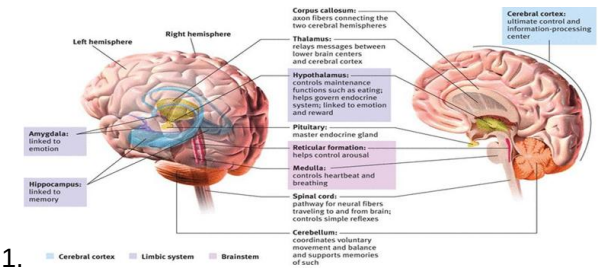
INTRODUCTION

In the field of data mining, classification is a sub-discipline. It is possible to classify medical pictures using artificial neural networks or fuzzy c-means, support vector machines, decision trees, or Bayesian classification. Many researchers have contributed to the development of classification systems for medical imaging classification. Most researchers employ MRI imaging for tumor identification because it has the highest resolution of all the medical imaging modalities now accessible for tumor detection. “These include positron emission tomography (PET), x-rays, computed tomography (CT), and MRI. A combination of contrast enhancement and mid-range stretch was utilized to enhance the MRI images in this study's findings. After the image has been enhanced, the segmentation step may be completed easily. Using segmentation, images with problematic areas may be isolated.

HUMAN BRAIN

The brain is a spongy, mushy, no replaceable organ that is extremely vulnerable. It's a safe haven where repeating structures can settle in. It's where our modelled, emotions, & experiences originate. All of the body's autonomic & static balancing functions are coordinated and integrated by it as well. Emotional hormones are secreted by the brain and used to control emotional processing, recognition, cognition, & integration. The skin, skull bones, & meanings all work together to preserve and sustain it. The cerebrospinal fluid inside of it is watery. The ventricles in the brain & spaces in between them are filled with this fluid. Example human brains are displayed in figure



1.

Figure 1: Brain Structure

It is the brain's anatomy that is depicted in Figure 1. The brain and brainstem are included. It's connected to performing, thinking, & sensing. It is also split in two, with one half located on either side of the body. Everyone has dominion over their "opposite" side. Furthermore, as shown in FIG. 2, each hemisphere is divided into four lobes: the temporal, parietal, occipital, & frontal lobes.

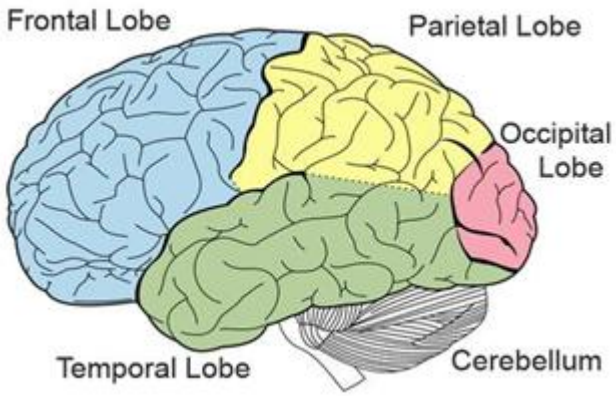


Figure 2: Human Brain Lobes

The lobe serves these functions:

1. **Front of the brain:** The cerebral cortex includes the areas that lie beneath the forehead. It is present in mental & physical actions, including speech & muscle motions.
2. **Occipital lobes:** The cerebral cortex includes the areas that are behind the head. The bulletin board data retrieval features are among these.
3. **Periallappening:** It's a bit of the brain that sits at the very top & very rear of your skull. It takes in information from the senses of touch and bodily position.
4. **The temporal lobes:** It's a section of the brain right about where your ear would be. The information from the listening region, especially the dominant ear, is included here.

The skin acts as a barrier to stop bodily harm to underlying tissues, bacterial & chemical invasion, and activity of the sweat glands & blood vessels. Additionally, it aids in keeping the body's temperature steady. The skull is another important protector of brain. It is a highly complex structure and it has compact and spongy types of bones. It provides the framework of the face and it protects the brain. The meanings are three connective membranes enclosing the brain & spinal cord. Their functions are to protect the Central Nervous System (CNS), blood vessels, enclose the venous sinuses, cerebrospinal fluid. The meninges are affected by a type of tumor called meningioma. The affected rate given by WHO in the year 2007 is 7.06%. Meningiomas are most common in adults and children. Ventricles are affected by Pediatric brain tumors in the rate of 8-10% and it blocks the flow of Cerebrospinal Fluid (CSF). The forebrain, midbrain, & hindbrain are the three main regions of the brain. The forebrain is made up of the thalamus, hypothalamus, and cerebrum. The midbrain contains the tectum&tegmentum. The hindbrain is made up of the medulla, pons, & cerebellum.

Forebrain

The largest region of the brain is the forebrain, which is primarily made up of the cerebrum. The limbic system, thalamus, & hypothalamus are some other crucial forebrain regions. The two cerebral hemispheres of the cerebrum are joined by a callous, a mass of white matter. The frontal, parietal, occipital, and temporal lobes make up each of the four halves of the brain. The cerebral cortex, which covers the surface of each hemisphere, is strongly folded to enhance the amount of cortical surface area that can fit inside the skull. The ability to focus, reason, & think abstractly are all higher cognitive abilities that are controlled by the cortex, along with perception, memory, and other cognitive processes.

Cerebral Hemispheres

On the topmost region of the brain are the cerebral hemispheres. It accounts for about 83% of the entire brain's mass. The cerebral cortex & basal ganglia are located on different levels in this region. The cerebrum is the name given to them all together. Higher motor, cognitive, & perceptual functions are affected by this. 40% of the total rain mass is located in the cortex, which has a surface layer of grey matter that is 2-4 mm thick. It has three different functional sections: the motor areas, the sensory areas, and the association areas, and it is in charge of conscious Modelled. the basal ganglia responsible for regulating muscle action. The frontal, parietal, or occipital lobes are among the four lobes that make up its two hemispheres &subregions.

Diencephalons

The thalamus & hypothalamus are parts of a structure called the Diencephalons. Sensory input is a worry for the thalamus. It is made up of constituent nuclei, each of which sends sensory information to various regions of the cerebral cortex. The pituitary gland, the autonomic nervous system, & hormonal secretions are all controlled by the hypothalamus. It regulates fundamental processes like mating, feeding, & combat. The pituitary gland & hypothalamus are close to each other in the region where cranial hemangiomas tumors grow.

Midbrain

The 2 cm long midbrain is located halfway between the forebrain & hindbrain. It makes up a sizable portion of the brainstem. It aids in bridging the forebrain & spinal cord. Tectum&tegmentum are part of it. To control reflexes related to vision, movement, and hearing, these structures create crucial connections between the cerebral cortex, brainstem, & spinal cord. Gliomas of the brainstem nearly always affect young patients. Around 6 years old is when development typically begins. It may take the tumor a long time to start showing symptoms.

Hindbrain

The cerebellum, pons, & medulla oblongata are parts of the hindbrain that work together to support critical bodily functions. The medulla connects to the

spinal cord & regulates a number of unconscious bodily processes, including breathing, swallowing, blood flow, & muscle tone. Medulloblastoma tumor affects the medulla. These are the most common types of brain tumors that form in children.

BRAIN TUMOR

A brain tumor is a malignant growth that forms in the brain or central medullary tissue, which can impede normal brain function & raise intracranial pressure. Certain brain tissues are transferred, forced against the scalp, or accountable for nerve loss from other healthy brain tissues as a result of the increased pressure on the brain. Cancers of the brain & spinal cord manifest in varying ways in each individual. They manifest in various organs , tissues, develop from various cell types, and may respond differently to various therapies.

Many people use the term "benign brain tumor" to refer to the least destructive type of brain tumor. Most brain tumors originate in brain tissue, grow slowly, have well-defined borders, or don't metastasize to other organs. Prior to the development of symptoms, they might attain a considerable size. When these tumors are successfully removed, they rarely return. Nonetheless, their size & proximity to other brain areas determine whether or not they cause substantial neurological problems. Even benign tumors have the potential to worsen and become fatal.

Brain tumors are extremely lethal because they contain cancer cells & rarely have distinct borders. It is thought that life is harmful because it multiplies rapidly and invades neighboring brain tissue. Brain tumors are relatively uncommon, yet they can spread to the brain & spinal cord. After undergoing treatment for their tumors, whether through surgery, chemotherapy, or radiation, they can try again.

Primary brain tumor is still the name given to the tumor in the brain, even though it is cancerous. In contrast to distant organ metastases from primary brain tumors, secondary brain or spinal cord tumors are more frequent. Whether or whether the cancer has gone to your brain, if you have a brain tumor, it most likely started elsewhere in your body.These tumors originate in this region are more common than malignant brain tumors. Lung, breast, colon, & skin cancers, among others, are treated differently depending on their location of origin. The biochemical, radiological, & clinical characteristics of each of these cancers are distinct from the others.

Brain Tumor Grading

Tumors are given names that correspond to the types of cells they are made of, which range from one to four (the numbers I through IV in Roman numerals). The "grade" represents the pace of cell growth and division. This knowledge is crucial for determining a course of treatment and for anticipating results.

Grade I & II cancers are less aggressive than higher grades and are often associated with long-term survival. These appear to be very typical under a microscope are easily treatable by surgical means. A grade II tumor can metastasize to nearby healthy tissue and behave aggressively. Tumors with a high grade (III/IV) tend to progress more rapidly, cause more severe symptoms, more challenging to cure. They are thought to be carcinogenic or fatal. When examined through a microscope, these features stand out as aberrant. While necrosis (dead tissue) in the middle of a tumor may contain cells of varying grades, the most deadly cell is what ultimately decides the tumor's grade (even though most tumors are of lower grade). Tumors can change their growth & mortality rates over time.

Brain Tumor Types

WHO has established a system for classifying cancers. The WHO classifies brain tumors into more than 120 subtypes based on the characteristics of the tumor cells present in each case, making diagnosis particularly challenging. Schwannomas, meningiomas, gliomas, pituitary tumors, & CNS lymphomas are the most common primary tumors in adults. Glial cells in the brain's underlying tissue are the tumor's seed. The two main subtypes of glioma are astrocytomas&oligodendrogliomas, which are themselves divided into subtypes based on tumor location and time of onset. These manifest first in the brain's glial cells, also known as astrocytes. It is there in the brain that they are most prevalent. Stress, fits of shaking, and altered behavior are the results of these drugs in adults. Most astrocytomas fall into one of two categories, high (grade III and IV) or low (grades I & II) (grade III and IV). Glioblastoma, a brain tumor of the highest grade (IV), is the most lethal type of brain tumor. Compared to other glioma forms, oligodendrogliomas have a superior prognosis and treatment outcome. At most, they are intermediate.

A benign, slowly expanding tumor known as a meningioma can appear in the membranes that surround the brain & spinal cord. This kind makes up about one-third of adult brain tumors. They are frequently found in the hemispheres of the brain and can go unnoticed for years.

Schwann cells, which are present in the cochlea, give rise to schwannomas, which are frequently benign tumors. Vestibular schwannomas, which are tumors of the vestibular nerve, frequently cause imbalance, hearing loss, or one-sided facial paralysis. Running them could be challenging no matter where they are. Conversely, in some circumstances, such tumors may be treated with radiotherapy (or a combination of surgery & radiotherapy).

The pituitary gland, which is situated close to the base of the brain, releases hormones that control

several other organs, such as the thyroid, ovaries & testicles, adrenal glands, the glands that produce milk in pregnant women, and the kidneys. The regular operation of the pituitary gland may be hampered if a tumor develops in or around the gland. Visual deficits may also be present in patients. The best course of action for treating a benign pituitary tumor is frequently surgical removal. Certain individuals receive drugs that either decrease or get rid of their tumors.

A primary malignant tumor of the brain, lymphoma of the central nervous system (CNS) develops from lymphocytes in the brain, eyes, or spinal cord. Only the brain and spinal cord are impacted. Common treatment modalities include chemotherapy & radiation therapy.

Table 1 Brain Tumor Symptoms and Affected Rate

Basic Symptoms	Affected Rate
Headaches	76.80%
Strange feeling in head	43.55%
Seizures	32.97%
Problems finding the right words	34.46%
Weakness of the arm(s) or leg(s)	41.93%
Nausea / Vomiting	36.50%
Problems with vision	46.00%
Problems with sensation in your hands	22.80%
Strange smell felt	18.72%

CATEGORIES OF BRAIN TUMOR

Brain tumors have names based on where they first appeared in the brain. The cerebral tissue masses known as tumors are a result of aberrant and uncontrolled cell division. Brain tumors can also develop as a result of the spread of cancer to other organs. The main tumors are seen in the cerebral hemispheres when basic tumors are present in the posterior cranial fossa. There are several types of brain tumors, including benign, malignant, & others. The classification is based on the tissues affected, the location of the tumor, and other factors. The main classifications are given names based on the cell types that are classed as benign, or non-cancerous, and malignant. While malignant expand to nearby places are invasive, benign does not infiltrate neighboring tissues or spread elsewhere. Brain tumors with metastases, which begin in another part of the body but spread to the brain, fall under the secondary group. It might start in the kidneys, lungs, or even skin melanomas. Edema and necrosis, which both eventually lead to death, are associated with benign & malignant conditions, respectively. The pituitary gland, choroids plexus, pineal gland, pituitary infundibulum, & veins all exhibit enhanced contrast. By employing contrast enhanced T1-weighted imaging (CE-T1w), it is possible to distinguish between tumor & edema in terms of their anatomical characteristics.

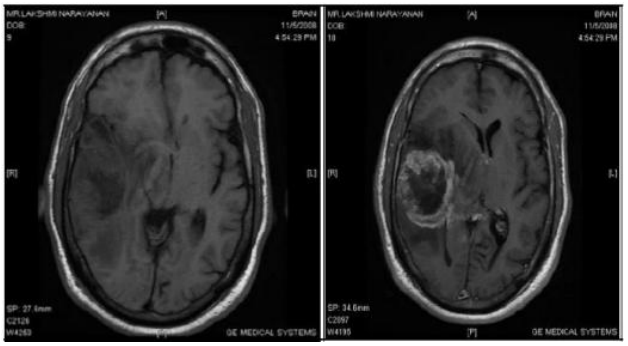


Figure 3(a) A contrast-enhanced T1-weighted MRI scan of the brain (b) Contrast-enhanced T1-weighted magnetic resonance imaging of the brain

Figure3(a) with an example of T1-weighted and Figure 3 (b) shows contrast enhanced T1-weighted image. MR image analysis is an important process for assessing and detecting tumor growth. The treatment responses and MRI analysis go hand in hand and it is a time consuming process.

CLASSIFICATION OF BRAIN TUMORS

Primary brain tumors are often categorized according to the tissue of origin, with tumor location also playing a role. Histopathological characteristics or central nervous system location are often used to categorize these cancers (CNS). This latest WHO classification of CNS cancers (Louis et al. 2007) is the norm for defining CNS malignancies globally, yet despite these seemingly easy criteria, there are a large number of distinct CNS tumor forms. The histopathologic characteristics of a tumor are diagnostic for its malignancy grade. It has been very challenging to construct a universally agreed histological classification system for brain tumors due to their high degree of heterogeneity and peculiar biology (Doolittle 2004). Tumor detection & segmentation may potentially benefit from a categorization based on radiographic features and anatomical context. Another classification of cancers has been employed for the segmentation of internal brain regions based on the modification of other structures owing to the tumor. Tumors are classified into different stages according to the presence or absence of four cellular features: nuclear atypia, mitoses, endothelial cell proliferation, and necrosis; this method was created by DaumasDuport et al. (2000) and is based on discrete variables. Grade I brain tumors, for instance, lack any of the aforementioned cellular traits, while Grade II tumors exhibit just one, Grade III tumors two, and Grade IV tumors three or four. Later on, the Daumas-Duport method was renamed the St-Anne system. In the 1970s, neuropathologists worked with the WHO to create a new system for classifying brain tumors. The World Health Organization's grading system was a continuous-variable approach that took into account both survival &histopathological characteristics (Smirniotopoulos 1999).

BRAIN IMAGING TECHNIQUES

Denoising, feature extraction & classification are the preliminary requirement in tumour detection, diagnosis and therapy. The blurring and noisy medical images make the analysis process a complex and difficult one. As the tumour is based mainly on structural or physical appearances, the complication in the detection of tumors, edema and necrotic tissues increases precisely. As the appearance display contrast variations, a precise analysis based on those feature detection will lead to effective therapy. Biomedical image processing has been done through several techniques in past. Different methods of diagnosis through software and hardware based algorithms are implemented using new scientific methods. The various techniques are

- Transcranial Doppler (TCD),
- Cranial Ultrasound,
- Magnetic Resonance Spectroscopy (MRS),
- Computed Axial Tomography (CAT) and
- Magnetic Resonance Imaging (MRI).
- haemorrhage Computed Tomography (CT)
- Computed Axial Tomography (CAT)
- The Transcranial Color Doppler (TCCD)
- MRI, the Magnetic Resonance Imaging

LITERATURE REVIEW

Gurbinăet. al. (2019) The brain is one of our bodies' most complicated organs, which is a blessing for humans. A mass of cells that are abnormally reproducing that surrounds or resides inside the brain is referred to as a "cerebral tumor."This sort of cell is capable of disrupting brain function and killing healthy cells. Malignant or high-grade brain tumors (grades 3 and 4) are classified as either benign or malignant (grades 3 and 4). In the upper third and fourth grades. The proposed method is designed to discriminate between normal & malignant brain tissue (benign or malign). Glioblastoma, bronchogenic carcinoma tumors, and soft tissue sarcomas are only few of the malignancies that may be detected with brain MRI. Support vector machines and wavelet transformations are utilized to identify & classify MRI brain tumors. Accurate and automatic MRI brain picture classification is essential for medical analysis and interpretation.

Prabhpreet Kaur et al. (2018) US Computer Aided Diagnostic (CAD) and detection for breast, skin lesions; brain tumour MRI diagnosis; X-Ray for chest analysis; Breast cancer using MRI imaging are six radiology applications examined". According to this research, radiologists can make more accurate diagnoses using the ML approach. In this study, the different denoising methods were evaluated.

Shree and Kumar (2018) A segmented & identified infectious region of a brain tumor is found. Obtaining MRI images involves a lot of effort. The human body's anatomical structures can be viewed utilizing image processing principles. It is challenging to see the aberrant architecture of the human brain using simple imaging techniques. The neural organization of the human brain is identified & clarified using the MRI technique. MRI technology uses a range of imaging techniques to scan and record the human brain. This study focused on noise reduction and the extraction of GLCM features to simplify and improve performance of DWT-based brain tumor area growth segmentation. After that, any remaining segmentation noise was eliminated using morphological filtering. In order to train & evaluate the performance accuracy in tumor location recognition in brain MRI images, a probabilistic neural network classifier was utilized. The experimental outcomes utilizing brain MR images showed that the suggested technique was virtually 100% accurate in differentiating between healthy & sick regions.

Zhang et al., (2017) "A feed-forward convolution neural network was explored as a way of incorporating the advancement in very deep architecture, learning algorithm, and regularization approach into image demising (DnCNNs). To expedite training & improve denoising results, batch normalization & relative learning were applied. Unlike prior discriminative denoising models, which typically train a specialized model for additive white noise, it can handle any level of white Gaussian noise. Using the residual learning technique, DnCNN automatically removes the latent clean image from the hidden layers. For instance, they might perform JPEG deblocking, single picture super-resolution, & Gaussian denoising all utilizing the same DnCNN model. Zhang etalexperiments.'s demonstrate that their DnCNN model is both easy to use & highly effective for a variety of broad picture denoising applications.

Ghimpeteanu et al.,(2016) A new paradigm for picture decomposition and denoising is presented. Components of image processing were calculated in an encoded moving frame based on local geometry. This was followed by a method for denoising the image components in real time, which preserved the image's local geometry and prevented it from being corrupted by the processing. It has been shown via experiments that this method outperforms directly denoising the image in terms of peak signal to noise and structure similarity index measurements.

In the year **2015 Jain A.** Medical ultrasonography denoised using Wavelet. In this study, Jain A. tackled the issue of speckle noise in ultrasonic imaging. Speckle noise reduced the efficacy of the ultrasonic imaging. The complexity of the imaging challenge dictated the speckle pattern. In a novel method, Jain made use of an adaptive threshold estimator. Different sub-band coefficients were used at different stages of the ultrasonic imaging system. As a result, this method has been shown to be more flexible. The threshold was calculated using the

scale parameter, variance in noise, and standard deviation for each sub-band of the noisy images. Based on the number of decompositions and the sub band sizes, the scale parameter was determined The experiment was conducted using ultrasound imaging. The proposed model outperforms denoising methods such as Normal Shrink, Median Filter, and Wiener Filter.

In the year **2012 Wang S.,and Summers R.M.** review of the potential of radiology-specific machine learning. It is impossible to overestimate the relevance of radiologic imaging in patient care. These new CT scanners and MRI technologies have made radiological imaging safer and more feasible for the general population. The number of images that radiologists must interpret is growing exponentially. Fatigue may develop in for the radiologist as their caseload grows. It is possible to employ computer-aided diagnosis (CAD) and image segmentation, registration, and registration for radiological images. Medical image processing & diagnosis may be automated using machine learning. Radiology reports, image retrieval systems, and text analysis all benefit from machine learning that incorporates natural language processing and comprehension.

CONCLUSION

The detection of brain tumors by MRI is a major challenge for modern medical imaging research. Radiologists typically use MRI scans to create pictures of human organs and tissues that are soft to the touch. It's a noninvasive alternative to surgical tissue removal and study of human organs. Image segmentation is essential for the diagnosis of brain tumors. This is a crucial yet challenging step in the process of diagnosing a brain tumor. Segmentation & classification of Brain MR images utilizing integrated texture region characteristics are presented in this chapter for overview. Intracranial neoplasms, which include brain tumors, are abnormal tissues characterized by the uncontrollable proliferation & differentiation of cells. Due to its disruptive & proliferative nature in the confined space of the cerebral cavity, this condition is of crucial importance. Both malignant & benign forms of brain tumors have been documented.

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