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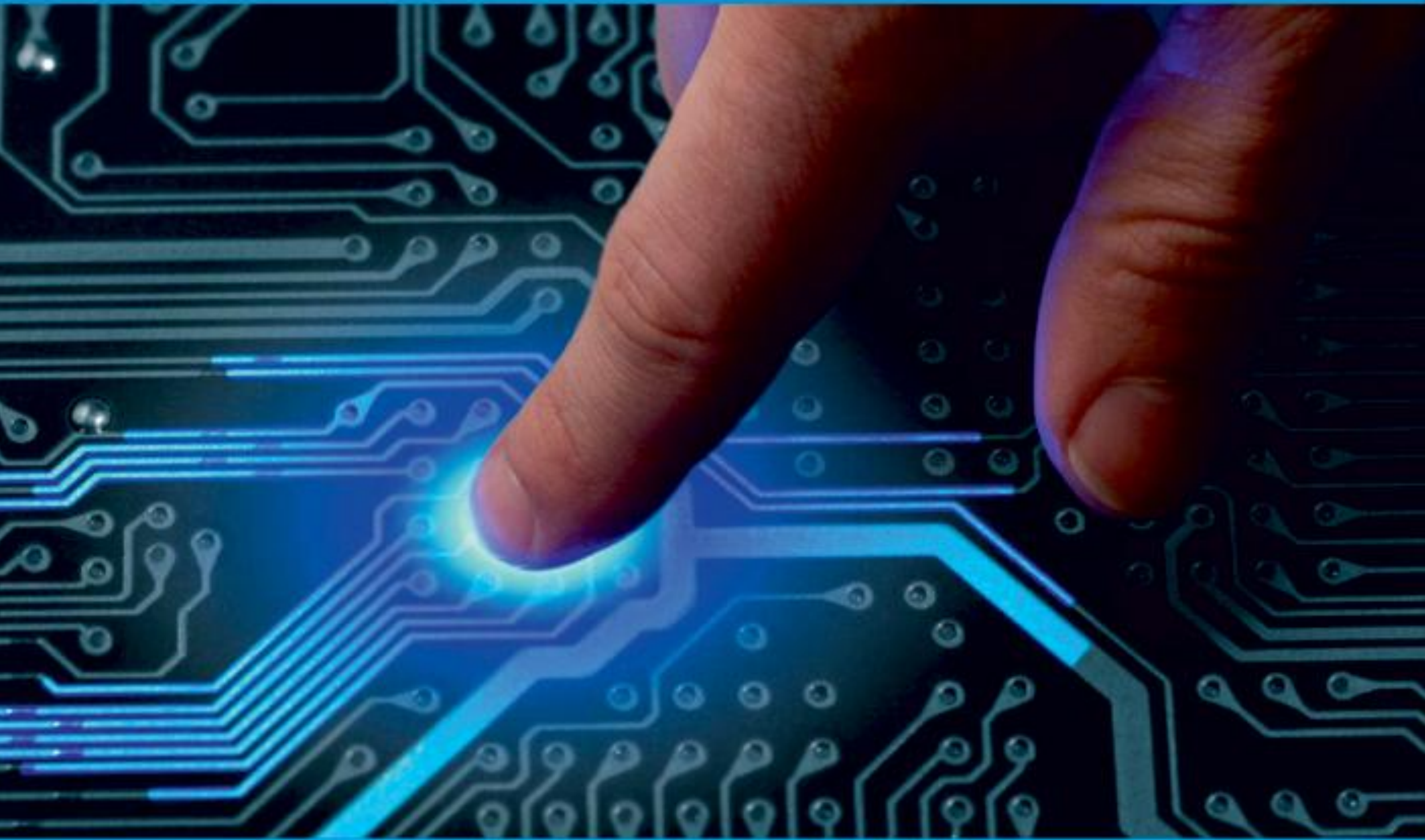

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Review on Detecting Brain Tumor using MRI

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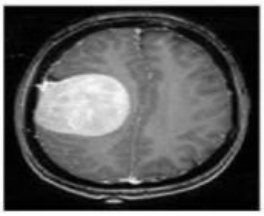
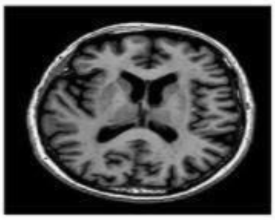
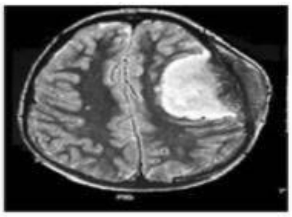
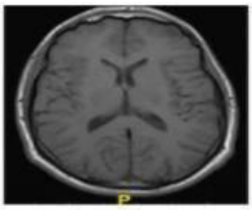
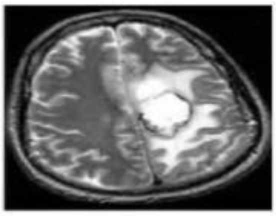
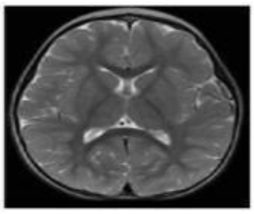
ABSTRACT: Tumors are swellings or overgrowths resulting from uncontrolled and unregulated cell division. Brain tumors are a particularly dangerous type of tumor. There are several types of brain tumors, which are divided into grades. The course of medical treatment for brain tumors depends on the type, extent, and location of the tumor. Brain tumor can be fatal if not detected early. Magnetic resonance imaging (MRI) images are used by medical professionals and neurosurgeons to diagnose brain tumors. Accuracy depends on the experience and domain knowledge of these experts, which is also a time-consuming and expensive process. To overcome these limitations, several deep learning algorithms have been proposed to detect the presence of brain tumors. In this review, a comprehensive and exhaustive guide to the subfield of brain tumor detection, focusing primarily on its segmentation and classification, is presented by comparing and summarizing recent research in this field. The study compared 30 research papers his times and highlighted different cutting-edge approaches. Given that there are studies ongoing in this area, this paper will be helpful to all future researchers.

I. INTRODUCTION

The brain is one of the most important and sensitive organs in the body and is the center of all neural activity. Problems that affect the brain are generally considered the most difficult to treat. With approximately 350,000 new brain tumors occurring worldwide each year, her 5-year survival rate for those diagnosed with a brain tumor is only 36% [12]. Brain tumors can be classified as benign (benign tumors) or malignant (cancerous tumors) [19]. The World Health Organization (WHO) classifies brain tumors into four grades, ranging from grade I to grade IV, depending on their severity. Neurosurgeons often recommend surgery to treat brain tumors. However, alternative approaches using radiation and chemotherapy are often proposed for the final stages of tumors. This means that the only possible diagnosis is to kill cancer cells or slow their growth [16]. Early detection of brain tumors is very important for proper treatment, as the mortality rate for those diagnosed with brain tumors is very high. Images from multiple medical imaging modalities can be collected for diagnostic purposes. Medical imaging modalities include PET (positron emission tomography), MRI (magnetic resonance imaging), and CT (computed tomography) [14]. Among these, MRI is considered to be the most effective medical imaging technique, especially for soft tissue and nervous system examinations. An MRI uses a powerful magnet and radio waves to create images of the body's structures by emitting weak signals. Unlike CT scans, MRIs do not use harmful x-rays. MRI images have high resolution and excellent detail, so even the smallest can be seen [7,18]. Tumors may appear as white areas or bright white patterns However, there are other parts of the brain which have a similar behavior as these cells and can lead to a wrong diagnosis.

As tens of thousands of patients suffer from brain tumors each year, the use of deep learning techniques for automatic detection and classification of brain tumors has become an area of interest. These techniques have also been used for brain tumor segmentation, and this area has received much attention from the medical community [17]. The purpose of segmentation is to change the representation of different regions of the image, making it easier to interpret regions of the image with different features. By dividing the image of the brain into these separate unique regions, each region is spatially continuous [2,3]. The most common problems with manual brain tumor detection are the considerable time required and the potential for misclassification due to the complexity of the problem. Therefore, automated segmentation of brain tumor MRI images can greatly improve diagnostic and therapeutic strategies, especially when access to trained specialists and radiologists is difficult [4]. This article describes the latest research in this field.

Brain Tumor Image	Brain Non Tumor Image
	
	
	

II. LITERATURE SURVEY

Sakshi Ahuja et al. [2] Using transfer learning and superpixel techniques for brain tumor detection and brain segmentation, respectively. The dataset used was from the BRATS 2019. Brain Tumor Segmentation Challenge. Trained with 19 transfer learning models. Tumors were segmented into LGG and HGG images using the Superpixel technique. This resulted in an average cube index of 0.934, in contrast to the ground truth data.

Hajar Cherguif et al. [3] used U-Net for semantic segmentation in medical images. U-Net architecture was used to develop an excellent folded 2D segmentation network. The BRATS 2017 dataset was used for testing and evaluation of the proposed model. The proposed U-Net architecture had 27 layers of convolution, 4 layers of deconvolutional and a Dice coefficient of 0.81.

Chirodip Lodh Choudhury et al. [4] Using deep learning techniques with deep neural networks, integrated them into a convolutional neural network model to obtain accurate results for MRI scans. A 3-layer CNN architecture was proposed and further connected to a fully connected neural network. An F-score of 97.33 and an accuracy of 96.05% were achieved.

Ahmad Habbie et al.,[5] T1-weighted MRI images were acquired and analyzed for possible brain tumor using semi automatic segmentation with an active contour model. The performance of edgeless morphological active contours, active snake contours, and morphological geodesic active contours was analyzed. As the data shows, MGAC won the top three out of a total of 4,444.

Neelum et al. [6] used a linkage approach to a deep learning model of in this article to analyze the likelihood that had brain tumors. We used pre-trained deep learning models, Inception – v3, and DenseNet201 to detect and classify brain tumors. An Inception v3 model was pre-trained to extract features and these features were concatenated for tumor classification. Next, the classifier was performed by a softmax classifier.

Ms. Swati Jayade et al. [7] used a hybrid classifier. Tumor classification was divided into malignant and benign. The feature dataset here was created using the Gray Level Co occurrence Matrix (GLCM) feature extraction method. A hybrid method of classifiers using KNN and SVM classifiers is proposed to improve efficiency.

Zheshu Jia et al.,[8] the author performed fully automated his heterogeneous segmentation using SVM (Support Vector Machine). We trained and validated the accuracy of his tumor detection on MRI images using a classification system known as the Probabilistic Neural Network Classification System. A multispectral brain dataset was used and this model focuses on automatic segmentation of meningioma

DR. Akey Sungheetha, DR. Rajesh Sharma R. [9] Gabor transform was used with soft and hard clustering to detect edges in CT and MRI images. A total of, 4500, 3000 MRI images and CT images were used. K-means clustering was used to separate the similar traits into subgroups. To represent the image in terms of histogram properties, the authors used fuzzy c means.

Parnian Afshar et al., [10] used a Bayesian approach to classify brain tumors using capsule networks. To improve the results of tumor detection, the capsule network was used instead of CNN because CNN can lose important spatial information. The team proposed his BayesCap framework. To test the proposed model, they used his benchmark brain tumor dataset.

III. BRAIN TUMOR DETECTION

The brain is the most sophisticated organ in the human body. It is a mass of nerve tissue composed of roughly 100 billion neurons. The brain is responsible for integrating sensory information, motor responses and is the center of learning. The Central Nervous System is made up of the brain and the spinal column. The CNS is responsible for the control of the vital functions of the body such as thought, speech and body movements. A brain tumor is an abnormal growth caused by the uncontrolled multiplication of cells. This abnormal growth in the brain or central spine can disrupt the normal functioning of the body and can affect the way a person talks, moves and processes thoughts. There are two types of brain tumors, primary tumors and secondary tumors. Primary brain tumors originate from the brain, and can further be classified as low grade or high grade. Low grade tumors grow at a slower pace as compared to high grade tumors. Secondary brain tumors are cancerous, and can start from some different part of the body and then spread to the brain [2].

The brain has a highly complex structure, making the diagnosis of brain tumors difficult Brain tumors take the lives of nearly 250,000 people each year. Accurate diagnosis of brain tumors can save the lives of people to some extent. MRI images are extensively used to detect brain tumors. The following steps are involved in detection and treatment of brain tumors:

1. Pre-processing: This is done to improve the quality of the raw MRI images and transform them into a form, suitable for processing by humans or machines. This step also helps in removing undesired noise and enhancing overall appearance of the MRI images. Image pre-processing involves steps such as creating functions to load image datasets into arrays, resizing raw images to an established base size before feeding it to the neural network, applying normalization to rescale the pixel values so they lie within a fixed range, data augmentation to increase the size of the dataset if insufficient number of images are available, among other steps [19, 28]. These preprocessing tasks help improve classification accuracy and also speed up the training process.

2. Skull Stripping: This is the process of removing parts of the images which have non-brain tissues. Through this, cerebral tissue which is not required for the analysis of the brain tumor, such as fat or skin, is removed [18]. Some popular techniques for skull stripping are based on Segmentation and contouring of images.

3. Segmentation: This step aims to differentiate abnormal brain tissue from the normal brain tissue. There are manual, semi-automatic and fully automatic segmentation techniques [20]. In manual segmentation, the outline of the affected tissue area is manually traced. This method has the highest accuracy; however, it is time-consuming and cumbersome. Semi-automatic segmentation involves the users inputting some initial data to obtain the final results. In fully automatic methods, the values of the parameters do not have to be set manually and these methods can automatically detect and segment the brain tumor.

4. Feature Extraction: This step will improve accuracy of the system by selecting the more prominent features for us. It is used as a method for dimensionality reduction, and the Initial data is reduced into a format which is more suitable for processing.

5. Post-processing: Post-processing provides an insight into the brain image of the tumor area. This step can include methods such as limits on the shape of the samples, contextual Limitations for more accurate results and spatial control. Brain scans can be done through different methods, the most common of which is MRI scans. The proposed algorithms discussed In this paper make the use of MRI scans, and involve the discussion of three broad tumor types:

1. Benign Tumor: Benign tumors are not cancerous and do not spread to other parts of the body or invade adjoining tissues. They grow at a slower pace, however, benign tumors can pose a serious problem if they press on nerves, restrict the blood flow or crowd the normal parts of the brain [17]. They generally respond well to treatment and can be removed through surgery in most cases. These tumors have low chances of recurrence.

2. Pre-malignant Tumor: It is not necessary that benign tumors turn cancerous, they might not. However, they can turn cancerous if the uncontrolled multiplication of tumor cells continue. Such types of tumors need to be carefully monitored for changes in the cell such as the cell appearance and growth rate.

3. Malignant Tumor: Malignant tumors are cancerous and can invade nearby tissues. The cancerous cells may break away from the tumor, and can then spread to other parts of the body through the lymphatic system or the bloodstream [22]. This is known as metastasis. Malignant tumors grow rapidly and can also recur, not necessarily at the same area where they initially appeared. Treatment of this type of tumors requires aggressive treatment methodologies which may include chemotherapy, radiation techniques and surgery. They are life threatening and necessitate some sort of treatment.

1. Threshold based segmentation: This is one of the simpler segmentation techniques. It replaces the pixels of the images with either black or white. In this technique, the comparison of the pixel value with a threshold value is done. If the value of the pixel is lower than the threshold value, the pixel is replaced with black colour, otherwise it is replaced with white. The value of the threshold can be changed as per the requirements. It is commonly used to separate the foreground and background, but the division is always into only 2 classes which is a drawback. This method can prove to be useful if the objects in question have more intensity than the background or the unwanted portions of the image.

2. Edge based segmentation: This technique detects edges in an image, which in turn can be used to identify certain objects [8]. Two of the common edge segmentation techniques are sobel and canny edge algorithms.

3. Clustering based segmentation: This technique creates segmented images from a rough initial pixel clustering. With the help of gradient ascent methods, these clusters are refined until the image is segmented. These methods try to minimize the distance between the pixels and the clusters formed [14, 28]. K- means clustering, SLIC, watershed etc. are commonly used clustering algorithms.

4. Graph based segmentation: In graph based segmentation, the individual pixels are considered as nodes of a graph. The degree of similarity between the adjacent pixels is then proportional to the weights of the edges between these nodes of the graph. Using the set of nodes and edges, pixels are grouped into superpixels or distinct segments. Graph cut and Normal cut are two commonly used graph based segmentation techniques.

V. MAGNETIC RESONANCE IMAGING

Magnetic Resonance Imaging is a medical imaging technique in which radio waves generated by a computer and strong magnetic fields are used to provide detailed data and images of different parts and structures of the body. Unlike CT scans, MRI does not make use of damaging radiation of X-rays and is of no harm to the human brain [19]. It helps in providing a cross-sectional image of the brain, which can be evaluated to ascertain the location and size of the tumor, if present. It is a non-invasive procedure. MRI machines are typically tube-shaped and surrounded by circular magnets.

The patient is asked to lie on a table, which slides into the tube shaped machine and examination is done. Normally, the water molecules in the body are arranged in a random manner. The working principle of MRI is that the magnetic field aligns the protons in the hydrogen atoms. These atoms are then exposed to a beam of radio waves, causing the protons to spin in a particular direction and emit faint signals which are received by the MRI machine. These signals are processed to form MRI images for further analysis [12]. Through this process, cross- sectional images of the brain can be created. These images can be used to locate the tumor and analyse its shape and size, and assess the best course of action to treat the brain tumor.

VI. CONCLUSION

This paper introduces the concept of brain tumor detection and segmentation and highlights and compares some of the key points of state-of-the-art approaches used in this domain. Some of the commonly used techniques are ML techniques like Fuzzy K-means clustering and Random Forests, as well as the use of CNN architectures is prevalent. In particular, S.Krishnakumar et al. [28] achieved the highest accuracy of 99.7% with the use of MKSVM algorithm on the MMRI dataset. High accuracy of classification of 99.12% was also achieved through the use of a combination of feature extraction algorithm and CNN [22].There are a few challenges encountered in further research work in this domain. Deep learning methods require large datasets for training purposes, and the lack of such large publicly available datasets is an obstacle.

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