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A Review on Various Brain Tumor Classification methods by using machine-learning techniques

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***Abstract*— Tumor is a condition where an abnormal growth of body tissue takes place inside the body; these can be cancerous or non-cancerous. Among all the types of cancers, Brain tumors are very rare but deadly. These tumors are difficult to cure as compared to the tumors in other body parts, as they exist within the protected location inside the brain. However, generally, CT scan (Computer Tomography scan) and MRIs (Magnetic Resonance Imaging) are used for detection of tumors and for the treatment surgery, radiation and chemotherapy are done but it has been observed that these treatments effects badly on the normal functionality of the brain, also CT Scans and MRIs can only detect tumors in their later stages. Thus, to save one's life early detection of the brain tumor is very crucial. Machine Learning is an emerging technology these days which can be a revolutionary milestone in medical science hence, a survey has been conducted on the various available machine-learning techniques so that early detection of brain tumors become possible and the techniques, which are still unnoticed, can grab the attention giving benefit to the mankind.**

As per the reports given by World health organization, to identify accurately about brain tumor identification or detection on the basis of what is its type, in which location it is existing inside the brain and what is the grade of tumor. Finding the brain tumor location is crucial for further for performing segmentation process and rest of the other steps involved in the classification. Dataset taken from openly accessible resources majorly contains information related to the grade, location of existence and type of brain tumor it belongs to. The main objective behind this is to decrease the complexity by new techniques. In this survey, we have come across various such proposed methodologies by using various machine learning techniques or classifiers with the final goal to achieve good accuracy and to identify the brain tumor in the human body as early as possible.

Keywords: Machine Learning, Brain tumor, Classification Techniques

I. INTRODUCTION

A brain tumor, which is also known as intracranial tumor, is a condition where abnormal growth of tissue and uncontrolled cell proliferation took place in the location within the brain. Over 150 types of brain tumors have been cited until date. Mainly, brain tumors fall into two categories namely Primary Brain Tumors and Metastatic Brain tumors. Tumors that are developed from brain tissues itself are referred as Primary brain tumors. Primary brain tumors are further classified as glial or non-glial and benign or malignant whereas Metastatic brain tumors arise elsewhere in the body such as the breast or lungs and spread to the brain through the bloodstream. Metastatic tumors are cancerous and malignant. Around 150,000 people are affected by this deadly disease each year. Patients with brain tumors usually develop headaches, nausea, hearing issues, and vision problems. Diagnosis of brain tumors is done by imaging techniques like CT scan, MRI scan, and biopsy. However, all these techniques can diagnose tumors in the later stages of the tumor. As per the reports given by world cancer research, the primary cause of death is cancer. Hence, early detection of tumors is crucial so that timely treatment can be provided to the patients. The already existing techniques are however able to diagnose brain tumors but they are not able to diagnose brain tumors in its very early stage which is very crucial, Thus to detect brain tumors in their very early stages machine learning has played a vital role. This paper survey includes description of various such implied and used machine-learning techniques, which are providing very accurate results. Machine learning is a method by which systems can learn from experience without being explicitly programmed. It is the development of computer programs having the ability to access data and make use of it independently. By combining machine-learning algorithms with magnetic resonance imaging (MRI) signals, one can replace conventional invasive tumor classification methods with less invasive techniques. The process of brain tumor detection by machine-learning techniques involves these steps: First Step is the collection of datasets in the form MRI Images available in the various publicly available sources. These standard brain tumors images databases for example BRATS, BrainNet etc. ,the whole process is known as Image Acquisition and Database Collection as the next step these collected database are pre-processed. The purpose of pre-processing is to improve the visual quality of image

databases by filtering all noise. After pre-processing next step is Segmentation, it yields appropriate interpretations and treatment plans by separating the cyst from healthy brain tissue, however sometimes segmentation can be skipped if direct classification is being applied, After segmentation next step is followed is Feature Extraction it is an approximate analysis approach to predict the shape and location of tumor by edge detection method. Later Classification method is applied to the dataset by using various machine-learning techniques already presented in the literature survey. In the paper mainly deep-learning CNN model, image processing, methods have been utilized. A deep learning technique is a specialized approach to machine learning. With deep learning, classification can be carried out directly on a dataset of images, sounds, or texts. The development of deep learning models requires a large volume of labelled data and the use of a multilayered neural network architecture. As deep learning utilizes many layers of neural networks to perform advanced feature recognition or prediction, it is sometimes called a deep neural network. Deep neural networks (DNN) are neural networks that have multiple layers between inputs and outputs (ANNs).In a deep neural network, each mathematical operation is treated as a layer. Convolutional neural networks (CNNs or ConvNets) are a class of deep neural networks. In convolutional networks, the matrix multiplication takes place in at least one layer of the network by activating convolutional processes. There are three layers to a convolutional neural network: an input layer, an output layer, and hidden layers. CNNs are feed-forward neural networks used for image recognition and classification.

II. LITERATURE SURVEY

The accompanying writing study is led to analyze and discover the precision of proposed different machine learning methods for the order of cerebrum tumors on their beginning phases, depicted as follows:

TABLE 1.

WORK DONE RELATED TO THE CLASSIFICATION OF BRAIN TUMORS USING MACHINE-LEARNING TECHNIQUES.

NAME OF AUTHOR	CLASSIFICATION METHOD	DATA SET	FEATURE EXTRACTION METHOD USED	ACCURACY
Abdu Gumaei, 2019	In this article, a hybrid feature extraction method conjoined with regularized extreme learning machine (RELM) has been used for classification method [16].	Cheng [26],[27] Images.	The feature extraction method applied is Principal component analysis (PCA)-based normalized GIST [16].	91.51 % to 94.233 %
Zahraa a. Al-Saffar et al. 2020	In this paper as an input to the classifier, a significant subset of features from a new method called mutual information-accelerated singular value decomposition (MI-ASVD) is used [8].	1467 axial-plane FLAIR MR Images [8].	Feature extraction methods include grey-level run-length matrix (GLRLM), texture and colour intensity features. [8].	
Annapareddy V. N. Reddy et al. 2020	For classification of glioblastoma (GBM) tumors with magnetic resonance imaging (MRI), deep belief networks (DBN) technologies were utilized.DBN is constructed from stacked restricted Boltzmann machines (RBM) [7].	Data obtained from Rider Neuro MRI image collections in the cancer imaging archive repository [7].	Feature extraction methods mainly includes Discrete wavelet transform (DWT), vectorization [7].	91% to 97%
Sadia Anjum, et al. 2020	LDA (Linear discriminant analysis) and SVM (Support Vector Machine) with linear and quadratic kernels is used for classification purpose [22].	The dataset used in this study comes from the School of Biomedical Engineering, Southern Medical University, Guangzhou, China. (https://github.com/chengjun583/brainTumorRetrieval) [22].	Feature extraction methods were being used is based on (Reconstruction Independent Component Analysis) RICA technique [22].	94.35 %
Zar Nawab Khan et al. 2019	A proposed technique utilized a Deep CNN model and a fine-tuning procedure, which depends on transfer learning [13].	CE-MRI dataset (Cheng, 2017) is available at (https://figshare.com/articles/brain tumor dataset/1512427) [13].	A deep learning approach has been used here to automate feature extraction by converting manual feature extraction into self-learning [13].	94.82 %

Khalid Usman Et al. 2017	Using MRI scans with a variety of classifiers, an algorithm has been introduced that uses input parameters such as intensity, intensity difference, and neighborhood information and wavelet features [19].	BraTS dataset.	Here, wavelet-based feature extraction is used [19].	97%
S. Deepak , P.M. Ameer 2019	The proposed classification system relies on deep transfer learning [11].	Figshare dataset with 3064 brain imaging images from 233 patients [11].	Here, feature extraction is done by using deep transfer learned CNN model [11].	97.1%
Javaria Amina, et al. 2019	Local Binary Pattern (LBP) and Gabor Wavelet Transform (GWT) features are combined for accurate classification. Also before applying LBP and GWT techniques for de-noising Weiner filter with other wavelet bands along with Potential Field (PF) clustering is also used. Apart from the above-mentioned techniques to segregate the tumor region Global, threshold and distinct mathematical morphology procedures are also applied to various datasets example Flair and T2 MRIs [10].	BRATS 2013[10]	Feature extraction methods includes Local binary pattern (LBP) and Gabor wavelet transform (GWT) [10].	96%
Chao Ma, et al. 2018	In this script, for the automated segmentation of the gliomas from multimodal volumetric MR images, a new approach has been introduced that combines random forests and active contour model and later used for segmentation process. [18].	BRATS2017 [18].	Specific feature extraction method is not mentioned [18].	90%
Marcin Woz´niak1 Et al. 2021	The combined power of a convolutional neural network (CNN) and a classic architecture has been introduced as the correlation learning mechanism (CLM) for deep neural networks [2].	Brain MRI images from Kaggle portal is used as dataset [2].	Pooling technique for feature extraction method [2].	96% to 95%
N. Varuna Shree • T. N. R. Kumar 2018	In this journal, DWT (Discrete wavelet transform) and probabilistic neural network techniques has been used as classification method [17].	Two type of dataset has been used: first, one is Trained dataset collected from "www.dicom.com" and another was test dataset. Almost 650 collected samples from the 25 images of DICOM dataset, of which 18 are already affected by tumor brain tissues and others normal for the analysis has been picked up for implying proposed method	Gray-level co-occurrence matrix (GLCM) for statistical feature extraction is applied [17].	100%

		[17].		
Salma Al-qazzaz, et al. 2021	This journal presents a classification-based approach for automatic brain tumor tissue segmentation based on combined CNN and handcrafted features [1].	BraTS 2017[1].	Multilinear singular value decomposition of a tensor constructed from multimodal MRI data, combined with Random Forests, and are used in feature extraction [1].	0.84% to 0.66%
Rajat Mehrotra et al. 2020	A Deep Learning algorithm is proposed for classifying types of brain tumors using open datasets to perform AI-based classification of BTs [3].	696 images on T1-weighted images has been used as dataset [3].	Feature extraction method has been performed using deep learning or CNN techniques [3].	99.04 %
Hossam H. Sultan et al. 2019	This paper proposes a Deep Learning algorithm based on a convolutional neural network for classifying brain tumors [14].	The dataset used for implying the proposed system has been collected from Nanfang Hospital and General Hospital, Tianjing Medical University, China between 2005 and 2010, and later published online with various versions since 2015 reaching its release in 2017[14].	Feature extraction process includes study of input patterns, followed by training the classification network on them [14].	96.13 % and 98.7%
Moham ed Shakeel et al. 2019	In this script, MLBPNN (multilayer back propagation neural network) is analysed using infrared sensor imaging technology. Therefore, the computationally multifaceted nature of the neural distinguishing proof is immediately diminished by fragmenting it into a few small parts [12].	Surgical Planning Laboratory (SPL) dataset [12].	To reduce the complexity of the analysis, we extract the features by using a Fractal Dimension Algorithm (FDA) and multifractal detection (MFD) techniques. [12].	99.8%
Zaka Ur Rehmana, et al. 2020	In the proposed method, both recent and most useful technologies are incorporated: (1) a texture image is created from the on-map text, and (2) the features are extracted from the super-pixels. [5].	BRATS 2012 dataset (FLAIR) [5].	The proposed feature extraction includes 11 first-order statistical levels of intensity and 5 histogram levels [5].	98.57 %
Muhammad Sajjad, et al. 2019	A new classification system for brain tumors based on convolutional neural networks (CNNs) is presented in this paper. [25].	The dataset comprises 121 MR images, which have been graded into four different categories by Radiopaedia [25].	The deep neural networks is used to extract features [25].	91% to 94%
Chirodip Lodh Choudhury, et al. 2020	Deep neural networks and CNN-based models are employed in the proposed work to classify the MRI images for brain tumor detection [24].	The dataset used from Kaggle [24].	CNN technique for feature extraction [24].	96.08 %
P.M. Siva Raja , et al 2020	This paper classified brain tumors by using a hybrid deep auto- encoder with Bayesian fuzzy clustering-based segmentation [27].	BRATS 2015 dataset [27].	Feature extraction process includes Wavelet packet Tsallis Entropy (WPTE), Scattering Transform (ST) [27].	98.5%
Gunasekaran Manoga	In this paper gamma distribution-	Dataset obtained from	GLCM Feature extraction method is used	99.55 %

ran; et al. 2018	based machine-learning approach, has been introduced for analysing the under-segments and over-segments of brain tumor regions [26].	MPI-Leipzig Mind-Brain-Body (https://legacy.openfmri.org/dataset/ds000221/) has been used [26].	[26].	

III. CHALLENGES

- Machine learning techniques used for the brain tumor detection proved to be a very efficient with the diagnosis and analysis of the disease. These techniques have been eased the work of radiologist and medical practiceners largely. For classification purpose, mainly SVM (Support Vector Machine), Fuzzy c –means (FCM), self-learning maps (SOM) etc. is used. However while performing the major steps: segmentation and clustering Artificial intelligence can also be combined together to improve results with more accuracy.

- In addition to machine use learning-based data fusions that can be applied to the analysis of brain tumors, this framework can also for other types of biomedical or biological data exchanges for sample classification.

- Another technique used for tumor detection is the combination of DWT(Discrete wavelet transform) and DNN(Deep Neural Networks) which has definitely yields good results but in future a combination of DWT(Discrete wavelet transform) and CNN(Convolutional Neural Network) must be used the results should be compared for better accuracy.

- MLBPNN (Machine Learning based Back Propagation Neural Networks) technique is used on 2D brain images and proved to given better output with good accuracy it can be further be implied to 3D brain tumor images by using various machine learning approaches using infrared sensor imaging techniques.

- Deep learning based pre trained Convolutional Neural Network, technique was used for classifying MRI images into various categories. The study shows that per trained DL network's performance applied on datasets heavily depends on the type of optimizer chosen, this affects the accuracy and time taken to train the network, hence it is required to apply pretrained networks more on larger datasets and can focus on the reduction of time taken and getting accuracy improvements.

Different classifiers can be utilized to increase accuracy with a large dataset that contains many different scenarios. These classifiers include DWT (discrete wavelet transform), PNN (probabilistic neural network), and GLCM (gray-level co-occurrence matrix).

- Deep Neural Networks needs to be more exploration in neuroimaging fields using 3-D VOIs and increasing the number of classes of tumors.

IV. CONCLUSION

The paper summarizes and presents various proposed methodologies for brain tumor detection and classification using different machine learning and deep learning techniques, which is really proving to be a boon and innovative towards the medical field. A variety of techniques has been utilized, including genetic algorithms to optimize the segmentation and convolutional neural networks to just classify the images. Several of these methods have yielded good results with accuracy even as high as 100%.The proposed methods are particularly giving good results but they can also be used further utilized on different datasets and pre trained networks where they can be envisioned and combined together to achieve more new outputs with better accuracy. In addition, there is a possibility that these methods will yields similar expected results in different type of cancerous diseases too.

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