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Brain Tumor Diagnosis using Machine Learning: A Review

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ABSTRACT

Recently, early brain tumor diagnosis has grown in importance as a study area recently. The patient's rate of survival rises with early tumor detection for primary treatment. Because of the high processing overhead caused by the enormous volume regarding image input to processing system, processing magnetic resonance image (MRI) for the early detection of tumors presents a problem. This led to a significant delay and a decline in system effectiveness. As a result, recently, there has been an increased requirement for an improved detection system for precise representation and segmentation for accurate and faster processing. Latest literature has suggested the creation of novel methods depending on enhanced processing and learning for the detection of brain tumors. This essay provides a succinct overview of the MRI-related advancements. The machine learning (ML) algorithms' capacity for fine processing and learning has shown an enhancement in the efficiency and accuracy of processing for the detection of the brain tumor in existing automation systems. Restrictions, advantages, and outlook for future regarding the present approaches for computer-aided diagnostics (CAD) in the detection of the brain tumor are discussed, along with current advances in automation related to brain tumor detections. In the presented study, researcher explore the history of numerous methods that have been put forth to image brain tumors across a variety of domains.

Keywords: Magnetic Resonance Image (MRI), Machine Learning (ML), Neural Network (NN), Support Vector Machine (SVM), Convolutional Neural Network (CNN).

1. INTRODUCTION

Expansile lesions that start in the brain are called brain tumors. Benign (i.e. non-cancerous) and malignant (i.e. cancerous) types could be distinguished between them [1]. Brain tumor segmentation and classification became essential for image analysis in this situation [2]. Various techniques, such as computer-aided classification and manual classification, could be used for brain tumors classification. Manual classification related to brain tumors is considered to be error-prone and time-consuming [3, 4]. Manual classification, on the other hand, cannot be disregarded because it continues to serve as the gold standard for clinical care and as a benchmark against which other procedures are measured [5]. Currently, radiological and clinical data are used to inform management and diagnosis. Even though traditional imaging has substantial limitations in assessing predicting grade, tumor extent, and measuring treatment response, MRI remains the standard for the evaluation regarding brain tumors' patients [6]. To enhance lesion characterization, therapy assessment, and management, new acquisition methods are being developed [8]. Yet, due to the wealth of information included in radiological images, new image analysis methods were gaining popularity [9]. Since it provides crucial information for both medical and surgical diagnosis, the classification and detection of tumors in MRI have grown in importance following a technical evaluation [10]. For two reasons, MRI is regarded as the most precise method for examining tumors in soft tissues. The first is that MRI images provide a wealth of information regarding the tumor, and the second is that radiation exposure has no known adverse consequences [11].

An effective tool for pattern recognition as well as other cognitive activities carried out by the human brain is a neural network (NN) model. The learning mechanism type that has been used in order to produce the output from network is the foundation of the NN method for pattern recognition [12]. The problem of people using false identities has gotten worse recently due to the various proposed ways for brain tumor detection. In the presented work, we examine a method for detecting brain tumors in great detail using a NN. This study residual parts are organized as follows: the literature review of a few approaches proposed in the most recent ten years is found in Section 2. Comparative examination of schemes that have been outlined in Section 2 is presented in Section 3. Lastly, Section 4 presents the conclusions.

2. LITERATURE SURVEY

There have been numerous methods examined recently with regard to brain tumors. We talk about a few of such studies in this section.

In the presented work, Su Ruan, Qingmin Liao, Stéphane Lebonvallet, Nan Zhang, and Yuemin Zhu all contributed [13]. Lately, techniques for employing an MRI equipment to more accurately detect brain tumors were created. A suggestion for segmenting brain tumors. The objective is to use an MRI scan for defining tumor progression. The definition of a tumor involves two steps. With the use of SVM, the first assigns a multiple outcome relative to the tumor region. The second phase entails enhancing the contour regarding the tumor area with the use of measurements of maximum likelihood and distance. The multi-kernel SVM approach that was suggested works with several inputs of data and handles the challenging tumor segmentation problem with reliable results. When put to comparison with a traditional single SVM, it produces better outcomes with "excellent" parameters across the data.

Muhammad Naeem Tahir [14], this work used MRI regarding the brain and it is conducted in stages, including the insertion of images depending on the texture, location, edge, and color of the tumor as well as from the segmented images, which will after that be identified with the use of classification methods. The patient's normality or abnormality is after that determined using DNN technology. Venkatramaphanikumar Sistla, Venkata Krishna Kishore Koll and Siva Koteswara Rao Chinnam [15] discuss this topic in their work. Apply SVM PUK first to eliminate noise and smooth brain images. The study extracts statistical features. Then, spin features are extracted using Gabor Wavelets. The SVM-PUK classifier is used to classify statistical Gabor features as well as reduced PCA, both of which are complex features.

Yogesh Kumar Meena, Neha Mathur, Divya Mathur, and Shruti Mathur [16] discuss this topic. For detecting edges with the use of a fuzzy method, we utilize an MRI regarding the human brain. Also, the edge detection is carried out with the use of automatic threshold value generation, a fuzzy approach, and the performance of traditional and literal Sobel detectors depending on human judgment. There aren't many bezel options for the traditional Sobel. The traditional Sobel approach is used, which improves its performance by giving the tumor's whole edges.

In this study MilicaM. Badza et al., Convolutional neural networks (CNN) have seen significant improvements in image segmentation thanks to ML algorithms [17]. It has been done in three stages: the first stage makes use of an image database that employs (t1), the second stage makes use of a database analysis, and the third stage makes use of a CNN.

Bahadure NB Ray AK Thethi HP [18], in this work, the authors classified brain tissues into normal tissues like gray matter, cerebrospinal fluid (posterior), white matter, and tumor tissues using the FCM. Pre-processing was employed to lessen the impact of undesired noise that was acquired throughout the acquisition regarding MR images, and automatic enhanced FCM technology was utilized for optimization to boost the quality related to raw MR images. The threshold technique-based skull stripping removes unwanted brain tissue, including skin and fat. The trait vector is retrieved, improved, and classed with the use of a genetic algorithm to increase the precision regarding tumor stage classification.

This study is employed by G. Revathi, Suganthe, S. Monisha, and R. Pavithran [19], and it includes the stages listed below: - A variety of feature extraction and classification techniques are employed in this study to use MRI to identify a brain tumor. Early-stage tumor detection using a CNN image classification technique proved highly accurate. A repetitive NN, a kind of ANN where connections between nodes create a vector graph over a time sequence, was utilized to identify cancer cells. For automating feature extraction, DL techniques were developed. In the case when put to comparison with current system, the suggested study has improved accuracy and decreased loss.

Brain tumor image classification is a crucial component of medical image processing, according to Zongxuan Shen, Xiaoqing Gu, Yiqing Fan, Jing Xue, and Tongguang Ni1[20]. It is helpful for the clinicians to develop accurate diagnoses and treatment approaches. One of the primary imaging methods that have been utilized in order to examine brain tissues is MRI. In this paper, the authors suggested a convolutional dictionary learning with local constraint (CDLLC) brain tumor MR image classification approach. For the purpose of investigating discriminative information, the approach includes multi-layer dictionary learning into the CNN structure. A vector on a dictionary could be thought of as being projected numerous times into different spaces, and the resulting coding vector is sparse. We create the local constraint regarding atoms through a supervised k-nearest neighbor network for preserving the geometric structure related to the data and use the supervised information, resulting in a dictionary with strong discrimination. An effective method of iterative optimization is created to address the problem. On the REMBRANDT and Cheng datasets, two clinically pertinent multi-class classification tasks are constructed for the experiment. The evaluation outcomes show that the approach is efficient for classifying brain tumors in MR images, and it may outperform other alternatives.

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3. COMPARATIVE ANALYSIS OF THE SCHEMES

Table1 below demonstrates a comparison between the preceding systems.

Table 1.1. Comparative analysis of schemes for some data-set

Reference Paper	Dataset	Preprocessing and Features	Recognition rate (RR) %	Method used
Nan Zhang et al.,[13]	Real patient images	Segmentation of Multi-Kernel(SVM), Principal Components Analysis)	98.9%	Multi-Kernel(SVM)
Muhammad Naeem Tahir [14]	Image of tumor and non-tumor	Segmentation of MRI and classification	90%	Deep neural network technique
Siva Koteswara Rao Chinnam, et al.,[13]	BRATS- 2018	Gray-Level Co-Occurrence Matrix) GLCM), Gabor wavelet	91.31 %	SVM with PUK.
Neha Mathur, et al.,[16]	MRI image 7.tif	K-means segmentation threshold.	Good	fuzzy-based K-means clustering system
MilicaM. Badža et al .,[17]	T1-weighted contrast-enhanced MRI images	transformation has been image rotation by 90^{o}. The second transformation has been flipping the images in a vertical manner	96.56%	Convolutional Neural Network(CNN)
Nilesh Bhaskarrao et al ., [18]	Digital Imaging and Communications in Medicine (DICOM)	ation using watershed, FCD,DCT,BWT	93.79%	genetic algorithm (GA)
Dr.R.C. Suganthe, et al., [19]	IXI,REMBRANDT	MR as radio frequency pulses and gradients. T1 and T2 The grey matter (GM) and white matter (WM) images	90%	Recurrent Neural Network (RNN)
Xiaoqing Gu، et al., [20]	Cheng and Repository of Molecular Brain Neoplasia Data (REMBRANDT)	tic gradient descent (SGD) and Tensor Flow	97.12%	Convolution dictionary learning with Local Constraint

4. CONCLUSION

The approaches created for the suggested study of brain tumor detection are thoroughly researched in literature. Because of the intricate nature of the brain's anatomy, finding a brain tumor is a significant difficulty. The brain is in charge of directing all bodily organ operations. Deep and machine learning methods play a significant role in the automatic classification regarding early-stage brain tumors. Those systems enable the prompt diagnosis and raise likelihood of the survival for the patients. In this study, we examined different dependencies on NNs across network using a timeline (2009-2021).

Due to its fine-grained features, complicated decision-making, and volumetric data presentation, the automation of brain tumors is a crucial endeavor. The complexity of the calculations and processing speed both affect system performance. Latest advancements

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have tended to incorporate new ML systems that have increased the usage of ML techniques in MRI diagnostics, enhancing operational efficiency. The study discussed latest developments in feature presentation, classification models, segmentation, and automated brain tumor detection. An advantage was offered in the classification and processing regarding non-tumorous and tumors regions in the sample by using an intelligent method to ML techniques, like neural network (NN) convolution neural network. The opportunity to create new methods for the enhancement of automated performance with quicker speeds and greater accuracy has been provided by ML techniques. A novel filtration method with adaptive filtering parameters depending upon dynamic windowing and recurrent mapping is being focused in the future to enhance the performance related to brain tumor detection. Focus is placed on segmentation enhancement via multiple scaling together with sophisticated feature extraction and classification. We will overcome learning burden and classification restriction with regard to precision and processing speed.

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