Comparison Among Different ”Brain Tumor Detection” Methods

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REVIEW PAPER

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ABSTRACT

Brain Tumor is a condition which arises due to the growth of abnormal cells which may be cancerous or non-cancerous. Early disease identification and curing strategies are important to know for a person suffering to ensure better life longevity. Radiology and diagnostics have brain tumor as its critical area that is aimed at enhancing early detection and patient outcomes. This review consolidates findings from 15-20 research studies, summarizing key advancements and comparing methods in brain tumor detection. The key techniques reviewed includes MRI-based imaging, machine learning, deep learning including neural networks, and advanced segmentation methods, each contributing to improved accuracy in detection. While significant progress has been made, challenges such as accuracy and computational requirements remain. Future research directions are proposed for enhancing detection methodologies. This paper provides a consolidated resource for researchers in the field, highlighting existing advancements and recognizing fields for upcoming analysis in detecting brain tumor.

I. INTRODUCTION

Recovering,keeping in reserve,presenting and sharing medical visuals are the tasks performed during image manipulation in medical image processing. Isotope imaging,Sonography and EM energy imaging are all included under medical image processing [1]. For assisting in brain tumor (BT) identification, algorithms of DL and ML increasingly applied to large datasets, such as Brain MRI scans [2].

Brain tumors, which result from abnormal cell proliferation in the brain, arise in a highly complex structure where different regions control various nervous system functions. ML advancements, especially deep learning, have greatly improved segmentation capabilities. For instance, Kwon et al. (2021) developed a DL-based system for glioma division in scanned images of MRI, surpassing traditional approaches in accuracy and sensitivity [3].

Segmentation aims to differentiate image regions by unique properties, aiding interpretation and highlighting distinct sections within a brain image. After segmentation, each region becomes spatially contiguous, allowing detailed examination of areas like tumor size, location, and range. Treatment options for brain tumors depend on factors such as tumor characteristics, patient age, and overall health and might involve surgical procedures, radiation therapy, or the use of chemotherapy and targeted therapies[4].

Diagnostic and therapy accuracy can be increased by self-operating partitioning of 3 dimensional MRI images of the brain, especially where radiologist availability is limited [4]. Gliomas, the most prevalent brain tumors (Sanai and Berger, 2012), include subtypes such as ependymomas, gangliogliomas, glioblastomas, astrocytomas and oligodendrogliomas (Louis et al., 2021). Notably aggressive and poor prognosis cells are called Glioblastomas cells that arise from glial cells. Each subclass has different properties and therapy protocols, necessitating separate assessments by healthcare professionals. MRI data offers visual insights into these tumor types, aiding in their diagnosis and management[5].

The organization of this paper falls into these following succeeding sections. *Section II* addresses the literature survey of techniques involving machine learning, feature extraction and image segmentation for tumor detection. *Section III* includes the experimental results of deep learning neural networks. *Section IV* involves entropy based thresholding and *Section V* states conclusions followed by acknowledgements and references.

II. MACHINE LEARNING AND IMAGE SEGMENTATION

A. Detection of Saudi pediatric patients' primary tumor of brain using MRI pictures and machine learning.

[6] Magnetic Resonance Imaging uses AI, mainly Artificial Neural Network (ANN), which helps in accurate detection of brain tumor. The study demonstrated that AI methods achieved comparable accuracy to radiologist reports, thereby improving the diagnosis and patient management process. In deep learning applications for tumor for brain classification MRI pictures play a crucial part, demonstrating superior accuracy compared to alternative methods. Enhancing data augmentation techniques and employing artificial neural networks (ANNs) further augments classification accuracy.

B. YOLO NAS Deep learning model for identification and categorization on brain tumor MRI images.

[7] This inquire approximately work centers on location and classification along with pituitary,meningioma, glioma, and non-tumorous tumors from mind tumor images using YOLO NAS. Hybrid anisotropic diffusion filtering (HADF) technique has been used to remove noise by the analysts for preprocessing the RGB photo to get rid of unwanted parts before the ROI process. The segmentation of the MRI photos are done using a deep neural network based on a pre-trained EfficientNet as the decoder and a U-Net as the encoder . Around 2570 MRI photos for training and 630 data for testing and validation of brain tumor cases are involved in this fusion approach giving its accuracy as 99.7%, F1-score as 99.2%, sensitivity as 98.5%, specificity as 98.5% and precision as 98.2% that made it one of the optimized method for detecting tumor.

C. Data analysis of Topological and decomposition of low-rank tensor used for better image identification and categorization.

[8] usually brain cancers, namely meningioma, glioma and pituitary are categorized and identified using this study using an ensemble approach involving magnetic resonance imaging (MRI). This approach is structured in two main stages. First,data preprocessing includes advanced image improvement methods, dimensionality is reduced using low-rank tensor decomposition, and the specific tumor type identification using ML classifiers. Second, MRI scans containing potential critical areas are recognized using a topological data analysis method(persistent homology) . The model's effectiveness was rigorously tested on a widely recognized MRI dataset, achieving an impressive categorization accuracy of 97.28% with the major randomized trees classifier.By combining Tucker decomposition for reducing dimensions and specific tumor type identification using machine learning models, alongside homology of persistent to define interest regions (ROIs) in MRI images, our system demonstrates a greater performance, with an F1-score of 97.16%. The use of TDA is especially valuable in identifying the spatial patterns and geometrical features of MRI data, helping to distinguish the tumor from adjacent morphologically altered tissues. This promising automated solution supports clinicians in diagnosing brain tumors in suspected patients and may have broader applications for other solid tumors in medical imaging.

D. A refined XGBoost technique for correct brain tumor identificati Refined XGBoost Approach for Accurate Tumor of Brain Detection Using Image Segmentation and Feature Selection

[9]Tumor of brain identification is often challenging due to noisy MRI images and the intricate structure of tumors, making manual analysis time-intensive and prone to errors. Early and accurate detection is critical, and segmentation plays a vital role in precise medical imaging analysis. With increasing image volumes, manual tumor evaluation risks misinterpretation, underscoring the necessity of automated solutions.

This study introduces an enhanced XGBoost-based model for reliable brain tumor identification, integrating feature selection and Contrast Limited Adaptive Histogram (CLAH) Equalization has been used to enhance the picture quality and advanced methods for photo processing, while for division, the K-Means algorithm is utilized to isolate regions of interest. Feature selection is further refined using Particle Swarm Optimization (PSO). Classification tasks leverage Iterative Dichotomiser 3 (ID3) algorithms, XGBoost, Naive Bayes. Results show that the refined XGBoost model achieved 98% precision, 97% specificity, 98% recall, and 97% accuracy. Future efforts aim to develop hybrid methodologies for improved tumor classification.

III. DEEP LEARNING INCLUDING NEURAL NETWORKS

A. Early brain tumor prediction using improved artificial rabbit optimization on brain data and improved attention based ensemble

learning.

[10] Deep learning greatly improves brain tumor prediction by integrating various data modalities and optimizing feature selection. The proposed model using an extended attention-based ensemble learning network shows remarkable accuracy in brain tumor prediction. We developed a deep ensemble network optimized by advanced methods for early prediction of tumors. An accuracy range of 6.44% to 13.06% has been achieved, showing superior accuracy compared to existing works. In future work, we will prioritize improving the mind tumors partitioning to improve the precision of the model.

B. Automated Metaheuristic Optimization Framework for Tumor Diagnosis and Classification Using CNNs

[11]This study presents a deep learning framework that employs convolutional neural networks (CNNs), pre-trained models, and MRFO optimization to classify brain tumors from X-ray and MRI images. The proposed approach demonstrated good performance and accuracy compared to other deep learning models. Using AI-driven methods, the framework effectively categorizes brain tumors based on imaging data. The MobileNetV3Large model became popular for binary classification, while Xception proved optimal for classifying tumors across three categories. The integration of CNNs and MRFO algorithms significantly enhanced diagnostic accuracy for both X-ray and MRI datasets.

C. Tumor of brain Detection Using MRI with Machine and Deep Learning Algorithms

[12] The study shown here, integrates DL and ML methodologies with MRI for diagnosing brain tumors which turns out to be an innovative approach. The process begins with collecting and preprocessing MRI scans using median filtering and adaptive contrast enhancement algorithm (ACEA). The preprocessed images undergo segmentation through a fuzzy c-means-based method. The key features such as mean, energy, entropy, and contrast are being extracted using gray level co-occurrence matrix. Classification using deep neural support vector machine model is done. The results validate the efficiency of this approach, achieving a high accuracy rate of 97.93%, sensitivity of 92%, and specificity of 98%, effectively distinguishing abnormal tissues from normal ones in brain MRI scans.

D. Improved Brain Tumors Classification and Detection using Deep Learning.

[13] This study focused on early diagnosis and classification of brain tumors, by building an intelligent hybrid system, for which the authors proposed an automatic contrast-enhanced tumor detector and classifier with a two-stage approach. At first, for accurate diagnosis, ODTW CHE was used to enlarge the contrast of the image. In next stage, the classifier use pre-trained Inception V3 models including VGG-19, AlexNet, GoogLeNet, ResNet-50 and

VGG-16 which falls under deep transfer learning and demonstrated excellent performance and it **achieves 98.89%** accuracy on public **data, including** MRI images.

E. **Efficient Tumor of brain Classification and Detection Using Pre-Trained models of CNN**

[14] In this study, to **divide** brain **cells** and detection, the application of CNN is shown. A **planned** approach utilizes a dataset divided into two broad categories: tumor and non-tumor, with further classification into three tumor types. For effective classification of brain cancer cases, a pre-trained CNN based model is introduced. To expand the dataset and enhance model performance, data augmentation techniques are applied. Metrics for example, Confusion matrix, Validation loss, and overall loss were used to calculate the model's efficiency. Leveraging architectures like ResNet50 and EfficientNet, the approach demonstrated superior accuracy, recall, and precision in detecting brain tumors.

F. **Exact Discovery of Brain Tumors Utilizing Profound Convolutional Neural Organize, Computational and Basic Biotechnology Diary.**

[15] Both the binary and multimodal mind tumors can be identified using the two DL-based learning models. Two publicly accessible datasets containing 3064 and 152 MRI data respectively are used in this process. Due to the greater amount of MRI training data present in the first dataset, a 23-layer CNN architecture has been used. An overfitting problem is faced by the second dataset using the same architecture as first due to smaller training data present. To overcome this problem, they used a 23-layer CNN model with VGG16 architecture and involved transfer learning. In the end, they compared the proposed model with models recorded information. Their experimental findings show that the model achieved classification accuracies up to 97.8% and 100%.

G. **Optimizing MRI-based brain tumor classification and discovery utilizing AI: A comparative examination of neural systems, exchange learning, information increase, and the cross-transformer arrange.**

[16] This **system** proposes an **investigation** of **progressed profound** learning **models** for brain tumor classification and **location**. InceptionV3, ResNet50V2 are several others are the networks that are trained with the help of a specific dataset Figshare. In the experiments, all models achieved high classification accuracies of over 97%, providing insight into the performance of each network. **We center** on tumor identification with brain MRI images and brain tumor detection **from the Cancer Low-Grade Glioma Dataset.** Accuracy was increased to 6% with a statistically significant p-value less than 0.05 after using data augmentation and transfer learning. For meningioma, glioma, and pituitary tumor classification (using the BTD dataset), InceptionResNetV2 achieved the highest accuracy of 97%, outperforming other networks with a Kruskal-Wallis test significance level of 0.07. Furthermore, for brain tumor detection, the MRI-D dataset was used

and InceptionResNetV2 improved the accuracy by up to 6% compared to using transfer learning or data proliferation for model training.

H. EfficientDet-based Tumor of Brain Recognition Using MRI.

[17] A current model is presented for mind tumor classification and recognition with the help of MRI data named Edet-BTR . Model achieves excellent accuracies of 99.13% and 99.08% on Figshare and Brain MRI databases, respectively. The EDetBTR method, which combines the EfficientDet model and EfficientNet-B0, shows high accuracy in brain tumor diagnosis and recognition. The ability of the method to distinguish between different tumor types and identify tumors in post-processed samples is remarkable.

IV. ENTROPY BASED THRESHOLDING

Visual Attention Algorithm for Brain Tumor Detection Utilizing Centered Saliency Maps and Superpixel-Based Structures

[18] Tumors of Brain pose significant dangerous challenges . Commonly diagnosed using imaging techniques like MRI, CT, and PET. This study introduces an innovative algorithm tailored for detecting tumors in brain MRI scans. Traditional detection methods have various limitations, prompting the need for advanced research. To tackle these challenges, the proposed method leverages visual attention principles. By employing a novel threshold entropy approach, it effectively isolates tumor regions from intricate brain MRI images. A centered saliency map is utilized to distinguish biologically relevant tumor areas accurately, while a superpixel-based framework captures detailed structural characteristics of the tumors. This method addresses common imaging issues, including motion artifacts, chemical shifts, contrast variability, intensity inconsistencies, noise, complex shapes, and discontinuous tumor edges. Experimental findings reveal superior performance compared to existing techniques, achieving JSI 0.9174, DSC 0.9569, and ACC 99.63%.

V. CONCLUSIONS

Abnormal cell growth in the brain leads to brain tumors, a critical focus of medical research. Recent advancements in the field of deep learning and ML have revolutionized brain tumor identification and classification. This overview highlights the recent developments in tumor identification, emphasizing MRI-based imaging alongside ML and DL methodologies. Techniques like segmentation and classification have demonstrated notable improvements in accuracy, efficiency, and reliability, offering valuable support for clinical diagnosis and enhancing patient care.

For example, models such as YOLO NAS and EfficientDet have shown impressive results with over 99% accuracy. Advanced techniques such as entropy-based thresholding and visual attention mechanisms further enhance the detection process by accurately identifying tumor regions and managing complex tumor morphologies. Topological data analysis and low-level tensor decomposition have also contributed to improving the detection accuracy of various tumor types by addressing the inherent dimensionality and noise issues in MRI data. Despite these advances, challenges such as high computational requirements, limited generalization across datasets, and difficulty in early detection of complex cases still remain. Future research should focus on improving segmentation methods, improving feature extraction, and exploring effective hybrid models to address these issues. Additionally, **Learning** and **willingness to modify support profiles can develop a general** and **robust model for different** patient **datasets**.This review **provides** a **valuable** resource for researchers **to document** the current state of development in brain **cancer research and identify areas for future research**.

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