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Unified approach for accurate brain tumor Multi-Classification and segmentation through fusion of advanced methodologies

A. Karthik [a,*], Santosh Kumar Sahoo [b], Ajay Kumar [c], Nileshkumar Patel [c], P. Chinnaraj [d], Lakshmana Phaneendra Maguluri [e], Mohammed shuaib [f], A. Rajaram [g]

[a] Institute of Aeronautical Engineering, Dundigal, Hyderabad, Telangana, 500043
[b] School of Computing Engineering, VIT University Bhopal, Madhya Pradesh 466114 India
[c] Computer Science and Engineering, Jaypee University of Engineering and Technology, Guna
[d] Department of Mathematics, PSG Institute of Technology and Applied Research, Neelambur, Coimbatore, Pin Code- 641062, Coimbatore, Tamilnadu, India
[e] Department of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur AP, India
[f] Department of Computer Science, College of Engineering & Computer Science, Jazan University, Jazan, Kingdom of Saudi Arabia
[g] Department of Electronics and Communication Engineering, E.G.S Pillay Engineering College, Nagapattinam, Tamilnadu, 611002

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ABSTRACT

This research introduces a unified approach for accurate brain tumor Multi-classification and segmentation through the fusion of diverse yet complementary methodologies. Brain tumor classification using magnetic resonance imaging (MRI) scans is crucial in non-invasive assessment of brain tumors, providing anatomical information for accurate classification. Classifying brain tumors involves several challenges, inherent complexity of tumor heterogeneity, imaging protocols variations, and the need for distinguishing between benign and malignant lesions. Traditional methods often face limitations in handling the intricate patterns present in medical images, prompting the adoption of sophisticated computational approaches. The process involves analyzing MRI data to categorize brain tumors based on various characteristics. The proposed model integrates an Attention-Augmented Convolutional Neural Network (CNN), Random Forest (RF), and U-Net to leverage the strengths of attention mechanisms, ensemble learning, and semantic segmentation. The Attention-Augmented CNN captures intricate features with attention focus, the RF refines classification decisions through ensemble learning, and the U-Net ensures precise tumor segmentation. The fusion of these components results in a comprehensive framework that not only achieves high accuracy in classification but also provides detailed and accurate tumor segmentation in MRI brain images. Experimental results on a diverse dataset of medical MRI brain images demonstrate the effectiveness of the proposed unified model, showcasing its potential for advancing brain tumor analysis in medical imaging. The fusion of Attention-Augmented CNN and Random Forest contributed to a robust ensemble-based classification, while U-Net enhanced segmentation precision. The performance metrics like recall, precision, accuracy, loss, and F1-score are verified in Python. Selecting the best advanced machine-learning classification algorithm for brain tumor prediction will be made easier by the results.

1. Introduction

Brain tumors, characterized by abnormal cell growth within the brain, present a complex and challenging spectrum of diseases. Their manifestation often leads to a diverse range of symptoms, including memory loss and speech problems. Distinguishing between the fundamental types of tumors is pivotal for effective treatment planning [4]. This research introduces a unified approach that integrates advanced computational methodologies to achieve precise brain tumor classification and segmentation.

Accurate classification of brain tumors is paramount for personalized treatment strategies and prognosis determination. Magnetic Resonance Imaging (MRI) stands as a cornerstone in the non-invasive evaluation of brain tumors, providing detailed anatomical insights crucial for precise classification. The integration of cutting-edge computational techniques, such as machine learning and deep learning, has revolutionized this process, allowing clinicians to harness vast datasets for enhanced diagnostic accuracy [10].

* Corresponding author.
E-mail addresses: karthik011190@gmail.com (A. Karthik), drrajaram@egspec.org (A. Rajaram).

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overall understanding of brain tumor images, offering a valuable tool for medical practitioners in diagnosis and treatment planning. The results from our experiments, as indicated by sensitivity, specificity, and accuracy metrics, underscore the effectiveness of our unified approach. The synergy among Attention-Augmented CNN, Random Forest, and U-Net demonstrates superior performance compared to individual models or traditional methods. Future work could explore optimization techniques, additional data modalities, and the integration of emerging technologies to continually enhance the capabilities of our proposed framework. The integration of these advanced techniques aims to enhance the accuracy and efficiency of brain tumor diagnosis and segmentation. The attention mechanism in the CNN contributes to improved feature extraction, while the Random Forest and U-Net fusion provides a robust framework for multi-classification and precise segmentation. The proposed methodology exhibits promising results, suggesting a potential breakthrough in advancing brain tumor analysis. The paper concludes by highlighting the future scope and potential applications of this integrated approach in the ongoing development of advanced medical imaging systems for brain tumor diagnosis and treatment planning.

Ethics Approval and Consent to Participate:

No participation of humans takes place in this implementation process.

Human and Animal Rights:

No violation of Human and Animal Rights is involved.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Further reading

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