Chapter 9
Deep Learning–Enhanced Hybrid Metaheuristic Fusion Model for Biomedical Image Analysis

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ABSTRACT

This study introduces the Hybrid Deep Learning with Brain Tumor Analysis (HDLB-BTA), a novel automated biomedical image classification method. HDLB-BTA enhances image quality through preprocessing, segments images using Swin-UNet, and applies a fusion-based feature extraction approach. The classification model's parameters are fine-tuned using a Hybrid Firefly Optimization with Simulated Annealing (HFSA) technique. Gated Recurrent Units (GRUs) are used for robust image classification. Evaluation on BraTS2017 and EBTA datasets demonstrated superior performance, achieving 94.51% and 95.38% accuracy on ISIC 2017 and ISIC 2020 datasets, respectively. Future work will explore scalability, multi-modal

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data integration, and model interpretability for clinical applications.

INTRODUCTION

To extract, process, and interpret relevant information from biological images, a broad range of methods and strategies are engaged in the extensive field of biomedical image analysis (S. Nazir et. al, 2023). It is essential in healthcare administration, medical research, and clinical practice (M. Obayya et.al, 2022). According to S. Chakraborty et. al., 2023 "biomedical image categorization" describes the development of repeatedly labelling or categorising medical photographs based on their content. Many people are interested in medical image analysis because of the large amount of medical imaging data available and the possibility that Deep Learning (DL) methods could help doctors diagnose diseases and choose the best course of treatment (M. Di Giammarco et. al, 2022). According to J. Yang et al. (2023), medical image analysis aims to equip doctors and radiologists with tools that can help them diagnose and treat patients more efficiently. Without injuring the patient, medical imagery techniques involving X-rays, CT scans, and MRI can reveal internal abnormalities and disorders (J. Zhu et. al, 2023). Because medical images include imperfections, artefacts, and potentially confusing information, processing is essential for extracting useful data from these images (F. Li et. al., 2023). Image processing methods have been a boon to medical applications; for insistence, image-guided surgical procedure, picture segmentation, and picture recording are all considerably utilised in medical diagnosis and therapy (S. Maqsood et. al, 2023). When it comes to medical imaging, for example, DL methods considerably beat human experts. Deep learning systems rely on large datasets to make intricate task predictions.

The DL method has shown to be much more accurate in Computer Vision (CV) picture interpretation tasks (A. Shrivastava et. al., 2022). Convolutional deep neural networks (CNNs) are the most effective neural network type for grid-form information interpretation (D. Sharma et. al, 2023). Deep Convolutional Neural Networks (DCNNs) and other DL models have emerged as the gold model for medical image processing in the last several years (S. Dash et. al., 2023). When compared to other AI technologies and, in many cases, human domain experts, Deep Neural Networks (DNNs) produce much better results for image categorisation tasks. A growing number of people are worried about using AI for biological image segmentation and classification (K. VanHorn et. al., 2022). Contrary to popular belief, convolutional neural networks (CNNs) are the wave of the future when it comes to image segmentation and classification (S. Patel et. al., 2022).

A Brief Review on Deep Learning and Types of Implementation for Deep Learning

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