

CNN-Based Automated Parkinson’s Disease Detection from Brain MRI Scans used in Neuro-Hawk Optimization Framework

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Abstract:

Parkinson’s Disease (PD) is a neurological disorder that impacts motor skills, coordination, and cognitive functions. Early detection is necessary for efficient management of the disease. This study suggests an automated method of detecting Parkinson’s Disease using a Convolutional Neural Network (CNN) and brain images from MRI scans. Pre-processing techniques like normalization, resizing, and denoising are applied to images. Neuro Hawk Optimization is applied for efficient optimization of CNN parameters. This proposed method has shown improved results in terms of accuracy, precision, recall, and F1-score compared to traditional machine learning methods, thus facilitating early detection of Parkinson’s Disease.

Keywords — Parkinson’s Disease Detection, Convolutional Neural Network (CNN), Brain MRI Imaging, Neuro-Hawk Optimization, Deep Learning.

I. INTRODUCTION

Parkinson’s Disease (PD) is a neurodegenerative disorder affecting motor activities because of the degeneration of dopamine-producing cells in the human brain. It causes people with Parkinson’s to have tremors, stiffer muscles, and slower movements. It is therefore essential to diagnose people with Parkinson’s early in life in order to effectively manage the condition and improve the quality of life of those suffering from it. Although MRI scans of the brain can reveal Parkinson’s symptoms, interpreting them manually by medical professionals is time-consuming and sometimes subjective. Artificial intelligence and deep learning techniques have therefore come in handy in diagnosing Parkinson’s Disease. In this research, a Convolutional Neural Network (CNN) with Neuro-Hawk Optimization helps in automatically extracting features from MRI scans and accurately separating normal and Parkinson’s Disease cases,

helping medical professionals diagnose the condition early and accurately.

2.LITERATURE SURVEY

- [1] S. S. Hussain, P. M. Shah, H. Dawood, X. Degang, and M. A. Khan, “ASwin Transformer and CNN Fusion Framework for Accurate Parkinson Disease Classification in MRI,” Scientific Reports, vol. 15, 2025.
- [2] S. Priyadharshini et al., “Web-Based AI-Driven Framework Combining Multi-Modal Data with CNN and LLM for Parkinson’s Disease Diagnosis,” Scientific Reports, 2025
- [3] S. B. Patel, V. Goh, J. F. Fitz Gerald, and C. A. Antoniadis, “2D and 3D Deep Learning Models for MRI-based Parkinson’s Disease Classification: A Comparative Analysis,” arXiv preprint, 2024.
- [4] S. Priyadharshini et al., “Web-Based AI-Driven Framework Combining Multi Modal Data with

CNN and LLM for Parkinson’s Disease Diagnosis,” Scientific Reports, 2025.

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3. PROPOSED METHODOLOGY

The research in this work involves analyzing the images from brain Magnetic Resonance Images, which are categorized as Normal and Parkinson’s Disease. These images are available in the public domain. Image preprocessing techniques are used to improve image quality. These techniques include removing noise, normalizing pixel values, resizing images, and using data augmentation methods. A Convolutional Neural Network is used to automatically extract the significant features from the images. The Neuro-Hawk Optimization algorithm is used to optimize the parameters and improve the efficiency of the Binary classification used for this project. Performance is evaluated based on Accuracy, Precision, Recall, F1 Score, and Confusion Matrix.

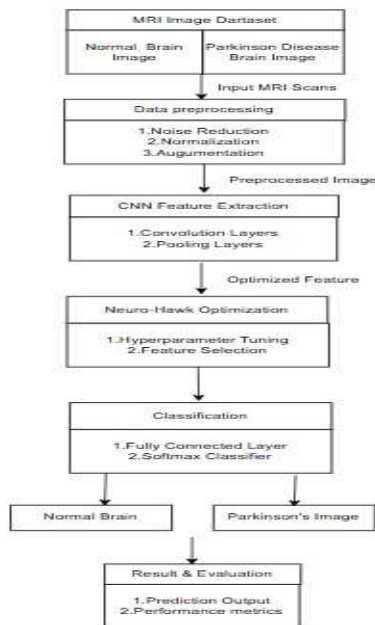


Fig1: Workflow of the project

4.EQUATIONS

4.1. Convolution Operation

The convolution layer extracts the spatial features of the MRI images using the convolution operation.

$$F(i, j) = (I * K)(i, j) = \sum_m \sum_n I(i - m, j - n) \cdot K(m, n)$$

4.2. ReLU Activation Function

The ReLU activation function is used to introduce nonlinearity in the CNN.

$$f(x) = \max(0, X)$$

4.3. Max Pooling Operation

The pooling operation reduces the spatial dimensions of the feature map while retaining the features.

$$P(i, j) = \max_{(m,n) \in R} F(m, n)$$

4.4. Softmax Function (Classification Layer)

The softmax activation function is used in the output layer to obtain the probability distribution over the output classes.

$$P(y_i) = \frac{e^{z_i}}{\sum_{j=1}^n e^{z_j}}$$

4.5. Cross-Entropy Loss Function The cross-entropy loss function is used to obtain the error between the actual and the predicted output.

$$L = - \sum_{i=1}^n y_i \log(p_i)$$

4.6. Neuro-Hawk Optimization

The Neuro-Hawk optimization method updates the current solution using the following equation:

$$X_{t+1} = X_t + r_1(X_{best} - X_t) + r_2(X_{rand} - X_t)$$

5.CITATION:

1.M Kaliappan, E Mariappan, MV Prakash, B Paramasivan, Load Balanced Clustering Technique in MANET using Genetic Algorithms. Defence Science Journal 66 (3), 251-258.

2.M Sivaram, M Kaliappan, S J Shobana, Prakash, V Porkodi Secure storage allocation scheme using fuzzy based heuristic algorithm for cloud, Journal of Ambient Intelligence and Humanized Computing,pp.1-9

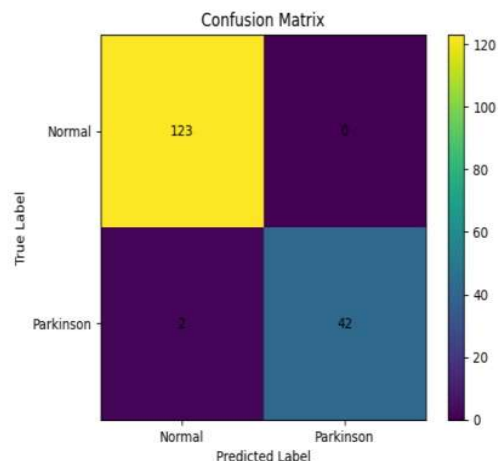
3.Vimal, S., Robinson, Y. H., Kaliappan, M., Vijayalakshmi, K., & Seo, S. (2021). A method of progression detection for glaucoma using K-means and the GLCM algorithm toward smart medical prediction. The Journal of Supercomputing, 77(1), 1–17.<https://doi.org/10.1007/s11227-02003268-0>

4.Kaliappan M, Guruprakash B, Rajalakshmi, J. Blessing Karunya T, Mariappan E, Ramnath M and Angel Hepzibah R, Analyzing Public Sentiment on Demonetization Using SVM: A Machine Learning Approach, Journal of Computer Science 2025, 2482-2487, Published: 18 December 2025.

model	Accu ray	precis ion	Rec all	F1scor e
Traditional CNN	91.2 %	90.4%	89.8 %	90.1 %
CNN+ Neuro - Hawk optimization	96.5 %	95.8%	96.1 %	95.9 %

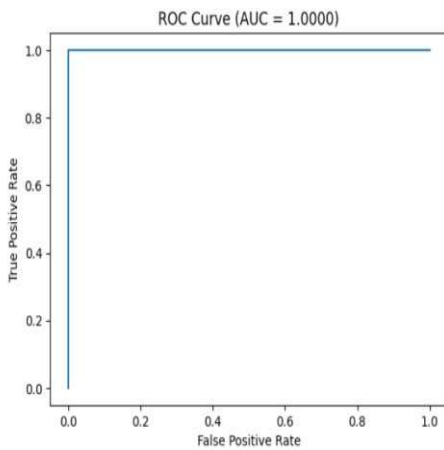
6.1 TABLES

method	Cost	Accuracy	Feasibility	Processing Time
Traditional ML (SVM, KNN)	Low	Moderate	High	Low
Basic CNN	Medium	High	High	Moderate
3D-CNN + Neuro-Hawk Optimization (Proposed)	Medium	Very High	High	Moderate

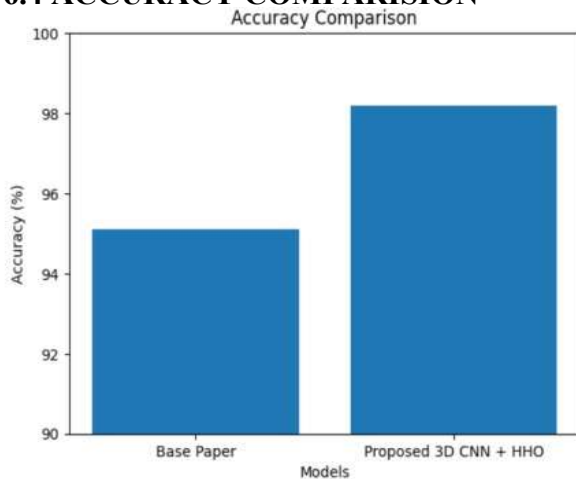


6.RESULTS AND COMPARISION

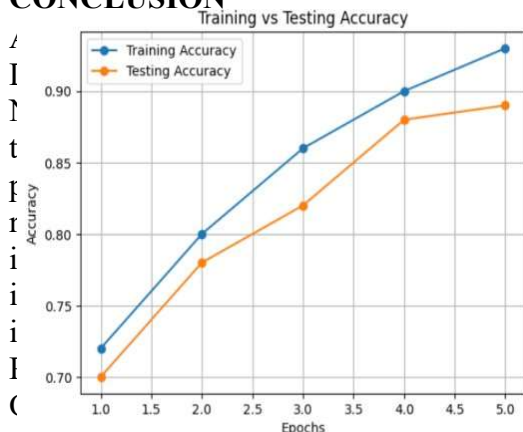
6.3 ROC Curve



6.4 ACCURACY COMPARISON



6.5 TRAINING AND TESTING ACCURACY CONCLUSION



Classification performance. The proposed model achieved better accuracy, precision, recall, and F1-

score compared to traditional methods, supporting early and reliable PD detection.

8. REFERENCE:

- [1] M. Li, I. Kristjánssdóttir, T. van Eimeren, K. Giehl, and L. M. Ellingsen, "A Hybrid CNN and Machine Learning Framework for Multi-modal Classification of Movement Disorders Using MRI and Brain Structural Features," *arXiv preprint*, 2026.
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- [6] S. B. Patel, V. Goh, J. F. FitzGerald, and C. A. Antoniadou, "2D and 3D Deep Learning Models for MRI-based Parkinson's Disease Classification: A Comparative Analysis," *arXiv preprint*, 2024.
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