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Parkinson's Disease Prognosis: Advancements In Early Detection Methods For Parkinson's Disease Enhancing Accuracy For Patient Outcomes

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Abstract: This paper proposes a novel approach utilizing machine-gaining knowledge of strategies and Xception architecture for PD detection, focusing on spiral and wave drawings, common diagnostic tools in clinical practice. Through a dataset collection process, including individuals with and without PD, preprocessed data were employed to train machine learning models. Results indicate promising performance, demonstrating the potential of machine learning and Xception architecture in early PD detection. This approach offers advanced accuracy and efficiency in diagnosis, ultimately leading to better patient outcomes and enhanced quality of life.

Index Terms - Parkinson's disease, Neurodegenerative disorder, Machine learning, Xception architecture, Early detection, Diagnosis, Spiral and wave drawings, Clinical practice, Image classification, Convolutional neural networks, Depthwise separable convolutions, Inception modules, Model performance

I. INTRODUCTION

Parkinson's disease is a debilitating neurodegenerative disorder affecting millions globally, characterized by motor symptoms like tremors, rigidity, and bradykinesia, alongside cognitive impairment and sleep disturbances. Timely detection is crucial for effective management, better patient outcomes, and potentially slowing disease progression. However, traditional diagnostic methods relying on clinical observation and expensive imaging pose challenges due to high costs, lack of precision, and limited accessibility, especially in low-resource settings. This paper, titled "Advancements in Early Detection Methods for Parkinson's Disease: Enhancing Accuracy for Patient Outcomes," aims to explore recent innovations in Parkinson's disease early detection. Focusing on leveraging technology and machine learning to analyze patients' writing patterns, we propose an alternative approach to conventional methods, potentially enhancing diagnostic accuracy and accessibility. By employing machine learning algorithms and big data, we can identify subtle patterns indicative of early-stage Parkinson's disease, even preceding motor symptom onset. Furthermore, we delve into the unique method of using writing analysis for detection, offering valuable insights into motor function without the need for specialized devices like smartwatches or smartphones. This approach can democratize early detection, potentially revolutionizing Parkinson's disease management and improving patient outcomes. Additionally, we introduce the utilization of the

Xception architecture, a deep learning model inspired by Inception modules but enhanced with depthwise separable convolutions. This architecture will be employed for analyzing and interpreting writing patterns in Parkinson's disease detection. Its efficiency in extracting features and its ability to handle large datasets make it a promising tool for this task. This paper emphasizes the significance of these advancements in digital health and their potential to transform the management of neurodegenerative disorders like Parkinson’s disease. By integrating technology and healthcare, we aim to adopt a more patient-centric approach, ensuring accurate, timely, and accessible diagnosis.

II. LITERATURE SURVEY

[1] Analysis of tremors in Parkinson’s Disease using accelerometer Parkinson’s Disease is one that affects the brain and symptoms include shaking, stiffness, and difficulty to walk. Tremor is the most identifiable symptom of this disease and it affects nearly 80% of the patients with Parkinson's Disease. This prototype was designed to observe and quantify the tremor signal from Parkinson's disease patients. The prototype is based on Arduino Uno programming and interfacing, and the ADXL335 tri-axial accelerometer is used as a sensor. The resting tremor signal was acquired in the form of acceleration using the sensor accelerometer from fingertip, wrist and forearm of the patient. The Arduino processed the data which was transferred to MATLAB for further processing. The resting tremor was observed in terms of amplitude and spectral density. For the three parts considered, the amplitude values of acceleration were ranging from 40 dB/Hz-80 dB/Hz and spectral density were observed and compared. Hence this basic prototype could be useful and developed further to assist the Parkinson's Disease patients. Lei Zaho and Lin Wang, price trend Prediction of stock marketplace using Outlier statistics Mining set of rules. in this paper we present a singular facts mining method to are expecting long time behavior of stock fashion. conventional techniques on inventory fashion prediction have shown their boundaries while using time series algorithms or volatility modelling on charge series. In our studies, a novel outlier mining algorithm is proposed to discover anomalies on the ideaof volume series of excessive frequency tick-by using tick statistics of inventory market. Such anomaly trades usually inference with the inventory rate inside the inventory marketplace. By using the cluster facts of such anomalies, our approach predicts the stock trend correctly within the truely international market. experiment outcomes show that the proposed method makes profits on the Chinese language stock marketplace, in particular in a lengthy-term usage.

[2] Enhanced Parkinson’s Disease Diagnosis Through Convolutional Neural Network Models Applied to SPECT DaTSCAN Images The paper introduces a computer-aided diagnosis (CAD) system aimed at enhancing Parkinson's Disease (PD) diagnosis using Single Photon Emission Computed Tomography (SPECT) imaging. Leveraging Convolutional Neural Network (CNN) architectures, the system undergoes adaptation through Transfer Learning and bilinear pooling techniques. This approach enables the analysis of a dataset comprising 2720 SPECT images. Among the various CNN models examined, the BCNN EfficientNet-B0-MobileNet-V2 emerges as the top performer, achieving a remarkable accuracy score of 98.47%. This outcome signifies a notable improvement over alternative models and existing diagnostic methods for PD. The CAD system presents a significant advancement in PD diagnosis, providing physicians with a reliable and efficient tool to aid in accurate disease identification. By automating the analysis of SPECT images using state-of-the-art machine learning techniques, the system enhances diagnostic accuracy and streamlines clinical decision-making processes. Furthermore, the high accuracy achieved by the BCNN model underscores the potential of advanced CNN architectures in medical imaging applications.

[3] Early Detection of Parkinson’s Disease by Neural Network Model The paper "Early Detection of Parkinson’s Disease by Neural Network Models" develops neural network models for recognizing Parkinson's disease (PD) at its early stage. The study is based on the upper limb movement conditions of 32 drug-naïve PD patients with variable disease severity and 16 age/gender-matched healthy controls. Inertial measurement unit (IMU) sensors are used to measure their motions. The IMU data is then used to develop neural network models that could identify patients with advanced-stage PD with an average accuracy of 92.72% in validation processes. The models also differentiated patients with early-stage PD from

normal elderly subjects with an accuracy of 99.67%. An independent group of participants recruited to test the developed models confirmed the successful discrimination of PD-affected from healthy elderly, as well as patients at different severity stages. The results provide support for early diagnosis and disease severity monitoring in patients with PD.

[4] Inertial-Based Gait Metrics During Turning Improve the Detection of Early-Stage Parkinson’s Disease Patients Inertial- Based Gait Metrics During Turning Improve the Detection of Early-Stage Parkinson’s Disease Patients" presents a study that uses Inertial Measurement Unit (IMU) sensors to measure the motions of 32 drug-naïve Parkinson's disease (PD) patients and 16 healthy controls during walking. The study proposes an IMU-based gait assessment model that quantifies comprehensive gait variables in both straight walking and turning tasks from five domains: gait spatiotemporal parameters, joint kinematic parameters, variability, asymmetry, and stability. The discriminating ability of gait parameters between PD and the control group was evaluated using receiver operating characteristic analysis. The study found that PD patients exhibited more gait abnormalities at turns, especially on the Range of Motion (RoM) and stability of the neck, shoulder, pelvic, and hip joints compared to the healthy control group.

[5] Static-Dynamic Temporal Networks for Parkinson’s Disease Detection and Severity Prediction The "Static-Dynamic Temporal Networks for Parkinson’s Disease Detection and Severity Prediction" is a research paper that proposes a new method for gait analysis in Parkinson's disease (PD) patients. The model involves a Static temporal pathway and a Dynamic temporal pathway. In the Static temporal pathway, the time series information of each sensor is processed independently with a parallel one-dimension convolutional neural network (1D-Convnet) to extract respective depth features. In the Dynamic temporal pathway, the stitched surface of the feet is deemed to be an irregular “image”, and the transfer of the force points at all levels on the sole is regarded as the “optical flow.” Then, the motion information of the force points at all levels is extracted by 16 parallel two-dimension convolutional neural network (2D-Convnet) independently. The results show that the Static-Dynamic temporal networks achieved better performance in gait detection of PD patients than other previous methods. Among them, the accuracy of PD diagnosis reached 96.7%, and the accuracy of severity prediction of PD reached 92.3%.

[6] Budget-Based Classification of Parkinson’s Disease From Resting State EEG The research paper "Budget-Based Classification of Parkinson’s Disease From Resting State EEG" introduces a novel approach for the early detection of Parkinson's Disease (PD) using resting-state electroencephalographic (EEG) recordings. The study explores how variations in the number and placement of EEG electrodes impact the classification of PD patients versus healthy controls using machine learning techniques based on EEG sample entropy. A custom budget-based search algorithm is developed to select optimized sets of EEG channels for classification, taking into account factors such as electrode placement and computational resources. The dataset comprises 60-channel EEG recordings collected from three different recording sites, with observations obtained under both eyes-open and eyes-closed conditions. The results demonstrate promising classification performance, with an accuracy (ACC) and area under the receiver operating characteristic curve (AUC) of 0.76, indicating a reasonably accurate distinction between PD patients and healthy individuals. Remarkably, this performance is achieved using only five EEG channels strategically placed at significant distances from each other. Overall, the study presents an innovative methodology for PD detection based on EEG data, highlighting the importance of electrode selection and placement in optimizing classification performance. The findings suggest the potential of EEG-based approaches for early PD diagnosis, paving the way for further research and development of non-invasive diagnostic tools for neurological disorders.

III. METHODOLOGY

A. Dataset Collection: Acquiring the dataset marks the initial phase of our system development. Data collection is a pivotal step that significantly influences the model's performance. Various techniques, such as web scraping or manual interventions, can be employed for this purpose. Our dataset, comprising 133 Parkinson's disease spiral drawings and 153 Parkinson's disease wave drawings, is sourced from the renowned Kaggle dataset repository, a standard reference for researchers. Access to the dataset is available within the project, residing in the designated model folder. The dataset's reliability and popularity stem from its origin on Kaggle, ensuring its suitability for research and development purposes.

(i) Spiral drawing

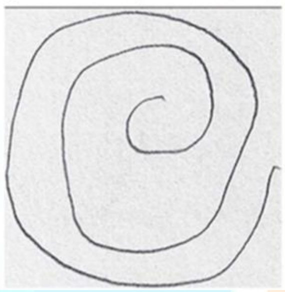


Fig 1: Healthy person’s spiral drawing

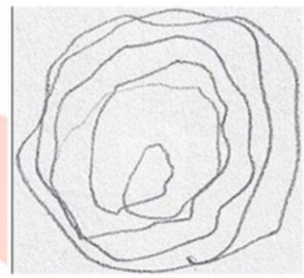


Fig 2: Parkinson’s patient spiral drawing

(ii) Wave drawing

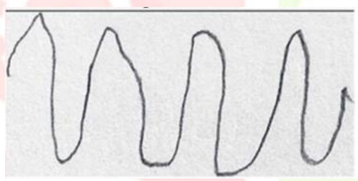


Fig 3: Healthy person’s wave drawing

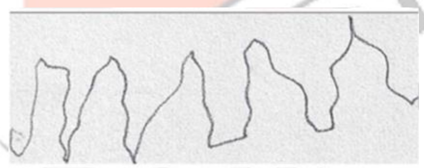


Fig 4: Parkinson’s patient wave drawing:

B. Importing Required Libraries:For this project, we'll utilize Python as our primary programming language. We'll begin by importing essential libraries such as Keras for model construction, scikit-learn for dataset splitting, PIL for image processing tasks, along with other fundamental libraries including Pandas, NumPy, Matplotlib, and TensorFlow.

C. Image Retrieval: This module involves extracting images from the dataset and converting them into a compatible format suitable for training and testing our model. Tasks encompass reading the images, resizing them to standardized dimensions, and normalizing pixel values. Image retrieval includes fetching both images and their corresponding labels. The images are resized to (224,224) for spiral drawings and (196,196) for wave drawings to ensure uniformity in dimensions, facilitating model recognition. Subsequently, the images are converted into NumPy arrays for further processing.

D. Dataset Splitting: In this module, the dataset undergoes division into distinct training and testing subsets. The split entails allocating 80% of the data for training and reserving the remaining 20% for testing. This partitioning strategy enables training the model on a representative subset, validating its performance, and evaluating its accuracy on unseen data. By segregating the dataset into training and testing sets, we ensure robust model evaluation and generalization capabilities.

(i) Training set

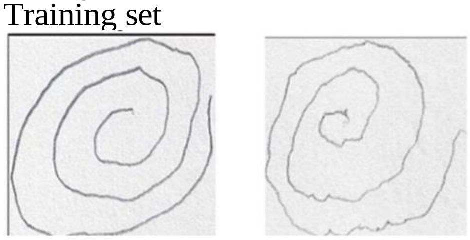


Fig 5: Training set for spiral drawing

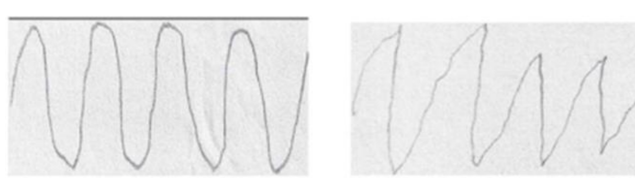


Fig 6: Training set for wave drawing

(ii)Testing set

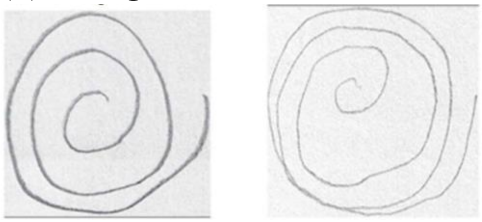


Fig 7: Testing set for spiral drawing

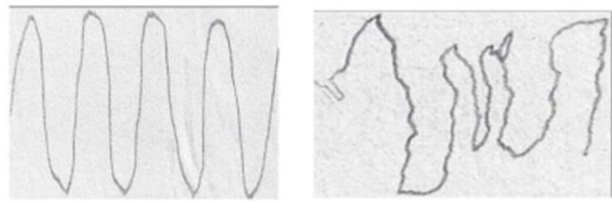


Fig 8: Testing set for wave drawing

IV. ALGORITHM AND TECHNIQUES

Xception | CNN Model Architecture: Xception architecture represents an evolution from the inception module, offering a streamlined and efficient design comparable to ResNet and Inception V4 in terms of effectiveness. The Xception module, a cornerstone of this architecture, reimagines convolutional operations, achieving remarkable performance with a simpler structure. Its architectural elegance lies in its ability to capture intricate features while maintaining computational efficiency, making it a preferred choice for various computer vision tasks. Convolutional Neural Networks (CNNs) distinguish themselves from traditional neural networks through their use of convolution operations. These operations systematically scan input images, seeking specific features with parameters like stride and padding type. In a classic Xception model, typically featuring two convolution layers, deeper layers search for higher-level features akin to human perception. During training, CNNs adjust weights to identify relevant features. Pooling operations reduce frame dimensions, while ReLU functions introduce non-linearity. Fully connected layers process flattened features, and a softmax layer provides classification probabilities. CNNs excel in feature extraction and processing, making them effective for tasks like Parkinson's disease detection from handwriting patterns.

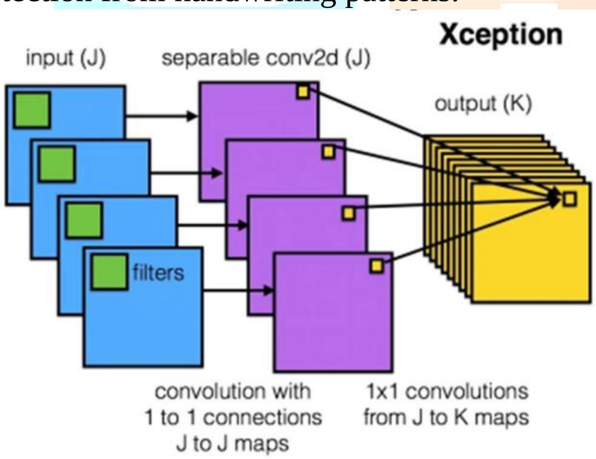
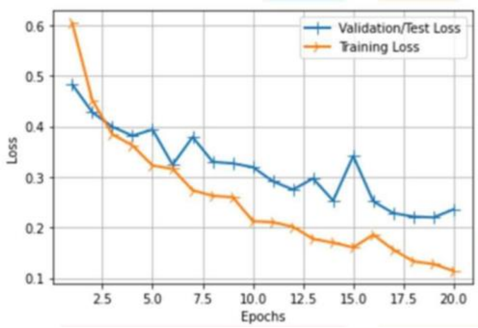


Fig 9: Xception Model

V. RESULTS AND DISCUSSION

Spiral drawing: After constructing the model, it undergoes validation using the validation set to assess its accuracy and loss. This evaluation involves plotting accuracy and loss against the number of epochs to visualize model performance. The model is compiled and applied using the fit function, with a batch size set to 1. Subsequently, graphs depicting accuracy and loss are generated. Our results indicate an average validation accuracy of 97.00% and an average training accuracy of 93.00%.



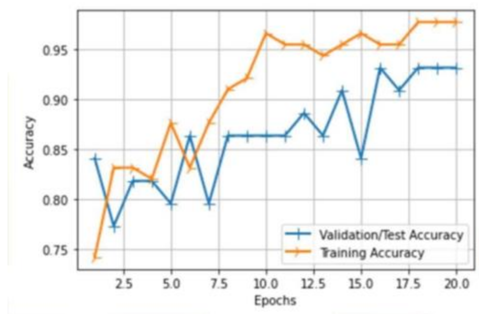
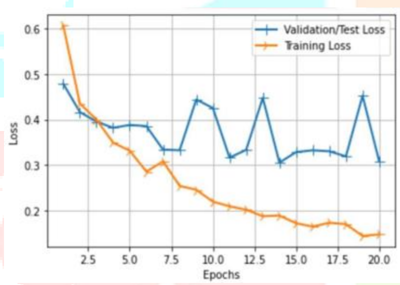


Fig 10: Validation and training loss for spiral drawing

Fig 11: Validation and training accuracy for spiral drawing

Wave drawing: After constructing the model, it undergoes validation using the validation set to assess its accuracy and loss. This evaluation involves plotting accuracy and loss against the number of epochs to visualize model performance. The model is compiled and applied using the fit function, with a batch size set to 1. Subsequently, graphs depicting accuracy and loss are generated. Our findings reveal an average validation accuracy of 93.00% and an average training accuracy of 86.00%.



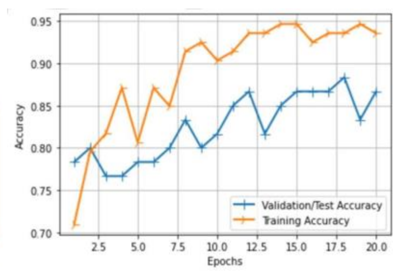


Fig 12: Validation and training loss for wave drawing

Fig 13: Validation and training accuracy for wave drawing

VI. CONCLUSION

The integration of machine learning, particularly the Xception model, offers a transformative approach to Parkinson's disease (PD) diagnosis and prognosis. With traditional methods facing limitations in accessibility and precision, innovative techniques leveraging convolutional neural networks provide a promising solution. By analyzing subtle handwriting patterns, these models can detect PD even before motor symptoms appear, enabling early intervention and personalized treatment plans. The Xception architecture, implemented in this study, demonstrated remarkable accuracy in discerning PD from spiral drawing patterns, showcasing its potential as a reliable diagnostic tool. Notably, its performance surpassed that of wave drawings, indicating its efficacy in capturing specific disease-related features. This advancement holds significant promise for improving PD management by facilitating timely interventions and enhancing clinicians' ability to assess patients' neurological health. Moving forward, further research and refinement of machine learning algorithms are essential to enhance diagnostic accuracy and accessibility, ultimately leading to improved patient outcomes and quality of life.

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