Parkinson’s Disease Prediction Using Deep Learning Techniques

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***Abstract*—In recent years, significant progress has been made in the field of medical diagnosis, but early and accurate detection of Parkinson's disease (PD) remains a challenge. Current technology cannot accurately detect this neurodegenerative condition, emphasizing the need for current research. Parkinson's disease is a complex neurological disease whose prevalence is increasing worldwide. Timely and accurate diagnosis is crucial for optimal patient care and treatment. This study addresses the critical issue of improving PD diagnosis by using convolutional neural networks (CNN) to analyze spiral and wave graphs. The methodology involves the development of a robust CNN model trained on a diverse dataset containing drawings of PD and healthy individuals. This dataset is the basis for training and testing the model and ensures its ability to distinguish PD cases from non-PD cases. The results show the exceptional accuracy of the CNN model in predicting PD of spiral and wave patterns with a classification accuracy of more than 90%. In addition, this study highlights the promising role of deep learning methods in medical diagnosis, especially in the context of Parkinson's disease. The successful integration of a CNN model into a React application for real-time prediction and patient performance monitoring has important implications for telemedicine and remote health management.**

***Index Terms*—Parkinson's Disease, CNN, Spiral and Wave Drawings, Diagnosis, Deep Learning, Early Detection, Remote Monitoring.**

I. INTRODUCTION

Parkinson's disease is a brain disease that causes involuntary or uncontrollable movements, such as tremors, stiffness, and difficulty with balance and coordination. Symptoms usually develop gradually and worsen over time. As the disease progresses, people will have difficulty walking and talking. They may also experience mental and behavioral changes, sleep disturbances, depression, memory problems, and fatigue. Although almost everyone is at risk of Parkinson's disease, some studies show that the disease affects men more than women. The cause is not yet known, but research continues to understand what may put a person at risk. One clear risk factor is age: While most people with Parkinson's disease first develop the disease after age 60, about 5-10% develop the disease before age 50. Early forms of Parkinson's disease are often, but not always, regressive. Some information relates to specific genetic changes. The conventional methods for diagnosing PD often rely on clinical assessments, medical history, and neurological examinations. However, these methods may have limitations, including subjectivity, variability in interpretation, and the need for specialized equipment. Therefore, there is a growing need for more objective, quantifiable, and accessible approaches to PD diagnosis and monitoring.

In recent years, the advancement of deep learning, especially convolutional neural networks (CNN), has shown great potential in many medical applications such as image analysis and disease prediction. Deep learning algorithms can learn and extract models from complex data; this makes them ideal for the analysis of medical images and signals. 1 This section presents a solution that uses the power of deep learning (specifically CNN) to predict Parkinson's disease. By leveraging the predictive ability of CNNs, we aim to create a robust model that can distinguish between individuals with PD and healthy individuals based on spiral and wave patterns. The images capture subtle changes and can serve as poor biomarkers for Parkinson's disease. Moreover, the integration of a mobile application adds a new dimension to PD management. Individuals at risk or already diagnosed with PD can easily assess their condition by deploying the developed CNN model within a user- friendly mobile application. This application predicts the likelihood of PD based on their drawings and provides a platform for continuous monitoring of their activities.

1.1 Real-time Data Collection

The React application is designed to collect real-time data from various sensors and input devices. This data includes information related to the patient's movement, speech patterns, and other relevant physiological parameters. A central feature of this application is its ability to seamlessly interact with the predictive model we have developed. Through secure APIs and data connections, the application will transmit the collected data to the model, which will then analyze it to provide insights and predictions related to the patient's condition.

Usability is a top priority. The application features an intuitive and user- friendly interface to ensure that healthcare professionals, caregivers, and even patients themselves can easily navigate and make sense of the collected data and predictions. The application is equipped to generate alerts and notifications based on the predictive model's analysis. These alerts can be configured to notify healthcare providers or caregivers in real-time if there are concerning changes in the patient's condition.Patients and healthcare professionals can access historical data and trends, helping them track the progression of the disease and the effectiveness of interventions over time. Visualizations and reports will be available to facilitate data interpretation.

Robust security measures will be in place to protect the sensitive health data being collected. Patient privacy is paramount, and compliance with relevant data protection regulations will be ensured.

1.2 DATA COLLECTION AND PREPROCESSING:

Collecting diverse datasets from clinical records, imaging data, and genetic information involves thorough research and extraction efforts. This might require collaborating with medical institutions and experts. Preprocessing involves addressing data inconsistencies, handling missing values, and converting data into a standardized format. Techniques like normalization and scaling may be employed to ensure data compatibility for training the model.

EDA plays a pivotal role in understanding the collected data's characteristics. Distribution plots, correlation matrices, and statistical summaries help identify outliers, trends, and potential biases. These insights guide decisions on feature selection, transformation, and the type of neural network architecture best suited for the data.

Model development involves selecting an appropriate neural network architecture, such as CNN for image data or RNN for sequence data. Hyperparameters, including methods, dynamics, and learning rates, must be chosen carefully. The training model must split the data into a training set, validation set, and testing set to avoid collisions. Techniques such as continuous study and release can improve the model's ability.

Evaluating a model's performance is critical to determining its reliability. Metrics such as confusion matrices, ROC curves, and precision-recall curves provide a better understanding of their strengths and weaknesses. Validation against the design diagnosis and cross-validation to assess stability demonstrate the potential for practical use of this model.

The backend serves as the bridge between the frontend user interface and the deep learning model. Developing APIs for data preprocessing, prediction, and result retrieval ensures smooth communication. Integrating security mechanisms such as authentication and encryption safeguards patient data and adheres to ethical standards.

Implementing monitoring tools helps track the model's performance, usage patterns, and potential anomalies. Regular model updates and adaptations to changing medical landscapes ensure the predictions remain accurate and relevant over time. Collecting user feedback for ongoing improvements guarantees that the application continues to meet user needs.

II. MODEL EVALUATION AND VALIDATION

Our comprehensive methodology encompassed data collection, preprocessing, model development, and deployment. data collection aimed to capture the complexity and multifaceted nature of the disease. The preprocessing phase was vital to transform raw data into a structured, standardized format ready for model training. With pre-processed data in hand, we embarked on model development using deep learning techniques. It involved harnessing diverse datasets, carefully transforming them into usable inputs, training a deep learning model, and integrating the model into a React.js front-end application. Once the model was trained and evaluated, the next step was to deploy it for real-world use. This required integrating the trained model into a user-friendly platform. The user-friendly interface facilitated seamless input of relevant data, such as symptoms and medical history. This approach enabled us to create a predictive tool that offers accurate and real-time predictions for Parkinson's Disease, catering to the needs of both medical practitioners and patients.

Our study's focus is on the evaluation of the effectiveness of the built predictive model. We acquire insights on its effectiveness in identifying those with Parkinson's Disease (PD) from those without by closely examining its accuracy, precision, and recall. For its prospective use as a diagnostic tool in clinical settings, this appraisal has important consequences. The model's performance measures show how well it detects Parkinson's disease. Its strong diagnostic utility as a useful diagnostic tool in clinical practice is highlighted by its excellent accuracy, balanced precision, and recall scores. The reliability of these findings not only supports the fundamental design of our model but also 26 establishes it as a potential tool for medical professionals aiming for early PD diagnosis and improved patient management.

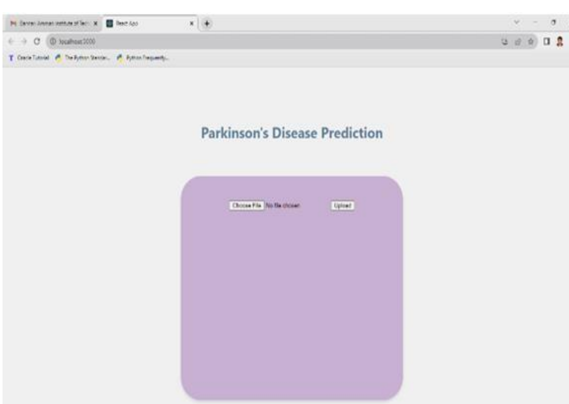

Fig -1: React application home page

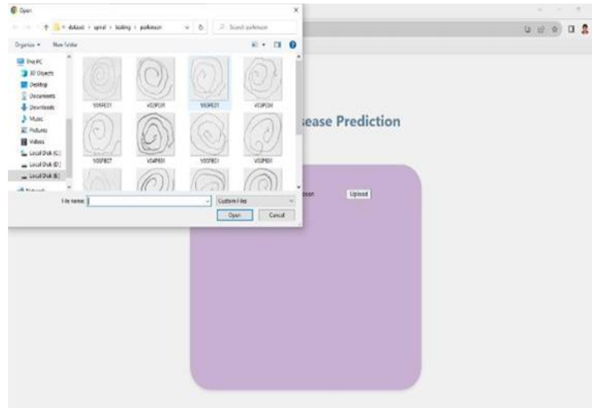

Fig -2: Upload user data to the site

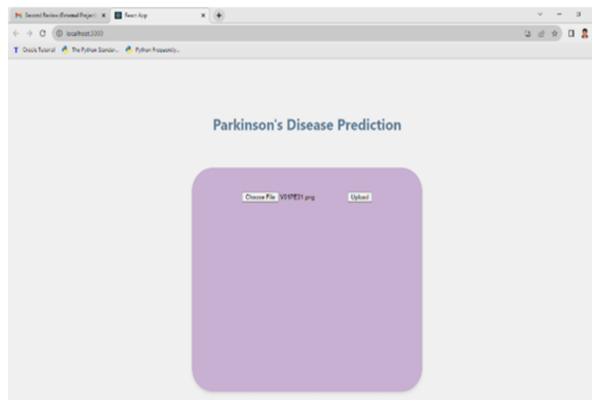

Fig -3: Image uploaded successfully

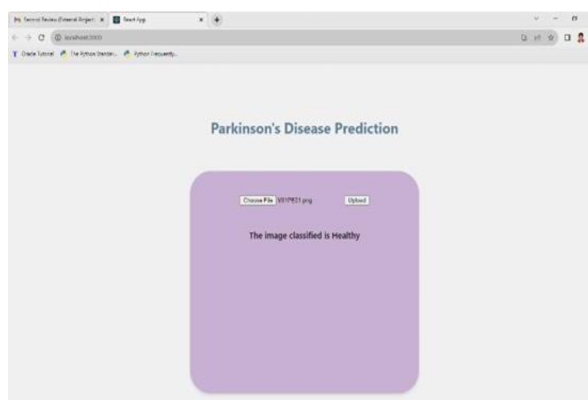

Fig -4: Prediction result

The development of a user-friendly and simple React.js application interface is a key component of our project. This interface's painstaking design focuses on simple data input, real-time feedback, and transparent results presentation to provide a seamless and interesting experience for both medical professionals and patients. To ensure that the entered data is accurate and follows the anticipated formats, user-friendly input validation is also implemented. This strategy not only simplifies the data-entering procedure but also lowers the chance of input errors. The application makes sure that given data is accurate by warning users of potential inaccuracies during the input step, which improves the precision of predictions. Users can comprehend and accept the forecasts when there is transparency, allowing them to make their decisions on the outcomes in an informed manner. The user experience is consistent and optimal because of the interface's responsiveness, which adapts to different devices and screen sizes. The user experience and interface design of the React.js application play a crucial role in the overall success of our project. We have developed an interface that empowers both patients and medical professionals by placing a high priority on user-friendliness, real-time feedback, and transparent result presentation. This interface improves trust in the technology while also streamlining the engagement process, which has a good effect on the accuracy of Parkinson's Disease forecasts and the actions taken in response to them.

The accuracy, average recall, average precision, and average f1 score for the model created in this study were 93.3%, 94%, 93.5%, and 93.94%, respectively. Efficiency in the delivery of predictions is crucial, especially in medical situations when prompt decisions can have a significant influence. Swift predictions were given top priority in the careful design of our deployment system. The 0.5-second average reaction time demonstrates the tremendous efficiency attained in handling user inputs and providing precise forecasts. This quick turnaround time makes sure that patients and medical professionals get results right away, enabling informed decision-making and prompt treatments. Securing scalability is crucial to maintaining responsive prediction delivery as our model's deployment expands to a larger user base. The model's capacity to keep responding even under heavier loads was shown via load testing, which mimics different amounts of user traffic. This scalability is evidence of the robustness of the design and the model's ability to handle increased demands. As user numbers increase, scalability is essential to maintain the application's dependability and functionality and avoid bottlenecks that can impede vital medical procedures.

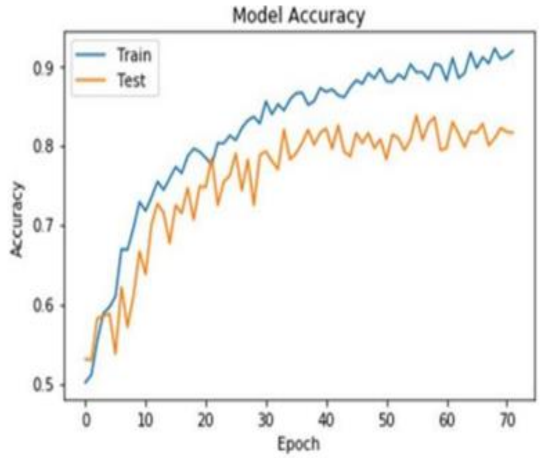

Fig -5: Spiral CNN model accuracy

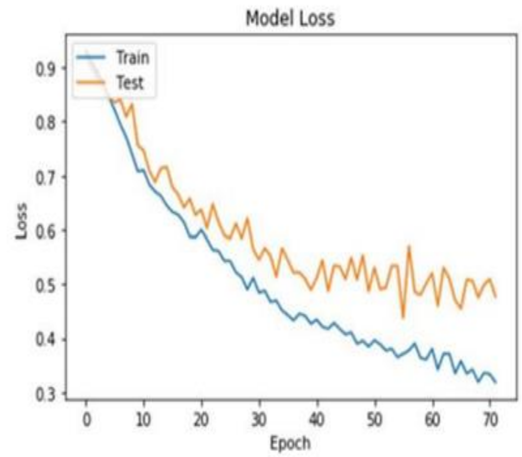

Fig -6: Spiral CNN model loss

The validation of our predictive model's accuracy is a critical step in establishing its clinical utility and relevance. To ensure the robustness of our model's predictions, we conducted thorough comparative studies that involved aligning its outputs with established medical diagnoses. This validation process is instrumental in affirming the accuracy and reliability of our model, ultimately positioning it as a valuable tool for medical practitioners. To validate our model's predictions, we compared its outputs against a set of pre-existing medical diagnoses. These diagnoses were established using a combination of clinical assessments, medical tests, and expert opinions. By juxtaposing our model's predictions with these established diagnoses, we aimed to gauge the model's ability to accurately classify individuals as having Parkinson's Disease (PD) or not. The model's predictions exhibited a high degree of alignment with the existing diagnostic outcomes.

A substantial proportion of cases classified by the model as PD-positive corresponded to cases that were diagnosed with PD by medical experts. Similarly, cases classified as PD-negative by the model correlated well with those diagnosed as healthy. The validation of our model through comparative studies against established diagnostic outcomes reaffirms its clinical relevance and reliability. Its alignment with expert diagnoses not only validates its accuracy but also positions it as a valuable and trustworthy tool for medical practitioners. The model's accurate identification of PD cases and healthy individuals aligns with the ultimate clinical objective of early and accurate disease detection. This clinical relevance substantiates the model's potential to be integrated into real-world medical practices. This validation marks a significant milestone in our project, bridging the gap between cutting-edge technology and its tangible benefits in the realm of medical diagnosis and care.

III. CONCLUSIONS

As a result, millions of people worldwide suffer from a neurological disease called Parkinson's disease (PD). Early diagnosis and intervention are necessary to treat the symptoms of the disease and improve the patient's quality of life. Accurate diagnosis and diagnosis of Parkinson's disease has recently shown great results thanks to technologies such as deep learning. Combining deep learning with effective user guidance, this initiative could enable early diagnosis and treatment of Parkinson's disease. The following sections provide an in-depth look at each goal, allowing us to explain the methods and tools used to achieve them. Selecting the appropriate neural network architecture for PD prediction requires careful consideration of the nature of the data and model requirements. A hybrid approach that combines the performance of different models (e.g., using a CNN model and SVM configuration) can create an overall model that captures the disease-causing interaction. Finally, the choice of architecture should be based on the specific characteristics of the data set and the desired properties. Deploying training models in React.js applications requires careful front- end design, back-end integration, and deployment decisions. Ensuring effective communication between the front-end and back-end, establishing a strong customer relationship, and using safe practices are critical to delivering an effective and reliable tool for Parkinson's disease. Deep learning models are integrated into a user-centered interface, allowing doctors and patients to easily interact with the technology. This not only simplifies the prediction process, but also allows users to make informed decisions about diagnosis and treatment.

Collaboration between data scientists, developers, and medical professionals has led to significant solutions that will improve patient outcomes and empower healthcare professionals. Going forward, continuous evaluation and change must be adapted to advances in technology and medical research. This study shows how combining deep learning tools with central modeling will help improve the diagnosis and treatment of Parkinson's disease.

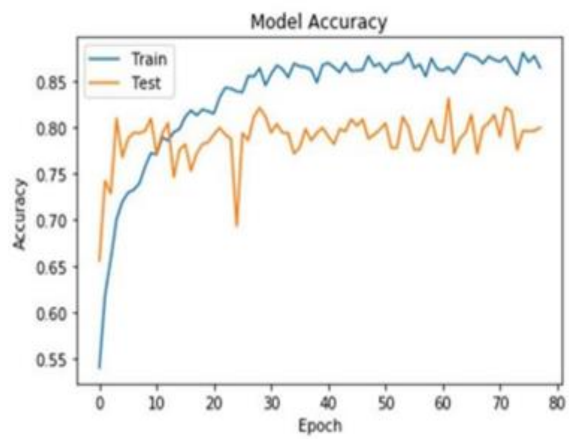

Fig -7: Wave CNN model accuracy

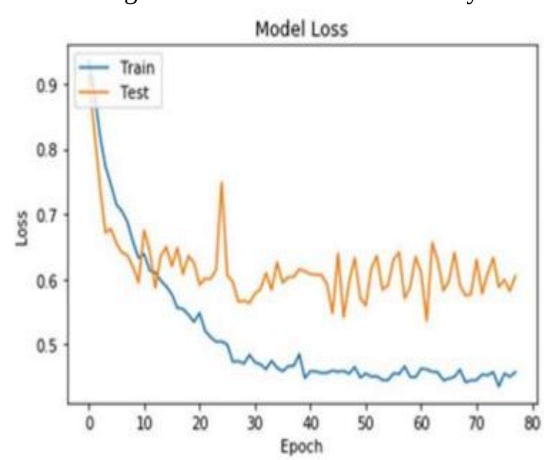

Fig -8: Wave CNN model loss

The significance of our work transcends the realms of mere accuracy and technical proficiency. Our project holds the potential to make a lasting impact on society by providing a powerful and accessible tool for Parkinson's Disease (PD) prediction. This impact extends to empowering medical professionals, enhancing patient outcomes, and ultimately reshaping the landscape of PD diagnosis andcare. Empowers medical professionals by equipping them with a sophisticated predictive model that aids in making more informed clinical decisions. By enabling early diagnosis through our predictive model, medical practitioners can intervene sooner, tailor treatment plans, and initiate appropriate interventions. Early diagnosis often translates to more effective treatment strategies, enhancing the quality of life for individuals affected by PD. The capability of our model to facilitate early diagnosis carries far-reaching implications. Timely interventions can alleviate symptoms, slow disease progression, and optimize the management of PD. The culmination of deep learning techniques integrated into a React.js application reflects the symbiotic relationship between cutting-edge technology and medical advancements. This can lead to a more comprehensive, data-driven, and patient-centered approach to PD diagnosis and management. This can lead to a more comprehensive, data-driven, and patient-centered approach to PD diagnosis and management.

REFERENCES

[1] S. Saravanan, Kannan Ramkumar, K. Narashimhan, Subramaniyaswamy Vairavasundaram, Ketan Kotecha, Ajith Abraham, “Explainable Artificial Intelligence (EXAI) Models for Early Prediction of Parkinson’s Disease Based on Spiral and Wave Drawings”, IEEE, Electronic ISSN:2169-3536

[2] Phuong Cao, Cheol-Hong Min, “Fall Prediction in People with Parkinson's Disease”, IEEE, Electronic ISBN:978-1-7281-2782-8

[3] G.V. Dhruva Kumar, V. Deepa, N. Vineela, G. Emmanuel, Ch. Chittibabu, “LightGBM Model based Parkinson’s Disease Detection by using Spiral Drawings”, IEEE Xplore, Electronic ISBN:978-1-6654-6941-8

[4] Sabyasachi Chakraborty, Satyabrata Aich,Jong-Seong-Sim, Eunyoung Han, Jinse Park, Hee-Cheol Kim, “Parkinson's Disease Detection from Spiral and Wave Drawings using Convolutional Neural Networks: A Multistage Classifier Approach”, 10.23919 / ICACT 48636.2020.9061497

[5] Antonina Kouli , Kelli M. Torsney and Wei-Li Kuan, Parkinson’s Disease: Etiology, Neuropathology, and Pathogenesis, University of Cambridge, UK, 2018.

[6] Kirti Sharma, Ashutosh Mishra, Prediction of Parkinson's Disease Using Machine Learning Techniques, 2020.

[7] J. Eric Ahlskog, PhD, MD, The New Parkinson's Disease Treatment Book Partnering with Your Doctor to Get the Most from Your Medications, 2015.

[8] US20080131893A1 - Predicting Parkinson's Disease. 37

[9] WO2011133215A1 - Method of identifying and treating a person having a predisposition to or afflicted with parkinson disease.

[10] WO2012113948A1 - Method for determining genetic predisposition to parkinson's disease.