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Parkinson Disease Detection Using CNN Algorithm

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Abstract: ***Parkinson's disease, a progressive neurological disorder, results from the depletion of dopamine-producing neurons in the brain, leading to diminished motor function. Common symptoms include tremors, rigidity, bradykinesia, shivering, and impaired balance. This study introduces two neural network architectures: the Voice Impairment Classifier, designed for early disease detection. The research conducted a thorough assessment of convolutional neural networks (CNNs) for classifying gait signals transformed into spectrogram images, and deep dense networks for analyzing voice recordings. Results demonstrated superior performance of the proposed models, with the VGFR Spectrogram Detector achieving 88.1% accuracy and the Voice Impairment Classifier achieving 89.15% accuracy, surpassing current state-of-the-art techniques.***
Index Terms: ***Parkinson disease, Machine Learning, Deep Learning, SVM(Support Vector Machine), Convolutional Neural Network, Accuracy Optimization***

I. INTRODUCTION

Every day, hospitals receive numerous new cases of Parkinson's disease, each presenting with unique and unfamiliar symptoms. Parkinson's is a complex condition with no definitive scale to detection its progression. It's a degenerative neurological disorder affecting motion functions due to reduced dopamine levels in the brain, leading to observable physical effects. The primary cause is the inability of neurons to regenerate; as people age, neurons deteriorate without replacement. Neurons produce dopamine, crucial for bodily movement and inter-neuronal signaling. With age, declining dopamine levels slow neurological functions, affecting various brain communication pathways. These effects manifest gradually, often unnoticed until the condition worsens. Symptoms include voice changes, balance loss, slow movements, posture instability, stiffness, sleep disturbances, facial masking, and more.

The World Health Organization reports Parkinson's disease affecting approximately 10 million individuals globally. Late diagnosis often leads to an untreatable, permanent neurological condition. In advanced stages, it becomes incurable, with fatal outcomes in most cases. In 2015, Parkinson's suffered around 6.2 million people worldwide, with 117,400 deaths. Diagnostic tests are expensive and lack accuracy. The societal costs are substantial, with the annual per-patient cost in the U.S. averaging $10,000 and total annual costs reaching $23 billion. In the UK, the annual cost ranges from £49 million to £3.3 billion.

These figures highlight the urgent need for a cost-effective, reliable, and precise early diagnosis method to potentially cure patients before the disease progresses to an incurable stage. This research aims to develop a comprehensive solution to address this pressing issue..

II. BACKGROUND

"Novel Machine Learning-Based Approach for Parkinson’s Disease Prediction"

Parkinson’s disease (PD) presents a significant global health challenge, affecting millions worldwide. Timely detection is crucial for initiating appropriate interventions. While motor symptoms are well-known, recent research focuses on identifying non-motor symptoms that may precede them. Early and accurate prediction is essential for timely treatment. Non-motor symptoms like Rapid Eye Movement sleep Behavior Disorder and olfactory loss are being explored for prediction purposes. Leveraging machine learning models for disease prediction can greatly enhance early detection efforts. This study extends previous research by incorporating non-motor features alongside important biomarkers. Various machine learning algorithms, including Multilayer Perceptron, BayesNet, Random Forest, and Boosted Logistic Regression, were utilized to develop automated diagnostic models. Results indicate that Boosted Logistic Regression achieved the highest accuracy of 97.159% and an area under the ROC curve of 98.9%, highlighting the effectiveness of these models for early Parkinson’s disease prediction.

"Deep Learning-Based Diagnosis of Parkinson's Disease"

Parkinson's disease results from the deficiency of dopamine-producing brain cell clusters, affecting both motor and non-motor functions. Beyond motor impairments, Parkinson's also impacts psychological and sleep-related functions. Accurate diagnosis involves analyzing speech patterns, presenting a significant classification challenge.

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This study proposes a deep neural network classifier comprising a stacked autoencoder and softmax classifier for diagnosing Parkinson's disease based on speech impairments, an early indicator. Extensive simulations using two databases demonstrate the classifier's effectiveness, surpassing current classification methods. Experimental findings and statistical analyses confirm the deep neural network classifier as a highly effective tool for diagnosing Parkinson's disease.

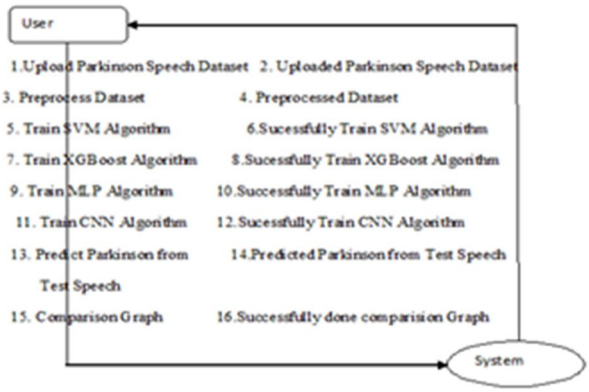
III. PROPOSED METHODOLOGY

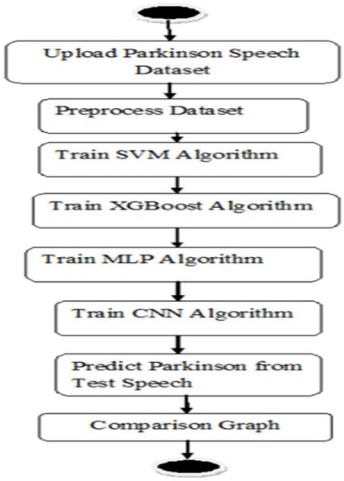
Convolutional Neural Networks (CNNs) have emerged as a dominant architecture within the realm of Deep Learning, particularly in the field of Computer Vision. Computer Vision, a subset of Artificial Intelligence, is dedicated to empowering machines to comprehend and interpret visual information, such as images.

Artificial Neural Networks, with CNNs at the forefront, have demonstrated remarkable efficacy across various Machine Learning applications. They find application in diverse domains, including but not limited to image analysis, speech recognition, and natural language processing. Different types of Neural Networks are tailored for specific tasks. For example, Recurrent Neural Networks (RNNs), particularly Long Short-Term Memory (LSTM) networks, excel in sequence prediction tasks. Conversely, Convolutional Neural Networks are purpose-built for tasks like image classification, leveraging their unique architecture optimized for extracting features from visual data..

The activity diagram holds significant value in UML as it portrays the dynamic elements of a system. Essentially, it functions as a flow chart that illustrates the transition from one activity to another

An activity can be defined as an operation within the system, and thus the control flow is depicted from one operation to the next. This flow can take the form of sequential, branched, or concurrent pathways..





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Data flow diagrams are visual representations that show how data is processed within a system. They highlight the inputs and outputs involved in this process. These figures are useful for providing a clear understanding of various business functions. The technique used to create these diagrams begins with an overview of the entire business and then delves into analyzing each specific area of interest. This analysis can be done in as much detail as needed. The technique employs a method called top-down expansion, which allows for a targeted and focused analysis. In summary, data flow diagrams are a valuable tool for illustrating the flow of information in a process and can be used to model and analyze information processes.

IV. IMPLEMENTATION AND RESULTS

A. *Preparation and Validation*

Preparation stands as a cornerstone in the design process, marking a phase where meticulous attention is crucial, as all decisions made during this stage profoundly impact the system's functionality. It serves as a pivotal juncture in ensuring the success of the system and instilling confidence in its users. Each component undergoes rigorous collective testing during development, using sample data to validate their cohesion as specified in the program requirements. The computer system and its environment undergo thorough testing to meet the satisfaction of stakeholders.

B. *Preparation*

The preparation phase diverges from the creative aspects of system design, focusing primarily on user training and transition management. It entails comprehensive training for users, ensuring seamless adaptation to the new system. Adjustments to the original system parameters may be necessary based on programming outcomes. Clear and concise operating procedures are provided to facilitate user comprehension of system functions. Additionally, various reports can be easily accessed and printed using available printing resources. The proposed system is designed for simplicity and ease of use, aiming to streamline operational processes. Overall, preparation signifies the conversion of a new or revised system design into a functional framework.

C. *Evaluation*

Evaluation constitutes the systematic process of validating system functionality through the utilization of carefully curated test data. It involves the collective examination of modules, followed by meticulous validation of individual field parameters. System-wide evaluation ensures the seamless integration and cohesive operation of all system elements. The selection of test data is crucial, encompassing a comprehensive range of conditions to thoroughly assess system performance. Evaluation serves as a critical preparatory phase, ensuring the system's direct and efficient operation before full-scale deployment. The testing strategies employed during this period are custom-tailored to validate system functionality and efficiency.

D. *System Evaluation*

Evaluation is an essential component of any system or design, particularly within the realm of information technology. The importance of evaluation cannot be overstated; it serves as a means of justification, determining whether a system is prepared to progress further. Evaluation is crucial for assessing a system's ability to withstand the challenges of real-world scenarios, making testing before development imperative. Prior to deployment, software undergoes rigorous testing to ensure it aligns with its intended purpose. Various testing methodologies are employed to guarantee software reliability. Logical testing procedures are executed, systematically analyzing program execution for different sets of data. Through meticulous testing, the software's functionality and resilience are thoroughly scrutinized, ensuring its suitability for operational use.

E. *Component Testing*

Component testing is an essential phase aimed at identifying potential flaws within each module of the system. This approach allows for the detection and rectification of errors without compromising the integrity of other modules. In instances where a module fails to meet its intended function, necessary corrections are made to ensure the desired outcome. Component testing is conducted in a systematic manner, starting from the lowest and smallest modules and progressing upwards. Each module undergoes independent testing to validate its functionality. For instance, the job bracket module undergoes rigorous testing with various job scenarios and their respective processing times. Test results are meticulously compared against manually set benchmarks to assess system efficiency. By testing each module independently, the system's overall performance is optimized, leading to reduced processing time and enhanced functionality.

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F. System Integration Assessment

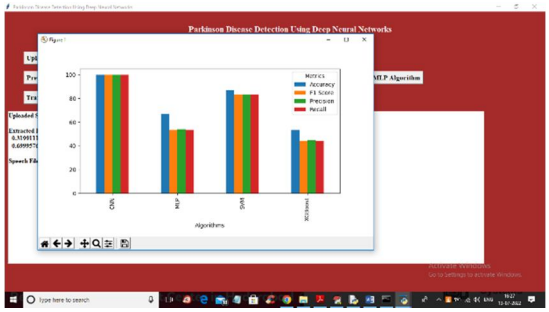
Following the completion of module testing, the system integration assessment phase is initiated. This crucial step aims to identify and rectify any potential discrepancies that may arise when integrating individual modules. Integration testing is essential as it ensures seamless connectivity and functionality across all system components. By conducting integration testing, any inconsistencies or errors that may occur during the linking of modules can be identified and addressed promptly. This comprehensive testing approach involves connecting all modules and verifying their interactions. The results obtained from integration testing are reliable and accurate, affirming the system's ability to perform effectively. Additionally, this phase ensures that the system correctly maps jobs with their respective functions, thereby enhancing operational efficiency and accuracy.

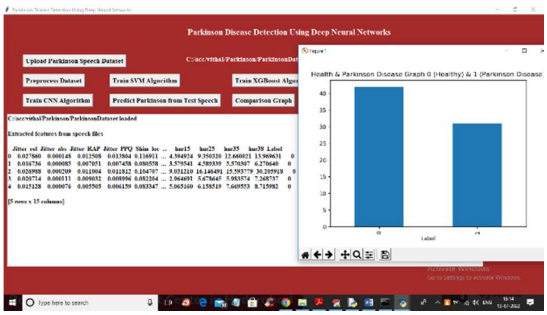
V. RESULT

In this paper we made use of various machine learning algorithms such as SVM, XGBOOST and MLP (multilayer perceptron) to predict Parkinson disease from SPEECH file but this algorithms prediction accuracy is not accurate so we are implementing advance Convolution Neural Network (CNN2D) and then compare its performance with machine learning algorithms.

To train all algorithms we have used speech files which contains spontaneous dialogs and TEXT READING and it contains two different folder called HC (healthy) and PD (Parkinson disease). Features are extracted from speech file by using python SOUND API. Below screen showing dataset audio files used in this project

In above screen from all audio files features are extracted and then in graph we are displaying total healthy and Parkinson disease found in dataset. In above dataset 0 mean healthy and 1 means Parkinson disease and now close above graph and then click on “Preprocess Dataset” to replace missing values and then normalize values and then split dataset into train and test and will get below output.





In above graph x-axis represents algorithm names and y-axis represents accuracy, precision, recall and FSCORE in different colour bars and in all algorithms CNN has got high performance .

VI. CONCLUSION

Several studies were examined to develop an effective approach for detecting Parkinson's Disease, leveraging both Machine Learning and Deep Learning algorithms. The research focused on distinguishing between individuals exhibiting normal symptoms and those displaying suspicious indications of the disease. Deep Learning emerged as particularly effective in addressing two

critical symptoms: abnormal gait patterns and speech impairments. Data were collected from reputable sources such as the UCI ML Repository and PhysioNet Database Bank.

Two distinct modules were developed: a VGFR Spectrogram Detector utilizing Convolutional Neural Networks (CNNs) and a Voice Impairment Detector employing Artificial Neural Networks (ANNs). These modules demonstrated promising results, achieving an accuracy of 88.17% and 89.15%, respectively, on the testing dataset. Comparative analysis against other algorithms including Support Vector Machines (SVM), XG Boost, and Multilayer Perceptrons (MLP) revealed superior performance of the proposed model.

Future endeavors entail integrating the outcomes of both modules to enhance detection efficacy. This involves incorporating additional critical features such as loss of olfactory sense and handwriting distortions. Additionally, exploration of novel algorithms aims to streamline computational processes and optimize overall system performance.

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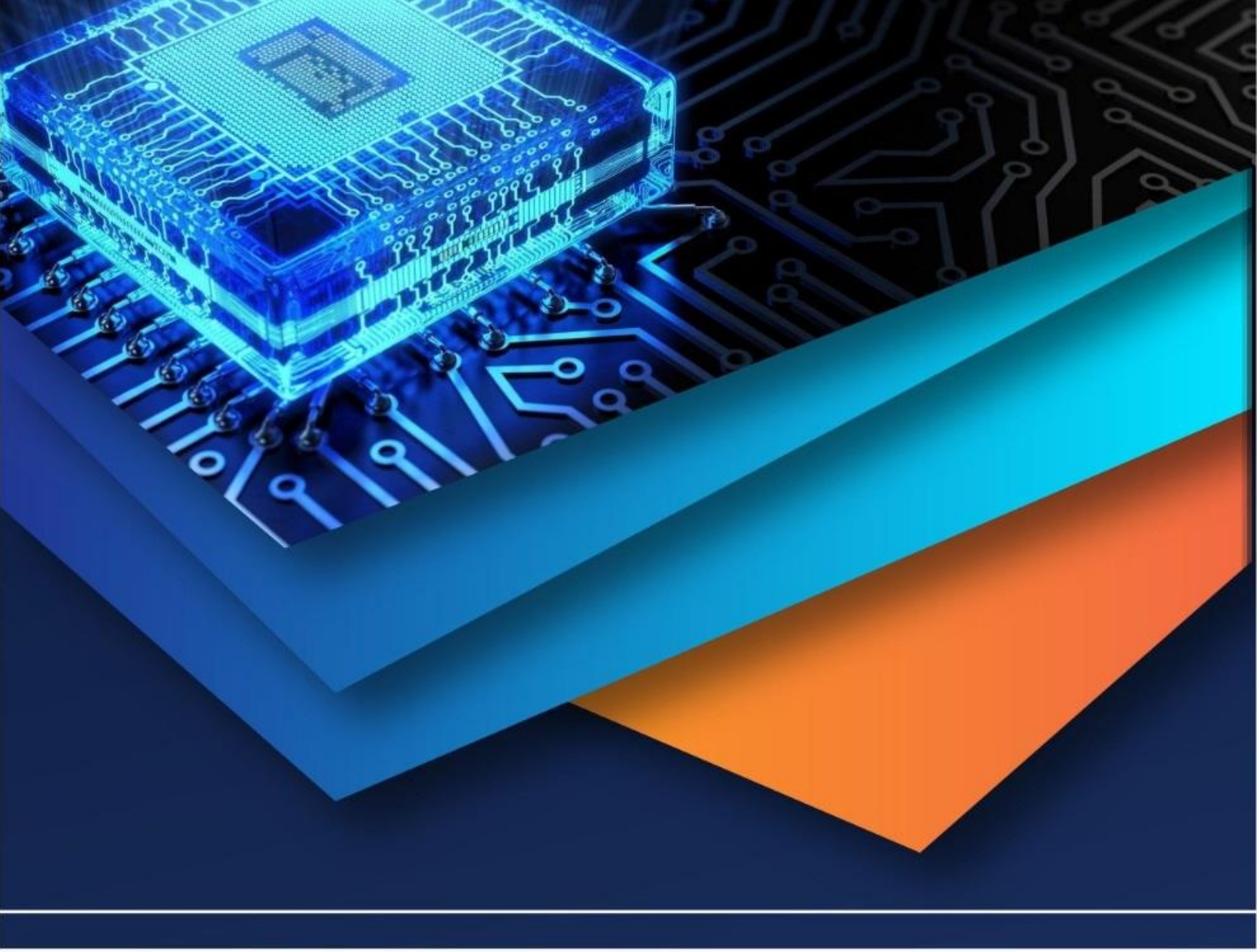
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