Parkinson's Disease Detection in Daily Life

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Abstract— "Parkinson's Disease Detection in Daily Life" Early classification Parkinson's disease of from magnetic resonance imaging (MRI) plays an important role in the diagnosis of such diseases. There are many diagnostic imaging methods used to identify Parkinson's disease. MRI is commonly used for such tasks because of its unmatched image quality. The relevance of artificial intelligence (AI) in the form of deep learning (DL) has revolutionized new methods of automated medical image diagnosis. This study aimed to develop a robust and efficient method based on transfer learning technique for classifying Parkinson's disease using MRI. In this article, the popular deep learning architectures are utilized to develop Parkinson's disease diagnostic system.

The pre-trained models such as Xception, NasNet Large, DenseNet121 and InceptionResNetV2 are used to extract the deep features from brain MRI. The experiment was performed using two benchmark datasets that are openly accessible from the web. Images from the dataset were first cropped, preprocessed, and augmented for accurate and fast training. The performance of the transfer learning models is evaluated using performance metrics such as accuracy, sensitivity, precision, specificity and F1-score. From the experimental results, our proposed CNN model based on the Xception architecture using ADAM optimizer. The proposed method is superior to the existing literature, indicating that it can be used to quickly and accurately classify Parkinson's diseases.

Our architecture used temporal Transformers, dimension reduction layers to reduce the dimension of the data, a spatial Transformer, two fully connected layers and an output layer for the final prediction. Our model outperforms the current state-of-the-art algorithm with 95.2% accuracy in distinguishing a Parkinsonian patient from a healthy one on the Physionet dataset. A key learning from this work is that Transformers allow for greater stability in results.

KEYWORDS: **Parkinson's Disease, Machine Learning (ML), Deep Learning (DL), Decision Tree (DT), Logistic Regression (LR), Naive Bayes (NB), Recurrent Neural Networks (RNN).**

INTRODUCTION

Parkinson's disease (PD) affects between 12 and 15 in every 100 000 inhabitants, making it the second most common neurological disorder after Alzheimer's disease . Age is the main factor explaining the onset of the disease: its prevalence in industrialized countries among the people over 60 reaches 1% . This disease reduces not only the life expectancy of patients, but is also an economic burden for society. Currently, there is no remedy to cure people suffering from PD. An early detection of the first symptoms of the disease allows the administration of drugs to mitigate the long-term effects.

However, diagnosing PD is a complex task due to inter individual variability, leading to
false diagnoses resulting from a lack of knowledge or subjective errors by physicians. This disease is caused by a lack of dopamine, a chemical messenger in the brain, causing motor and non-motor symptoms. Among the former, static tremors, rigidity, slowness of movement and postural instability are usually observed in patients. Non-motor symptoms are also described such as sleep disorder, speech disturbance and a loss of smell [3]

The aging of today's society is associated with an increasing number of patients suffering from neurodegenerative disorders. One of these disorders is Parkinson's disease (PD), and current estimates indicate that the number of people with PD will rise more than twofold, from 4 million in 2005 to 9 million by 2030 . The clinical presentations of PD include progressively slowing movements, limb rigidity, restremor, and posture instability.

Unfortunately, even those patients who receive dopaminergic treatment or deep brain stimulation still deteriorate with increasing age, and their mortality rate is two- to three-fold higher than that of the general population. Therefore, recognizing PD in its early stage is critical for initiating proper treatments to decrease morbidity and ease the medical burden in the elderly The

clinical severity of PD can be divided into five stages, called the Hoehn-Yahr Stages I–V . In Stage I, the patients bilateral and the patient's stability degrades; in Stage III, the disease affects the central reflex mechanism, and the patient tends to fall because of trunk instability; in Stage IV, the patient needs a wheelchair and other assistive devices; and in Stage V, the patient is wheelchair bound or even bedridden. Patients with PD can be classified as having early-stage or advanced-stage disease. In its early stages, denoted in this paper as Early PD and defined as Hoehn-Yahr Stage ≤2, the symptoms include asymmetrical movement reduction of one limb, asymmetrical hand movements, and shuffling when walking, with a preserved posture reflex. In the advanced stages, denoted here as Adv PD and defined as Hoehn-Yahr Stage >2, the symptoms are more progressed and include postural reflex losses, festinating gaits that cause walking instability, and experience unilateral symptoms, such as asymmetrical gait or hand swing; in Stage II, the disease influences are increased risk of falling. However, early detection of PD is challenging because the normal aging population might also exhibit progressive gait slowness, termed senile gait, due to joint osteoarthritis or sarcopenia. Therefore, the aim of the present study was to develop a neural network model that could help physicians recognize the PD gait based on motion characteristics occurring during walking. The model would also facilitate monitoring of the PD disease severity stages for appropriate medication adjustment and intervention. Advances in technology are now improving the early, timely, and accurate diagnosis of PD, especially when machine-learning techniques are applied.

I. Literature Survey

Parkinson's Disease Diagnosis Using Machine Learning and Voice. Biomarkers derived from human voice can offer insight into neurological disorders, such as Parkinson's disease (PD), because of their underlying cognitive and neuromuscular function. PD is a progressive neurodegenerative disorder that affects about one million people in the the United States, with approximately sixty thousand new clinical diagnoses made each year. Historically, PD has been difficult to quantify and doctors have tended to focus on some symptoms while ignoring others, relying primarily on subjective rating scales. Due to the decrease in motor control that is the hallmark of the disease, voice can be used as a means to detect and diagnose PD. With advancements in technology and the prevalence of audio collecting devices in daily lives, reliable models that can translate this audio data into a diagnostic tool for healthcare professionals would potentially provide diagnoses that are cheaper and more accurate. We provide evidence to validate this concept here using a voice dataset collected from people with and without PD. This paper explores the effectiveness of using supervised classification algorithms, such as deep neural networks, to accurately diagnose individuals with the disease. Our peak accuracy of 85% provided by the machine learning models exceed the average clinical diagnosis accuracy of non-experts (73.8%) and average accuracy of movement disorder specialists (79.6% without follow-up, 83.9% after follow-up) with pathological post-mortem examination as ground truth.

Early detection of Parkinson's disease using machine learning. Parkinson's disease (PD) is a neurodegenerative movement disease where the symptoms gradually develop start with a slight tremor in one hand and a feeling of stiffness in the body and it became worse over time. It affects over 6 million people worldwide. At present there is no conclusive result for this disease by non-specialist clinicians, particularly in the early stage of the disease where identification of the symptoms are very difficult in its earlier stages. The proposed predictive analytics framework is a combination of K-means clustering and Decision Tree which is used to gain insights from patients. By using machine learning techniques, the problem can be solved with minimal error rate. Voice data sets obtained from the UCI Machine learning repository if given as the input for voice data analysis. Also our proposed system provides accurate results by integrating spiral drawing inputs of normal and Parkinson's affected patients. From these drawings Random forest classification algorithm is used which converts these drawings into pixels for classification and the extracted values are been matched with the trained database to extract various features and results are produced with maximum accuracy. Also Open CV (Open Source Computer Vision Library) a library of programming functions mainly aimed at real-time computer vision was built to provide an infrastructure for computer vision applications and to accelerate the use of machine perception in the real time. Thus our output will showcase the early detection of the disease and can be able to increase the lifespan of the diseased patient with proper treatments and medications leads to peaceful life.

Prediction of Parkinson's Disease using Machine Learning Techniques on Speech dataset. In the present decade of accelerated advances in Medical Sciences, most studies fail to lay focus on ageing diseases. These are diseases that display their symptoms at a much advanced stage and make a complete recovery almost improbable. Parkinson's disease (PD) is the second most commonly diagnosed neurodegenerative disorder of the brain. One could argue, that it is almost incurable and inflicts a lot of pain on the patients. All these make it quite clear that there is an oncoming need for efficient, dependable and expandable diagnosis of Parkinson's disease. A dilemma of this intensity requires the automating of the diagnosis to lead accurate and reliable results. It has been observed that most PD Patients demonstrate some sort of impairment in speech or speech dysphonia, which makes speech measurements and indicators one of the most important aspects in prediction of PD. The aim of this work is to compare various machine learning models in the successful prediction of the severity of Parkinson's disease and develop an effective and accurate model in order to help diagnose the disease accurately at an earlier stage which could in turn help the doctors to assist in the cure and recovery of PD Patients. For the aforementioned purpose

we plan on using the Parkinson's Tele monitoring dataset which was acquired from the UCIML repository.

II. Proposed System Methodology

PROPOSED SYSTEM ARCHITECTURE

The proposed system has mainly five modules. Dataset, Pre-processing, Split the data, Build CNN model train Deep Neural network for epochs, and classification. In dataset we can take multiple MRI images and take one as input image. In pre-processing image to encoded the label and resize the image. In split the data we set the image as 80% Training Data and 20% Testing Data. Then build CNN model train deep neural network for epochs. Then classified the image as yes or no if PD is positive then it returns yes and the PDr is negative the it returns no.

The proposed framework model includes four stages. First, the input MR image is preprocessed (brain cropping and resizing, data splitting and normalization). Second, the data augmentation technique is used to increase the size of the dataset. Third, we investigated the four unique DL models, such as Xception, NasNet Large, DenseNet121, and InceptionResNetV2, using BT's preprocessed MR images and applied TL technique to extract features. The features extracted by the CNN models are classified using the softmax layer.

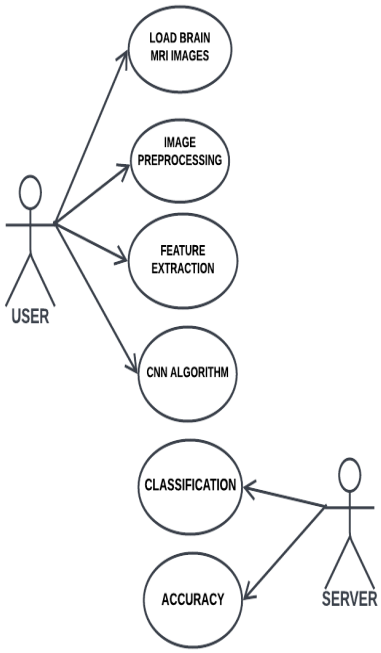


Fig. 1 Technical Architecture

I. HARDWARE REQUIREMENT

- Operating System
- Processor
- Memory – RAM and ROM
- Resolution

A. Operating System

An operating system (OS) is system software that manages computer hardware, software resources, and provides common services for computer programs. Time-sharing operating systems schedule tasks for efficient use of the system and may also include accounting software for cost allocation of processor time, mass storage, printing, and other resources.
Hardware functions such as input and output and memory allocation, the operating system acts as an intermediary between programs and the computer hardware,[1][2] although the application code is usually executed directly by the hardware and frequently makes system calls to an OS function or is interrupted by it. Operating systems are found on many devices that contain a computer – from cellular phones and video game consoles to web servers and supercomputers.

B. Processor

A processor is an integrated electronic circuit that performs the calculations that run a computer. A processor performs arithmetical, logical, input/output (I/O) and other basic instructions that are passed from an operating system (OS). Most other processes are dependent on the operations of a processor. The terms processor, central processing unit (CPU) and microprocessor are commonly linked as synonyms. Most people use the word "processor" interchangeably with the term "CPU" nowadays, it is technically not correct since the CPU is just one of the processors inside a personal computer (PC).The Graphics Processing Unit (GPU) is another processor, and even some hard drives are technically capable of performing some processing.

C. Memory – RAM and ROM

Memory is the electronic holding place for the instructions and data a computer needs to reach quickly. It's where information is stored for immediate use. Memory is one of the basic functions of a computer, because without it, a computer would not be able to function properly. Memory is also used by a computer's operating system, hardware and software.

D. *Resolution*

Resolution is indicated by how many pixels a monitor displays, and it will be one of the following:
1280 x 1024 Super-eXtended Graphics Array (SXGA)
1366 x 768 High Definition (HD)
1600 x 900 High Definition Plus (HD+)
1920 x 1080 Full High Definition (FHD)
1920 x 1200 Wide Ultra Extended Graphics Array (WUXGA)
2560 x 1440 Quad High Definition (QHD)
3440 x 1440 Wide Quad High Definition (WQHD)
3840 x 2160 4K or Ultra High Definition (UHD)
The letters after the two numbers is simply a designated name for that resolution. You can also use

that name when discussing monitors while shopping, rather than relying on the longer numeric resolution description.

II. SOFTWARE REQUIREMENTS

- Python
- PyCharm
- Tensorflow
- OpenCV

A. *Python*

Python is a runtime environment object-oriented high-level computer program with dynamic semantics. Since there is no compilation phase, the modify cycle is extremely fast. A source level breakpoint allows users to inspect local and global variables, run arbitrary expressions, set breakpoints, step through the code one line at a time, and so on. Python provides modules and packages, which assists with programming modularity and code reuse.

B. *PyCharm*

PyCharm is an integrated development environment (IDE) used for programming in Python. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems, and supports web development with Django. PyCharm is developed by the Czech company JetBrains. It is a cross platform, working on Microsoft Windows , macOS and Linux. PyCharm has a Professional Edition, released under a proprietary license and a Community Edition released under the Apache License.[6] PyCharm Community Edition is less extensive than the Professional Edition.

C. *Tensorflow*

TensorFlow was developed by the Google Brain team for internal Google use in research and production. The initial version was released under the Apache License 2.0 in 2015. Google released the updated version of TensorFlow, named TensorFlow 2.0, in September 2019.

D. *Open CV*

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis. To Identify image pattern and its various features we use vector space and perform mathematical operations on these features.

The first OpenCV version was 1.0. OpenCV is released under a BSD license and hence it's free for both academic and commercial use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. When OpenCV was designed the main focus was real-time applications for computational efficiency. All things are written in optimized C/C++ to take advantage of multi-core processing.

III. RESULT AND ANALYSIS

It is based on how accurate each algorithm is in detecting the disease that results in the final results. Below Fig-2 and Fig-3 shows the comparison chart of the all ML and DL algorithms used in our project, which shows the slight difference between the algorithms on their accuracy and its time stamp.

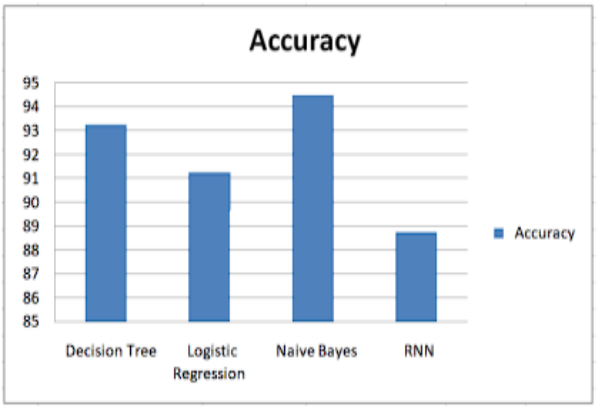
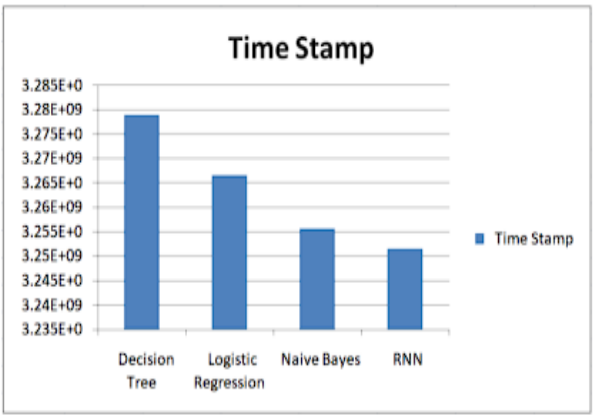


Fig-2 Accuracy Comparison Chart of all Algorithms



IV. CONCLUSION

In this study, we used transfer learning to develop a CNN model for automatic Parkinson's disease detection using MR images. Transfer learning uses weights from networks previously trained on millions of data. The proposed study implements four different transfer learning models with different optimizers (ADAM, SGD, RMSprop), and extensive experiments were performed on the two datasets with the largest number of MR images currently available. For these four models, the features are extracted using transfer learning, and three dense layers along with the softmax

layer are used for classification purposes. The proposed deep TL models shows fast learning by using the Adam optimizer, and the dropout method avoids the problem of overfitting. In future work, the performance of the system can still be improved by using larger data sets and using other deep learning techniques.

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