Parkinson's Disease Diagnosis using Data Driven Insights

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Abstract- Parkinson's disease is a progressive neurodegenerative disorder that affects millions worldwide. It affects the nervous system and the parts of the body controlled by the nerve. People may experience stiff muscles, difficulty in standing and walking, difficulty in speaking, jaw stiffness, amnesia. So, detection and diagnosis of PD is crucial to prescribe proper treatment for patient's productive and healthy lives. This project focuses on building a parkinson disease detection system by analyzing the data of spiral drawings and gait features.

Keywords: Spiral Drawings, Gait Features, Prescribe Treatment.

I INTRODUCTION

Parkinson's disease is a progressive neurological condition that affects movement. Parkinson's disease is the second most common neurodegenerative disease. More than 10 million people worldwide are having Parkinson's disease. It's caused by the loss of dopamine-producing cells in the brain. This neurotransmitter, dopamine, plays a vital role in coordinating muscle movements. As dopamine levels decrease, individuals experience motor symptoms like tremors, rigidity, slowness of movement (bradykinesia), and difficulties with balance and coordination. Parkinson's disease, a progressive neurological disorder, poses diagnostic challenges due to the absence of definitive tests. Its diagnosis relies on clinical evaluation, history, and ruling out other conditions. This complex process involves assessing symptoms through tools like the Unified Parkinson's Disease Rating Scale (UPDRS), utilizing imaging techniques (such as MRI or DaTscan), and occasionally employing blood tests. Despite these aids, diagnosing Parkinson's remains primarily a clinical judgment, and ongoing research endeavors seek more accurate diagnostic tools and early biomarkers for improved detection.

Diagnosing Parkinson's disease often involves a multifaceted approach that incorporates various methods, including voice recognition, assessment of spiral drawing patterns, and analyzing gait features. Parkinson's disease can affect speech patterns, causing changes in voice quality such as softness, hoarseness, or a monotone voice. Voice recognition technology can analyze these alterations to detect potential signs of the disease. Software can evaluate speech characteristics, including pitch, volume, and rhythm, aiding in early diagnosis or monitoring disease progression. Patients with Parkinson's may exhibit motor symptoms affecting fine motor skills. Drawing a spiral is a common test to assess these motor skills. Individuals with Parkinson's may produce smaller, more cramped, or irregular spirals due to tremors or lack of coordination. Analyzing these spiral images helps clinicians detect motor impairment, aiding in diagnosis and tracking progression. Parkinson's disease often affects gait, causing changes in walking patterns. Gait analysis involves assessing various aspects of walking, such as stride length, walking speed, balance, and posture. Technology can capture and analyze these gait features to identify deviations from normal patterns, providing additional diagnostic information.

Integrating these technologies and assessments can assist healthcare professionals in more accurately diagnosing Parkinson's disease, especially in its early stages, enabling timely interventions and management strategies. Parkinson's disease progresses gradually, and its severity and symptoms can vary widely among individuals. It's essential for those affected by Parkinson's, along with their caregivers and healthcare providers, to work together to manage the condition effectively and enhance daily functioning and well-being.

Data-driven insights hold promise in Parkinson's disease detection by leveraging technologies like machine learning and data analytics. These methods analyze various datasets, including patient symptoms, genetic information, imaging results, and more, to identify patterns and markers associated with the disease. Machine learning models can assist in diagnosing Parkinson's by: 1. Pattern Recognition: Identifying subtle patterns in patient data that might indicate the presence or progression of Parkinson's disease. 2. Predictive Analytics: Forecasting the likelihood of developing Parkinson's based on certain risk factors or early symptoms. 3. Image Analysis: Analyzing brain imaging data (like MRI scans) to detect structural changes or biomarkers indicative of Parkinson's.

However, despite the potential, these methods often require large, diverse datasets to train accurate models and must be validated extensively before clinical application. Ethical considerations and data privacy are also crucial in utilizing such approaches for healthcare purposes.

II LITERATURE SURVEY

Parkinson’s disease (PD) is a common and progressive neurodegenerative disorder with motor symptoms and a variety of non-motor symptoms. Experts regularly include handwriting as one of the Parkinson is an motor symptoms of PD and as a valuable tool that can aid in diagnosing and tracking the disease’s progression. PD patients have two periods. ‘On’ time is when levodopa is working well and your symptoms are controlled. ‘Off’ time is when levodopa is no longer working well and symptoms such as tremor, rigidity and slow movement re-emerge. This survey, presented new online Arabic handwriting dataset for analysing PD, which will make publicly available so that it could potentially be used for diagnosis, screening and monitoring the progression of PD. Dataset was collected from 30 healthy controls and 30 PD patients in both “off” and “on” at the Neurology Department, Habib Bourguiba Hospital, Sfax, Tunisia. All participants performed five different handwriting tasks [1].

The Inertial Measurement Unit (IMU) has been widely used in precision movement analysis and evaluation and applied in the diagnosis and treatment of many diseases. Parkinson disease (PD) is the most common neurodegenerative movement disorder with rest tremor, bradykinesia, and rigidity as the cardinal motor manifestations. A novel algorithm system has been derived to detect all the motor examinations of the Unified Parkinson's Disease Rating Scale (UPDRS), of which the accuracy has been verified by high-speed camera system. This system includes three categories of detection parameters: the trajectory parameters, time-frequency parameters, angle parameters. Average accuracy for the detection with IMU can reach to 87%, 90% and 95%, respectively [2].

Machine learning (ML) can be used to detect Parkinson's disease by analyzing patterns in data, such as hand drawings. The unique learning model (ULM) used for hand drawings to detect PD; a dataset IS collected containing drawings from both people with Parkinson's disease and healthy individuals. The model IS evaluated on this dataset to determine its accuracy, precision, recall, and F1 score. These metrics can be used to assess how well the model is able to distinguish between Parkinson's and healthy hand drawings. Overall, using ULM to detect PD from dataset has the potential to be a non-invasive, low-cost, and accessible method for early detection of the disease [3].

The detection and diagnosis of Parkinson disease (PD) are very important concerning the treatment of this disease. The freezing of gait (FoG) from subjects with Parkinson disease has been detected by the logistic regression modeling. First, the acceleration sensor has been placed on the ankle of the patients to get the signals. Second, the features from these acceleration signals have been extracted by the Fast Fourier Transform (FFT) algorithm. With the FFT algorithm, the frequency coefficients have been gotten. The classification of the accuracy of 81.3% has been achieved in the classification of FoG cases having PD from the acceleration signals [4].

The complex nature of Parkinson's disease (PD) makes difficult to rate its severity, mainly based on the visual inspection of motor impairments. A network of wearable sensors was used to measure motor capabilities, in 30 de novo PD patients and 30 healthy subjects, while performing five motor tasks. Measurement data were used to determine motor features useful to highlight impairments and were compared with the corresponding clinical scores. Three classifiers were used to differentiate PD from healthy subjects. Motor features gathered from wearable sensors showed a high degree of significance in discriminating the early untreated de novo PD patients from the healthy subjects, with 95% accuracy [5].

The problem of early PD identification through handwriting and drawing tasks, and by using three well-known PD data-sets. Given the scarcity of handwriting samples and the wide spectrum of Parkinson's disease symptoms, the challenge is known to be particularly difficult. To achieve reliable PD detection, employ diverse data augmentation techniques to expand the dataset size. Then, deploy and train the different architectures of deep Convolutional Neural Network (CNN) each of which extract different salient features and aspect of input data due to its unique layout and structure (i.e., number of layers, kernels, normalization, number of connected layers, etc.). After experimental analysis of the performance of individual CNNs, selected the promising feature vectors and employed different early fusion strategies before final classification. Experimental results show that the fusion of freeze features of multiple deep CNN models significantly achieves better exactness of 99.35% in comparison to uni model CNN and other state-of-the-art work [6].

III PROPOSED SYSTEM

Our proposed system utilizes computer vision and machine learning techniques to detect Parkinson's disease through analysis of human standing and spiral images. By leveraging the YOLO algorithm, the system identifies distinct features indicative of Parkinson's disease, such as posture abnormalities and tremors, from the collected dataset. Through preprocessing and feature extraction, the system enhances the quality and relevance of extracted features. Following model development and optimization, the system undergoes rigorous evaluation against validation datasets to ensure high accuracy and reliability. Upon successful validation, the system is poised for deployment in clinical settings, offering a non-invasive and accessible screening method for early Parkinson's disease detection and intervention.

Using human standing position and spiral images for Parkinson's disease detection based on the YOLO (You Only Look Once) algorithm involves several steps:

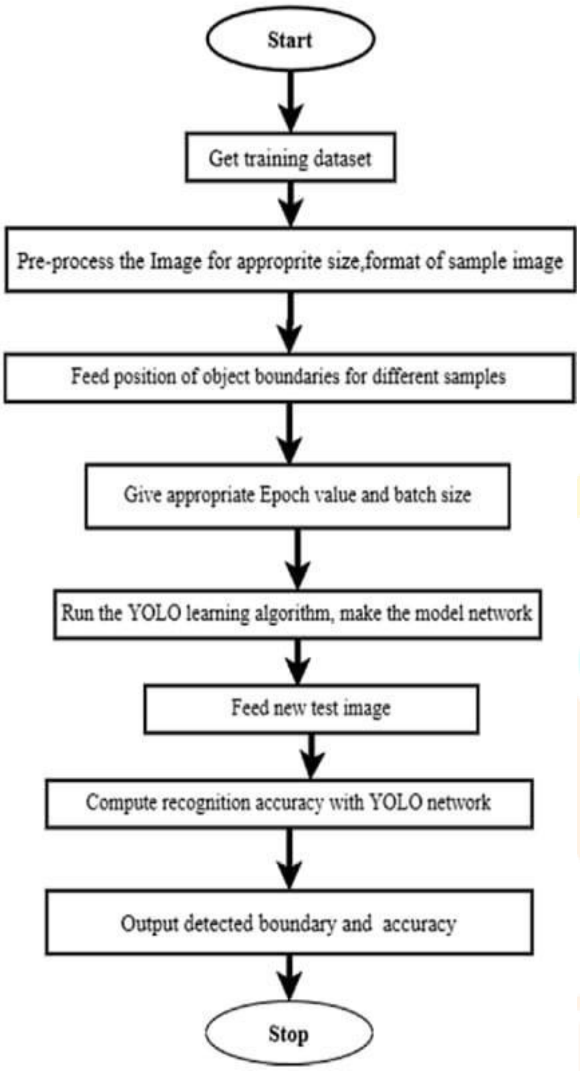

Fig 1. Architecture of proposed system

1. Data Collection: A dataset containing images of individuals in standing positions and spiral drawings are collected. These images include both healthy individuals and those diagnosed with Parkinson's disease.

2. Preprocessing: The images need to be preprocessed to enhance features and remove noise. This may involve resizing, normalization, and augmentation techniques to ensure uniformity and increase the robustness of the model.

3. Annotation: Each image in the dataset is annotated to indicate the presence or absence of Parkinson's disease. For standing position images, annotations include markers indicating the position of key body parts, while for spiral images, annotations involve marking the shape and characteristics of the spiral.

4. Training Data Preparation: The annotated dataset is divided into training, validation, and testing sets. The YOLO algorithm requires labeled bounding boxes for training, so each image is labeled accordingly.

5. Model Training: The YOLO algorithm is trained on the annotated dataset to learn the features associated with Parkinson's disease in standing position and spiral images. During training, the model learns to detect patterns and features that distinguish between healthy individuals and those with Parkinson's disease.

6. Model Evaluation: The trained model is evaluated using the validation set to assess its performance in detecting Parkinson's disease based on standing position and spiral images. Evaluation metrics such as precision, recall, and F1 score are used to measure the model's accuracy.

7. Testing: The final trained model is tested on unseen data from the testing set to evaluate its generalization performance. This step helps determine how well the model performs in real-world scenarios.

8. Deployment: Once the model has been trained and evaluated satisfactorily, it can be deployed for Parkinson's disease detection using standing position and spiral images. This could involve integrating the model into a software application or medical device that can analyze images and provide diagnostic insights.

Finally, the proposed system detects Parkinson’s disease using human standing position and spiral images.

Existing System

One existing system for Parkinson's disease detection utilizing human standing position and spiral images involves the application of computer vision techniques and machine learning algorithms. In this system, the algorithm commonly used is the Support Vector Machine (SVM) algorithm.

Existing systems may lack the precision to accurately detect subtle symptoms or early stages of Parkinson's disease, leading to false positives or false negatives. Many systems rely on manual assessment by healthcare professionals, which can be subjective and time-consuming, leading to inconsistencies in diagnosis. Some diagnostic methods involve invasive procedures or imaging techniques, which may pose risks to patients and limit accessibility, especially in resource-constrained settings. Certain diagnostic tools or imaging technologies used in existing systems can be expensive, making them inaccessible to individuals in underserved communities or regions with limited healthcare resources. Access to specialized equipment or expertise required for diagnosis may be restricted, particularly in rural or remote areas, hindering early detection and timely intervention. Patients may experience long waiting times for diagnostic tests or appointments with specialists, delaying diagnosis and treatment initiation, thereby impacting disease management and prognosis. Some existing systems may not effectively monitor disease progression over time, limiting their utility in tracking changes in symptoms and response to treatment. SVM relies heavily on handcrafted feature engineering, where features need to be carefully selected and engineered from the input data. This process can be complex, time-consuming, and may not fully capture the intricate patterns present in the images. SVM typically outputs class labels without providing precise localization information. While it can classify whether an image contains signs of Parkinson's disease or not, it may struggle to precisely localize the regions of interest within the images, such as specific postural abnormalities or irregularities in spiral patterns. As the dataset size increases, training and inference times may become prohibitively long. SVM may struggle to generalize well to diverse image characteristics, such as variations in lighting conditions, image resolutions, or background clutter. SVM treats each feature independently and does not explicitly model spatial relationships between features within the image.

While SVM has been widely used for classification tasks including medical image analysis, it may exhibit limitations in detecting complex patterns and localizing abnormalities within images compared to YOLO. Addressing these drawbacks requires the development of more accurate, accessible, and cost-effective diagnostic tools that integrate multiple modalities, prioritize patient-centered care, and facilitate seamless integration into clinical workflows.

IV METHODOLOGY

The You Only Look Once (YOLO) algorithm is a popular object detection algorithm in computer vision that can be adapted for various tasks, including medical image analysis such as Parkinson's disease detection. Here's how the YOLO algorithm can be used in the Parkinson's disease detection.

In the case of Parkinson's disease detection, the input data would consist of medical images such as MRI scans, CT scans, or even simpler images like standing position photographs or spiral drawings. These images would be used to detect patterns or anomalies indicative of Parkinson's disease. YOLO utilizes a CNN as its backbone architecture. The CNN is responsible for extracting features from the input images. These features capture various aspects of the image, such as edges, textures, and shapes, which are crucial for detecting objects or abnormalities. YOLO divides the input image into a grid of cells. Each cell is responsible for detecting objects within its boundaries. For Parkinson's disease detection, the grid cells would analyze different regions of the medical image to identify potential signs of the disease. Within each grid cell, YOLO predicts bounding boxes that enclose the detected objects. These bounding boxes represent the location and size of the detected objects within the grid cell.

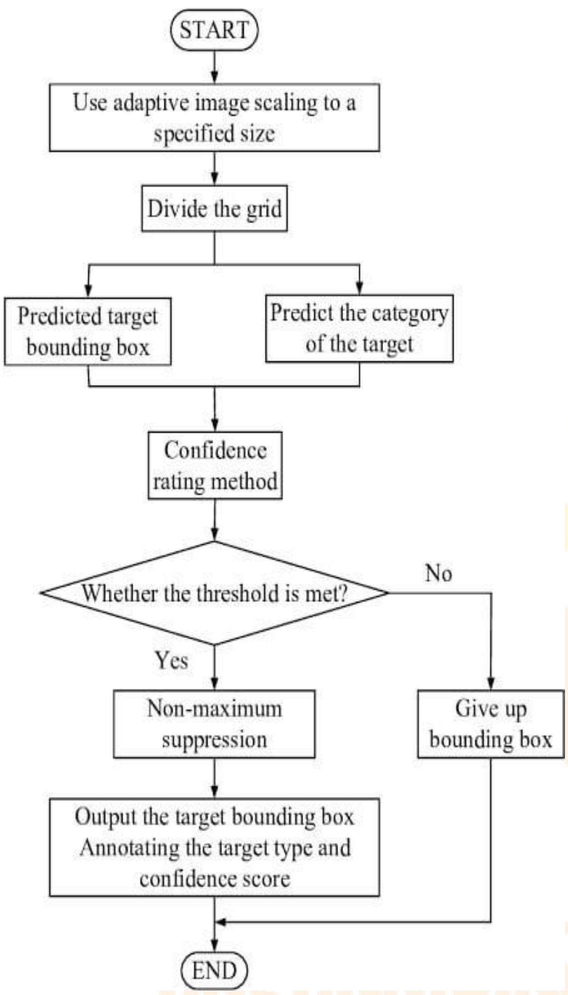

Fig 2. Methodology used for Detecting Parkinson's Disease

In Parkinson's disease detection, the bounding boxes would outline regions of interest in the medical image that exhibit characteristics associated with the disease. YOLO assigns a confidence score to each bounding box, indicating the likelihood that the detected object is present and correctly localized. In Parkinson's disease detection, the confidence score would reflect the algorithm's confidence in identifying abnormalities or signs of the disease within the bounding box regions. YOLO employs NMS to eliminate redundant or overlapping bounding boxes and retain only the most relevant detections. This helps ensure that each detected object is represented by a single bounding box with the highest confidence score. In the context of Parkinson's disease detection, NMS helps remove duplicate detections and refine the localization of abnormalities in the medical images. The final output of the YOLO algorithm is a set of bounding boxes, each associated with a confidence score and a predicted class label. For Parkinson's disease detection, the predicted bounding boxes would highlight regions of the medical image that are likely indicative of the disease, along with corresponding confidence scores.

YOLO algorithm can be adapted for Parkinson's disease detection by analyzing medical images and identifying abnormalities or signs associated with the disease using bounding box predictions, confidence scores, and object detection techniques.

V EXPECTED RESULT

Detecting Parkinson's disease based on human standing position can lead to early identification of the condition. Utilizing human standing position as a diagnostic marker for Parkinson's disease can complement existing diagnostic methods, such as clinical assessments and imaging techniques. This approach may enhance the accuracy and reliability of diagnosis by providing additional information about motor function and balance abnormalities associated with the disease.

Fig 3. Person with Parkinson's Disease

Fig 4. Person don't have Parkinson's Disease

Monitoring changes in human standing position over time can provide insights into disease progression and response to treatment. By tracking alterations in posture, gait patterns, and balance control, healthcare professionals can assess the effectiveness of interventions and adjust treatment plans accordingly.

Incorporating human standing position analysis into Parkinson's disease diagnosis promotes patient-centered care. Parkinson's disease detection using human standing position is to enhance diagnostic accuracy, facilitate early intervention, and improve patient care and outcomes. By leveraging the insights gained from analyzing posture and balance abnormalities, healthcare professionals can better identify and manage Parkinson's disease, ultimately enhancing the well-being of affected individuals.

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