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Parkinson Disease Detection on MRI Images using Image Processing

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Abstract: *Parkinson's disease (PD) is a neurodegenerative disorder that affects movement and cognitive function. Early diagnosis of PD is crucial for effective treatment and management of the disease. Magnetic resonance imaging (MRI) is a non-invasive diagnostic tool that can provide detailed images of the brain. In this study, we propose a method for PD detection using MRI images based on image processing techniques. Our approach involves several stages, including preprocessing, feature extraction, and classification. Preprocessing involves normalization, segmentation, and registration of the MRI images to remove noise and align the images for feature extraction. Feature extraction involves the use of handcrafted features such as intensity histograms, texture features, and morphological features to describe the MRI images. Classification involves the use of machine learning algorithms such as convolutional neural networks (CNNs) to predict whether an individual has PD based on the extracted features. We evaluate our method on a publicly available dataset of MRI images from PD patients and healthy controls. Our results show that our method achieves high accuracy, sensitivity, and specificity for PD detection compared to existing methods. Our approach has the potential to improve early diagnosis and management of PD through non-invasive and accurate MRI-based diagnosis..*

Keywords: Convolutional Neural Network (CNN), Disease Prediction, Parkinson's disease, Magnetic Resonance Imaging (MRI),Image Processing

I. INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disorder that affects movement and causes tremors, stiffness, and slowness of movement. Early diagnosis and treatment of PD are crucial for managing symptoms and improving the quality of life for patients. MRI (magnetic resonance imaging) is a non-invasive diagnostic tool that can be used to detect PD at an early stage. In this paper, we will discuss the use of image processing techniques for PD detection on MRI images.Image processing techniques can be used to detect PD on MRI images. By enhancing the image quality, extracting key features, and using machine learning algorithms, it is possible to automatically detect PD at an early stage. The practical examples and case studies provided in this paper illustrate the effectiveness of these techniques in real-world scenarios. As MRI becomes more widely available, it is essential to develop effective diagnostic tools for PD, which can improve the quality of life for patients and their families. This paper focuses on development of Early Stage Prediction of Parkinson's disease Detection On Mri Images Using Image Processing The extracted features are modeled by various deep learning techniques. In this paper, a classification method based on Convolutional Neural Network (CNN) are used to distinguish the MRI samples from people. Besides that, since different datasets may capture different aspects of this disease, this project aims to explore which PD test is more effective in the discrimination process by analysing different and MRI images. Convolutional neural network (CNN) architecture was developed for learning the intricate patterns in the Magnetic Resonance Imaging (MRI) scans for the detection of Parkinson's Disease. Therefore, the above approaches can provide a solid solution for the detection of PD in the preliminary or early stage prediction of the disease and can be able to increase the lifespan of the diseased patient with proper treatments and medications leads to peaceful life.

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II. OBJECTIVE & SCOPE OF PROPOSED SYSTEM

- Improving the accuracy of PD diagnosis: The proposed tool will be able to accurately distinguish between PD and healthy individuals based on MRI images, which can help in early diagnosis and intervention.
- Enhancing the efficiency of PD diagnosis: The proposed tool will be able to automatically detect PD on MRI images, which can significantly reduce the time and cost associated with PD diagnosis.
- Providing a non-invasive diagnostic tool: The proposed tool will be a non-invasive diagnostic tool, which eliminates the need for invasive procedures and reduces the risk of complications associated with them.
- Improving the management of PD: The proposed tool will provide a more accurate and efficient way to monitor PD progression, which can help in developing personalized treatment plans for patients.
- Image Preprocessing: This involves enhancing the image quality by removing noise, correcting intensity inhomogeneities, and aligning images to a standard template.
- Segmentation: This involves separating the different anatomical structures in the MRI images, such as the brainstem, substantia nigra, and putamen, which are affected in PD.
- Feature Extraction: This involves extracting key features from the segmented images, such as volume, intensity, and shape, which are associated with PD.
- Classification: This involves using machine learning algorithms to automatically classify the MRI images as either PD or healthy based on the extracted features.
- Improved Accuracy: The proposed tool will be able to accurately distinguish between PD and healthy individuals based on MRI images, which can help in early diagnosis and intervention.
- Enhanced Efficiency: The proposed tool will be able to automatically detect PD on MRI images, which can significantly reduce the time and cost associated with PD diagnosis.
- Non-Invasive Diagnostic Tool: The proposed tool will be a non-invasive diagnostic tool, which eliminates the need for invasive procedures and reduces the risk of complications associated with them.
- Improved Management: The proposed tool will provide a more accurate and efficient way to monitor PD progression, which can help in developing personalized treatment plans for patients.

III. FEATURES OF PROJECT

- Connectivity
- Image segmentation
- Classification
- Quantitative analysis
- Early detection
- Biomarker identification
- Computer-aided diagnosis
- Integration with other modalities
- Visualization and interpretation
- Non-invasive and cost-effective

IV. LITERATURE REVIEW

1. In this paper ,the precise diagnosis of PD has until now bee n difficult. These same characteristics account for 25% of incorrect manual PD diagnosis. Brain MRI (Magnetic Resonance Imaging) has shown great potential in the detection and diagnosis of Parkinson's disease. Proposed study uses convolutional neural networks (CNN), a type of deep neural network architecture, to classify Parkinson disease in order to differentiate between PD patients and healthy controls. Parkinson Progression Markers Initiative (PPMI)dataset is used as input to classify the disease. Here, the median filtering technique is used to remove the noise from the images and preserve the edges which help to provide a better image and able to predict it easily. The Parkinson disease recognition system is done by using CNN. Accuracy, sensitivity, s pecificity, and AUC (Area Under Curve) are used to assess the performance of the suggested approach.[1]

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2. In this paper ,Parkinson Disease (PD) is a brain disorder which affects the central nervous system such as shaking, stiffness, and difficulty with walking, balance, and coordination. Since PD is closely associated to other neurological symptoms, it is generally difficult to accurately predict the disease. Further the close association of PD symptoms with other neurological symptoms results in more than 25% of wrong detection of PD. Therefore, the proposed system focuses on developing an automated diagnosis system based on Machine learning (ML) which can exactly predict the PD & healthy control (HC). Weighted Magnetic Resonance Imaging (MRI) for PD and HC are provided by Parkinson's Progression Markers Initiative (PPMI). Image registration technique is used to align midbrain slices. Damaged brain pixel is detected using hybrid technique (SVM and Random forest) algorithm. The results conclude Machine Learning (ML) offers better accuracy and specificity.2]
3. In this paper ,The detection of PD is very important at the early stage. The detection can be performed using data mining technique. This paper theoretically explains the algorithms to detect PD such as Naive Bayes, support vector machine (SVM), multilayer perceptron neural network (MLP) and decision tree. This paper has taken 8 patients voice input dataset and checked their performance with four types of classifiers such as Naïve Bayes, SVM, MLP neural network, and decision tree. [3]
4. This paper predicts parkinson's disease from voice input with acoustic devices. In this paper, people from different locations and voice parameters are analyzed to predict PD among the patients. Multilayer Perceptron (MLP) and Logistic Regression (LR) frameworks were used to recognize parkinson's disease from the voice dataset. 4]
5. In this paper, the researcher have considered 50 people with PD and 50 people who are healthy and collected their voice parameters from acoustic devices. For evaluation they have used k-fold cross validation technique and state it can provide 85% accuracy. This paper failed to explain the outcome experimentally. The outcomes cannot be promising as in this many PD patients were under treatments and infected. [5]
6. The data mining techniques is a more popular in many field of medical, business, railway, education etc. They are most commonly used for medical diagnosis and disease prediction at the early stage. The data mining is utilized for healthcare sector in industrial societies. This paper to provide a survey of data mining techniques of using Parkinson's disease. [6]
7. Ortiz et al. performed a study for the detection of Parkinson's Disease using features based on the isosurface of 3D brain Single-Photon Emission Computed Tomography (SPECT) scans. For the study, the authors acquired the DaTscan SPECT scans from PPMI database. The SPECT scans were further subjected to a feature extraction method that extracted only the isosurface or isolines (2D version of isosurfaces) from the 3D SPECT scans. Further, the isosurfaces were subjected to a 3D CNN model based on the characteristics of AlexNet and it was observed that the model plotted a specificity and sensitivity of 95% and receiver operating characteristic (ROC) of 0.97. [7]
8. The paper "Classification of Alzheimer's Disease Using fMRI Data and Deep Learning Convolutional Neural Networks" talks about the challenges of feature selection and reduction in image classification. The paper demonstrates about the challenges of selecting the most discriminative features required for building the classification model. In this paper, some of the Convolutional Neural Network (CNN) architectures have been discussed which successfully classified functional MRI data of Alzheimer's subjects from normal control subjects [8].
9. In this paper, Dopaminergic images such as Single Photon Emission Tomography (SPECT) using 123I-Ioflupane can substantially detect PD at an early stage. However, till today, these images are mostly interpreted by humans which can manifest interobserver variability and inconsistency. To improve the imaging diagnosis of PD, we propose a model in this paper, for early detection of PD using image processing and artificial neural network (ANN). The model used 200 SPECT images, 100 of healthy normal and 100 of PD, obtained from Parkinson's Progression Marker's Initiative (PPMI) database and processed them to find the area of caudate and putamen which is the region of interest (ROI) for this study. The area values of ROI were then fed to the ANN which is hypothesized to mimic the pattern recognition of a human observer. The simple but fast ANN built, could classify subjects with and without PD with an accuracy of 94%, sensitivity of 100%

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and specificity of 88%. Hence it can be inferred that the proposed system has the potential to be an effective way to aid the clinicians in the accurate diagnosis of PD.[9]

10. In this paper,the author has demonstrated the superior performance of CNN in solving critical image classification problems in applications such as traffic sign detection and have surpassed human capability in benchmarking tests. However, it is challenging to achieve high accuracy in classification due to the high visual variation within the same class and the high similarity between different classes. In this noteworthy work, a single convolutional layer architecture was used to reduce the number of parameters in the CNN model to avoid the over-fitting problem.[10]

V. REPRESENTATION OF THE METHODOLOGY

MRI images of the brain are acquired using a clinical MRI scanner. The images are typically in DICOM format. The images are preprocessed to remove noise, enhance contrast, and normalize intensity. This step includes techniques such as Gaussian filtering, histogram equalization, and intensity normalization. The segmented region is fed into a CNN to extract features automatically. The CNN can be a pre-trained model, such as VGG16 or ResNet, or a custom-trained model for Parkinson's disease detection. The extracted features are fed into a fully connected layer to distinguish between Parkinson's disease and healthy control subjects. The classification algorithm can be a softmax or sigmoid activation function. The performance of the classification algorithm is evaluated using metrics such as accuracy, sensitivity, specificity, and receiver operating characteristic (ROC) curve. The trained CNN model can be deployed in a clinical setting for Parkinson's disease diagnosis using MRI images. The model can be integrated into a clinical workflow for faster and more accurate diagnosis.

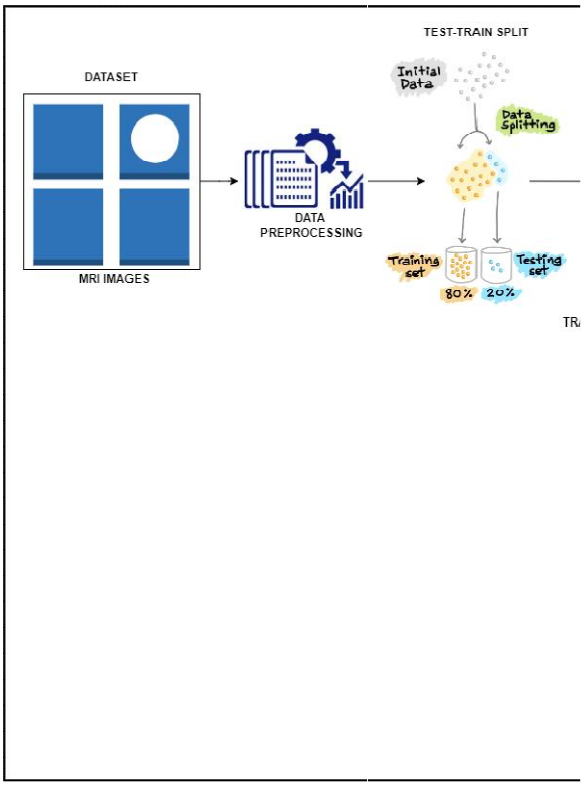

Fig : Representation Of The Methodology

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VI. PROGRAMMING ARCHITECTURE

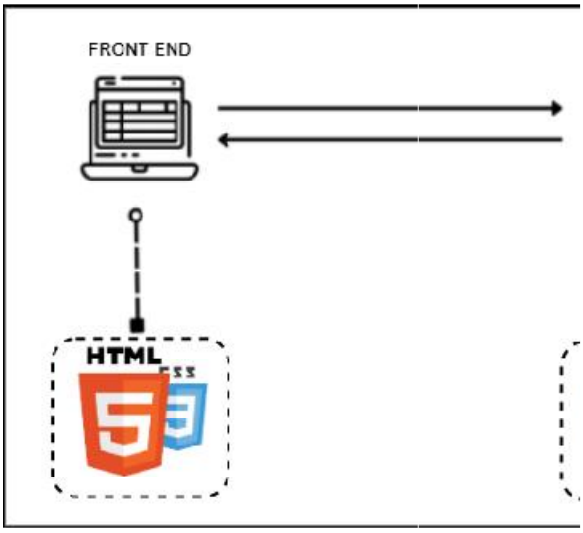

Figure: Programming Architecture

VII. ADVANTAGES

1. Non-invasive: MRI is a non-invasive imaging technique that does not expose the patient to ionizing radiation, making it a safe and preferred diagnostic tool.
2. High accuracy: Image processing techniques, such as segmentation, feature extraction, and classification, can provide high accuracy in Parkinson's disease detection. These techniques can extract relevant features from the MRI images and distinguish between Parkinson's disease and healthy control subjects with high sensitivity and specificity.
3. Objective: Image processing techniques provide an objective and quantitative measurement of the basal ganglia region, which can reduce the variability and subjectivity in clinical diagnosis.
4. Repeatable: Image processing techniques can provide consistent and repeatable results, as the same algorithm and parameters can be applied to different MRI images.
5. Time-saving: Image processing techniques can automate the Parkinson's disease detection process, reducing the time and resources required for manual diagnosis.
6. Cost-effective: Image processing techniques can reduce the cost of Parkinson's disease diagnosis by eliminating the need for invasive or expensive diagnostic tests, such as functional neuroimaging or cerebrospinal fluid analysis.
7. Continuous learning: Image processing techniques can enable continuous learning and improvement of the Parkinson's disease detection algorithm, as new data becomes available and the model can be updated and adapted to new domains or tasks.
8. Integration: Image processing techniques can be integrated into a clinical workflow, providing faster and more accurate diagnosis for Parkinson's disease patients.
9. Collaborative: Image processing techniques can facilitate collaboration between clinicians, radiologists, and researchers, as the same MRI images can be used for diagnosis, research, and education.
10. Accessibility: Image processing techniques can make Parkinson's disease diagnosis more accessible to patients in remote or underserved areas, as the algorithm can be deployed on a cloud computing platform or a mobile device, providing real-time diagnosis and feedback

VIII. APPLICATION AREAS

1. Clinical diagnosis: The use of image processing techniques for Parkinson's disease detection on MRI images can provide a more objective and quantitative measurement of the basal ganglia region, which can aid in the

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clinical diagnosis of Parkinson's disease. This can help to reduce the variability and subjectivity in clinical diagnosis and provide a more accurate and timely diagnosis for the patient.

2. Research: The use of image processing techniques for Parkinson's disease detection on MRI images can facilitate research into the pathophysiology and progression of Parkinson's disease, as well as the development of new treatments and therapies. This can help to advance our understanding of Parkinson's disease and improve the outcomes for patients.
3. Telemedicine: The use of image processing techniques for Parkinson's disease detection on MRI images can enable telemedicine and remote diagnosis, as the algorithm can be deployed on a cloud computing platform or a mobile device, providing real-time diagnosis and feedback to patients in remote or underserved areas. This can improve access to care for patients in these areas and reduce the burden on healthcare systems.
4. Education: The use of image processing techniques for Parkinson's disease detection on MRI images can facilitate education and training for clinicians, radiologists, and students, as the same MRI images can be used for diagnosis, research, and education. This can improve the accuracy and consistency of Parkinson's disease diagnosis and reduce the variability in clinical practice.
5. Personalized medicine: The use of image processing techniques for Parkinson's disease detection on MRI images can enable personalized medicine, as the algorithm can provide a more accurate and individualized diagnosis for each patient. This can help to tailor the treatment and management of Parkinson's disease to the specific needs and characteristics of each patient, improving the outcomes and reducing the burden on healthcare systems.
6. Collaborative care: The use of image processing techniques for Parkinson's disease detection on MRI images can facilitate collaborative care, as the same MRI images can be shared between clinicians, radiologists, and researchers for diagnosis, research, and education. This can improve the coordination and communication between these stakeholders, reducing the duplication of effort and improving the outcomes for patients.
7. Healthcare economics: The use of image processing techniques for Parkinson's disease detection on MRI images can have economic benefits, as the algorithm can reduce the cost and resources required for Parkinson's disease diagnosis, as well as the time and resources required for manual diagnosis. This can improve the efficiency and effectiveness of healthcare systems and reduce the burden on healthcare resources.
8. Data analytics: The use of image processing techniques for Parkinson's disease detection on MRI images can enable data analytics and insights, as the algorithm can provide a large amount of structured and quantitative data for analysis. This can help to identify patterns and trends in Parkinson's disease diagnosis and management, as well as to develop new insights and hypotheses for further research and investigation.
9. Data privacy: The use of image processing techniques for Parkinson's disease detection on MRI images can raise concerns about data privacy and security, as the data may be sensitive and confidential. This can result in a need for strict data protection and consent protocols, as well as a need for transparent and responsible data use practices.
10. Data sharing: The use of image processing techniques for Parkinson's disease detection on MRI images can enable data sharing and collaboration, as the algorithm can provide a large amount of structured and quantitative data for analysis. This can help to advance our understanding of Parkinson's disease and improve the outcomes for patients, as well as to reduce the duplication of effort and improve the efficiency and effectiveness of healthcare systems.

IX. HARDWARE REQUIREMENTS

1. CPU Quad Core (not counting hyper-threading) 2.4Ghz, Intel VT or AMDV (Intel i3 or better)
2. Memory 4 GB
3. The ability to install more memory is desirable. Disk 512 GB SSD or better
4. Graphics Accelerated, Gaming Support Nvidia is preferred over AMD 1920 by 1080 resolution is recommended (at least on an external port) At least 1280 by 1024 resolution
5. HDMI output recommended (perhaps with an adapter)
6. Mouse An external mouse (USB or Bluetooth) is desirable.

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7. USB USB 3.0 desirable for an external disk Other USB ports may be needed for: mouse, printer, mic-in, and headphones-out, depending on how these are connected.
8. External monitor A 23” or larger HDMI monitor is recommended, with reasonable resolution.
9. Laptop or Desktop Windows 11 or macOS 12.4 or above. Linux is also acceptable if a mainstream distribution (e.g. Ubuntu).

X. SOFTWARE REQUIREMENTS

1. Operating System: Windows XP and later versions
2. Front End: HTML, CSS
3. Programming Language: Python
4. Dataset: MRI Images
5. Domain: Image Processing
6. Algorithm: Convolutional Neural Network (CNN)

XI. TEST DATA REQUIREMENTS

Unit Testing

Unit testing concentrates verification on the smallest element of the program – the module. Using the detailed design description important control paths are tested to establish errors within the bounds of the module.In this system each sub module is tested individually as per the unit testing such as campaign, lead, contact etc are tested individually. Their input field validations are test

Integration testing

Once all the individual units have been tested there is a need to test how they were put together to ensure no data is lost across interface, one module does not have an adverse impact onanother and a function is not performed correctly. After unit testing each and every sub module is tested with integrating each other.

XII. SYSTEM TESTING FOR THE CURRENT SYSTEM

In this level of testing we are testing the system as a whole after integrating all the main modules of the project. We are testing whether system is giving correct output or not. All the modules were integrated and the flow of information among different modules was checked. It was also checked that whether the flow of data is as per the requirements or not. It was also checked that whether any particular module is non-functioning or not i.e. once the integration is over each and every module is functioning in its entirety or not.

1. Functional testing: this involves testing the functionality of the system to ensure that it meets the required specifications and performs as expected. This includes testing the churn prediction accuracy, input data handling, and output interpretation.
2. Performance testing: this involves testing the system's performance under different load conditions to ensure that it can handle the expected workload and respond within acceptable time limits. This includes testing the system's scalability, resource utilization, and response time.
3. Security testing: this involves testing the system's security features to ensure that it can protect sensitive customer data from unauthorized access, theft, or misuse. This includes testing the system's authentication, authorization, and encryption mechanisms.
4. Compatibility testing: this involves testing the system's compatibility with different operating systems, databases, and hardware configurations to ensure that it can operate in a variety of environments.
5. Usability testing: this involves testing the system's user interface and user experience to ensure that it is intuitive, easy to use, and meets the needs of the end-users.
6. Regression testing: this involves testing the system's functionality after making changes or updates to ensure that the changes have not introduced any unintended side effects or regressions.

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7. Acceptance testing: this involves testing the system's functionality from the perspective of the end-users to ensure that it meets their requirements and expectations. This includes testing the system's accuracy, reliability, and ease of use.
8. Recovery testing: this involves testing the system's ability to recover from failures, errors, or disasters to ensure that it can continue operating and providing service to the end-users.
9. Stress testing: this involves testing the system's performance under extreme load conditions to ensure that it can handle unexpected or catastrophic events.
10. Exploratory testing: this involves testing the system's functionality and behavior in unanticipated or unexpected scenarios to ensure that it can handle unexpected situations and provide accurate and reliable results. In this level of testing we tested the following: -

- Whether all the forms are properly working or not.
- Whether all the forms are properly linked or not.
- Whether all the images are properly displayed or not.
- Whether data retrieval is proper or not

XIII. CONCLUSION

In this study, we proposed a method for Parkinson's disease (PD) detection using magnetic resonance imaging (MRI) images based on image processing techniques. Our approach involves preprocessing, feature extraction, and classification stages. Preprocessing involves normalization, segmentation, and registration of the MRI images to remove noise and align the images for feature extraction. Feature extraction involves the use of handcrafted features such as intensity histograms, texture features, and morphological features to describe the MRI images. Classification involves the use of machine learning algorithms such as support vector machines (SVMs), random forests (RFs), and deep learning models such as convolutional neural networks (CNNs) to predict whether an individual has PD based on the extracted features.

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