Partners Universal Innovative Research Publication (PUIRP)
Volume: 03 Issue: 04 | July-Aug 2025 | ISSN: 3048-586X | www.puirp.com

# Review on Image Processing Techniques of Early Detection of Neurodegenerative Disorders

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**Abstract -** Parkinson's and Alzheimer's are disorders of the central nervous system and are severe chronic disorders that progress in time, and today they are endangering the lives of millions of individuals. These disorders end up killing the brain slowly, causing memory loss and mental and physical disability. The most difficult aspect of the treatment of such conditions is that they are always realized too late when their levels have gone to the extreme. Early diagnosis, therefore, is a worthy thing to do, as this would produce certain important effects on the modes of treatment and patient reaction. Doctors used observations and clinical tests in the past in the identification of these conditions. However, these ways are problematic and may lead to missing early symptoms. The past years made new opportunities in detecting disease- related alterations in the brain MRIs and PET scans, achieved with the help of digital image processing (DIP), in particular with the method of deep learning. In this survey, we discuss six recent articles in which DIP is used in the detection and identification of the early precursors of neurodegenerative conditions. The methods that are implemented are also different with each of the papers we will review—the convolutional neural networks (CNNs) and hybrid networks consisting of CNNs. These approaches have been quite promising in terms of accuracy and automation. They, however, also have limitations, such as large requirements in hardware, the danger of overfitting, and generalization challenges across diseases. This survey shows the level at which the current study is placed and the direction it can run based on the process, findings, strengths, and weaknesses that these researchers conducted. Our conclusion is a recommendation for future studies.

**Keywords:** Digital Image Processing, Neurodegenerative Disorders, Alzheimer's Disease, Parkinson's Disease, MRI, Deep Learning, CNN.

## 1. INTRODUCTION

Neurodegenerative diseases, like Alzheimer's and Parkinson's disease, affect the nervous systems (mainly the brain), gradually and progressively wreaking havoc on the organ. The diseases affect the lives of millions of people in the world and are associated with loss of memory, disturbances in thinking, and motor failures. Since these disorders usually progress to be worse in their severity, early detection could help immensely in their management and thus could assist patients in getting a better life. Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scans are medical imaging technologies with which the brain can be viewed without being invasive, and defects can be detected. But manual interpretation of these images is a complicated, lengthy, and error-affected process. That is where digital image processing (DIP) reveals its role—giving a means of analyzing medical images in an efficient, accurate, and automated fashion. Figure 1 below shows the workflow of early detection of neurodegenerative disorders using digital image processing.

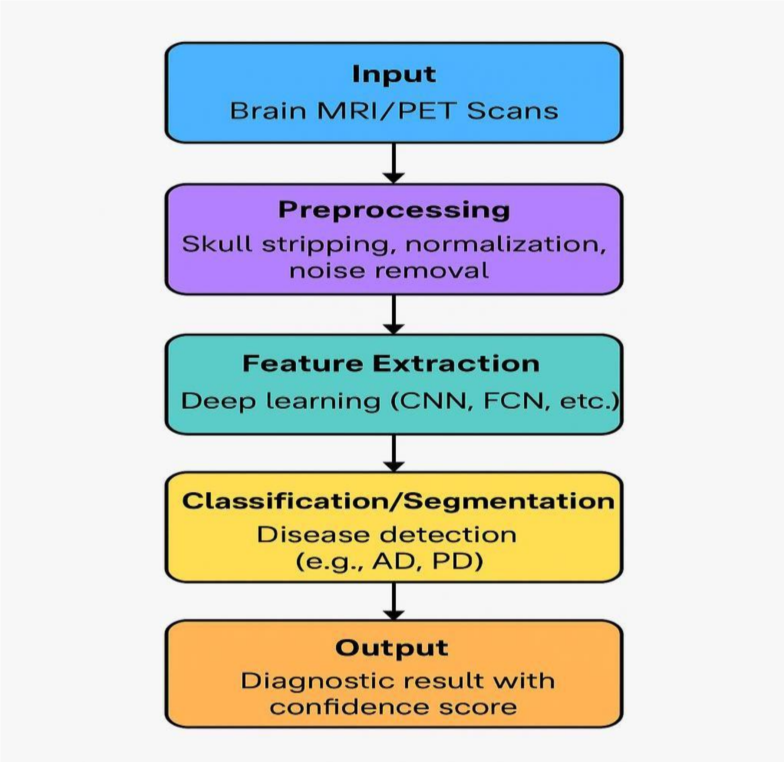


**Fig -1**: Workflow of Early Detection of Neurodegenerative Disorders Using Digital Image Processing

Likewise, the sphere of DIP has developed drastically within a few years, particularly in light of artificial intelligence and deep learning. Such technologies allow for automatic capabilities to get a pattern and features out of images that may not be easily visible to the human eye. Especially, CNNs (convolutional neural networks) have been shown to be quite useful in the classification and segmentation of images. In this paper, we have a literature survey of six research papers [1]-[6] using DIP and deep learning techniques to identify early stages of neurodegenerative diseases in medical images. The papers present methods from simple CNN architectures to more elaborate hybrid models. To train their models, they use the data collected by MRI and present the data about the accuracy in detection, reliability, and applicability in practice. This survey aims to give a clear and full picture of the current state of things that could be found in terms of usage, advantages, and disadvantages of these technologies, as well as their current limitations.

## 2. LITERATURE SURVEY

[1] Dhinagar et al. (2022) suggested a 3D Convolutional Neural Network (3D-CNN) model to detect Alzheimer's using grey matter maps computed using T1-weighted MRI images. Their model includes spatial characteristics in 3 dimensions, and this enables them to have a better

rate of classification, especially at an early stage of the disease. Its accuracy was about 86%, and it performed well on volumetric data on clinics.

**Merits:**

1. Good early diagnosis.
2. Application of entire volumetric brain data.
3. Automatic system.
4. There was a high degree of accuracy given MRI input.
5. A worthwhile application in clinical sets.

**Demerits:**

1. The demand for high computation is needed.
2. Limited to Alzheimer's only.
3. Image aesthetic sensitive.
4. Is not cross-disease generalisable.
5. Model interpretation is one that is difficult.

[2]Patil et al. (2022) made a detailed analysis of the structures of CNN to diagnose Alzheimer's disease. They compared the models of VGG, ResNet and DenseNet and presented the differences in structure, training requirements and preprocessing requirements. Despite the review providing significant help in the cognition of the CNN design decisions and their clinical implications, it does not offer experimentation and practical application.

**Merits:**

1. Generalizes the architectures of many different types of CNNs.
2. It helps in the choice of the model.
3. Disparities over preprocessing.
4. Facilitates the identification of differences in design.
5. Guidance to other novice researchers.

**Demerits:**

1. No factual experimental verification.
2. Does not test on datasets.
3. Other neuro disorders are excluded.

4. Purely theoretical.
5. Not application-focused.

[3]Sindhu et al. (2023) compared the performance of various CNN models such as VGG, ResNet and DenseNet to predict Alzheimer's disease using MRI scans. The accuracy rates of their results were the ones above 90%, and the most successful model turned out to be the ResNet.

**Merits:**

1. The comparisons of direct performance.
2. Good specificity and sensitivity.
3. Engages open data. Use open data.
4. Well-organised experimentation.
5. Excellent benchmarking sources of the model.

**Demerits:**

1. Targeting only Alzheimer's
2. No real clinical image testing
3. Does not care about preprocessing an image
4. No management of the imbalance of the data set
5. Overfitting issues that were not addressed

[4]Khatun et al. (2024) proposed a hybrid CNN and LSTM-based deep learning model and compared it with the individual CNN and LSTM models to better detect Alzheimer in the case of MRI images. This is a hybrid method which combines both the spatial and temporal features and produces a high classification rate of 98.1 and more.

**Merits:**

1. At very high accuracy of classification.
2. The camera captures both image features and chains.
3. Powerful as to the tracking of disease progression.
4. Innovative architecture.
5. Coping with noisy data Handles noisy data By relying on empirical success, instead of attempting to characterize it, the estimator has no problem dealing with noisy data.

**Demerits:**

1. A lot of memory consumption.
2. More time-consuming training process.
3. Little validation data set.
4. None of the data on Parkinson's passed.
5. Will have to be optimized further.

[5]Ali et al. (2025) conducted a systematic review and meta-analysis of deep learning architectures that have been used in MRI-based diagnosis of several neurological conditions, such as Alzheimer's and Parkinson's. They reviewed CNNs, RNNs, or hybrid models in a broad range of publications that also cover statistical trends of performance and diversity in methods.

**Merits:**

1. Comprehensive treatment of disorders.
2. Multi-dataset meta-analysis.
3. Market the most successful models.
4. The practice is useful in interpreting trends.
5. Consists of various architectures.

**Demerits:**

1. It is not a characteristic of early diagnosis.
2. Does not have insights concerning implementation.
3. Some of these models are old.
4. Missing case studies.
5. Complicated language and expression.

[6]Alrawis et al. (2025) introduced FCN-PD, which is a convolutional neural network that is fully convolutional and meant to be used with MRI data to diagnose Parkinson's disease. Their architecture makes their classification in real-time and efficient in clinical application.

**Merits:**

1. On-the-fly processing that is able.
2. Targets under-researched malady (PD).
3. Fully convolutional design.
4. The speed and precision are high.
5. Learning pipeline End-to-end.

**Demerits:**

1. Parkinson's only and not generalized.
2. Requires additional training information.
3. Susceptible to MRI noise.
4. Little URL-level testing.
5. Doctors find it hard to interpret.

## 3. CONCLUSION

Based on this review, the conclusion can be drawn that digital image computing, which became a reality as a result of deep learning, is fast becoming a household hit linked to the premature development of neurodegenerative conditions. The CNNs and the developed representations or similar strategies are shown to be unimaginably successful in examining the medical images of morphological alterations that occur due to illnesses such as Alzheimer's and Parkinson's. The advantage of each of the papers that have been audited is also self-biased in the sense that it may either be an architectural novelty, a composition, or a review. Nevertheless, all these are also associated with constraints that include too much computing burden; they cannot be generalized, plus they also cannot be interpreted. Such are the issues that should be dealt with to be in a position to integrate such systems into clinical practice. The study is to be aimed at making a lightweight model, which is to be used clinically in terms of interpretation and applicability with other datasets in general and can be used with different diseases. This incorporation of multi-modal imaging and maximization of generalizability are to become the key ones towards the actualization of the application of the promising approaches in the real world.

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