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Detecting Parkinson's Disease with Image Classification-Survey

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Abstract:- The algorithm in machine learning plays an essential role in the identification of patterns in biomedical sciences. For complex medical problems, there are many classifications of medical images and forecasts of the model. The neurological disease which largely attacks the motor system are Parkinson Disease (PD). With the help of a Magnetic Resonance Imaging (MRI) or any kind of scan can be used which can detect and predict the disease. By using the level of the dopamine, the PD is detected. This paper presents an overview of various prediction and detection techniques used to identify Parkinson disease. The deep learning and machine learning algorithm are compared here. The survey contains ANN, CNN and neural network- based paper are compared. The different strategies and algorithms in disease prediction and detection are recognized and evaluated. The results and principal issues of each study paper are discussed and analysed in this paper.

Keywords:- *Parkinson Disease (PD),CNN ,ANN ,Dopamine ,Neural Network, Deep Learning, Machine Learning.*

I. INTRODUCTION

Parkinson' disease is a neurodegenerative disease that affects the neurons in the brain. Nowadays PD has been changed to one of the most basic diseases and it mainly affects older adults. The increasing neurological disorder and non-curable disease is Parkinson Disease (PD), which essentially affect the human brain. As mentioned, the PD is a non-curable disease, early prediction and diagnosis can slow down the process and can give a brief relief to the patients.

It is a neurological disorder that affects the midbrain. The midbrain contains a thalamic region with the substantia nigra that produce a high level of dopamine neurons. The brain has many neurons to send messages or communication signals to each other for that it produces chemicals called dopamine. When we have a low level of dopamine flow then the PD occurs. That will result in Tremors, trembling of hands, arms, legs, jaw and face, Poor balance and coordination, Speech difficulty etc. Literature review.

Have a shortage of medical labs due to most of the diagnoses done at the advanced stages. And when compared to other existing neurodegeneration the accuracy is less. Frequently, when the dopamine is heavily lost the diagnosis for the patient is started. The most challenging task is to find the accurate detection of PD. if the Pd patient is detected as healthy because of inaccuracy that will face a big challenge. The most difficult stage of PD can lead to coma. So accurate detection is extremely essential. By using image processing, can detect the early stage of PD. Based on the few studies most commonly used approaches to confirm the PD there are two approaches of image are PET and SRECT. But due to the high-cost doctors don't favour using these methods. However, the MRI can also detect Parkinson's disease.

There are some Machine learning techniques used to detect the PD in MRI images including Baye, Decision Tree, Support Vector Machine (SVM) and Artificial Neural Network (ANN), Convolutional Neural Network (CNN) is a Deep Neural Network (DNN)

II. LITERATURE REVIEW

In this section, we review some existing machine learning techniques and deep learning for diagnoses of Parkinson Disease.

G. Solana-Lavelle et al. [3], they have proposed an approach for PD on MRI with the four main stages: (1) Region detection, (2) Extracting the features, (3) Selection of features, (4) classify the class, and (5) assessment of performance.

Dataset: images PPMI. The PPMI main goal is to gather the genomics, person's-report. It is shared publicly for research. The image parameter is T1-weighted, 1.5–3 Tesla scanner, minutes are about 20 to 30min. The T1- weighted MR images with 3D sequence, 1.5mm thickness or less, coronal, axial and sagittal are three different views. With total of 312 males in which 86 are male controls and 226 are PD male patients. The female PD patients areabout 64 in numbers.

In this paper- For detecting PD by using the MRI they used five different stages as discussed before, so the first stage is to find the region of interest [ROI] for the feature extraction, which can be done with the help of grey matter. Where there is less volume in the grey matter that area is called ROI. The ROI can be obtained by using the VBM method and there are two templates used (i.e.) healthy patients and PD patients.

This contains two proposed methods they are (1) ROI identification by using VBM, (2) for detecting the PD needed for the analysis of ROI. After the pattern identification needed to do (1) Statistics based in the 1st and 2nd order - feature extraction (2) principle component analysis - feature

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selection[FS], and the wrapper FS is done, (3)with the 10-fold CV classification is done based on the classifiers and they are K-nearest neighbour's with K = 5, SVM with a radial basis kernel, random forests and BN networks.

Sabyasachi Chakraborty et al. In this article [4], they have proposed an approach for PD detection on MRI scanned images by using convolutional neural network.

Here the dataset is collected by using the PPMI. It is a multi-centre study for imaging scans and contains different scan reports. The specification of MNIPD25-T1MPRAGE-1 used in this paper are dimensions-193X229X193pls, -0.0 mm of interslice gap, 1.0 mm is thickness of slice, spacing-1.0x1.0x1.0 mm, plane-sagittal. The methods used in this paper have been divided into four stages (1) MRI scan acquisition from the PPMI database, (2) data pre- processing, (3) registration, and (4) transformation.

In this paper, Parkinson's disease is detected by using the convolutional neural network model with the t1 weighted MRI scans. 35 layers include input and output, using the CNN network. There are 12 3D convolutional layers in the network architecture, that acknowledges the pattern to produce the feature forms of input brain MRI scans. By using the activation function, the convolution layers are activated.

What was observed after training, the study of prior hypothesis is used for the model performance which closely aligned with the results. The network gives the accuracy of 65%.

Soheil Esmaeilzadeh et al. In this article [5], they have proposed an approach for PD detection on MR-images using 3D-convolutional neural network and mainly focussed on MR images along with the deep learning techniques like regression and classification for the PD patients.

For the dataset, they have set 3-D brain images and collected them from the PPMI database. The brain images have three planes they are sagittal, coronal, and axial. The cut coordinates are x=36, y=10, z=36. The above states describe the brain tissues concurrently with the skull, scalp and dura. There are 452 PD affected patients [292 males and 160 females], and 204 images are from healthy conditions [134 males and 70 females]. The patients' age is around 61.

The stages are pre-processing of data, data augmentation and machine learning model development. In the first stage, they have done the skull-stripping under the pre-processing.In this stage, the skull, scalp, and dura are called non-cerebral tissues, are removed. To improve the accuracy of diagnosis and speed, they have done the skull stripping. The above method is the preliminary step in numerous medical applications. So, this can be part of tissue segmentation. In this paper, they have used the BET technique [Brain Extraction Technique] with SPM [Statistical Parametric Mapping]. The above methods will accommodate to takethe removed version with more important brain tissue strength and as a voxel-based approach for brain image segmentation and extraction.

By using skill-stripping they can reduce the size of images (980,100,108,1) [i.e.,800,000 pixels]. The next stage is data augmentation. Here, the MR-Images are flipped to right and left hemispheres of each patient scan image [i.e., brain image]. So, the above method purpose is that they can double the size of the dataset so that they can play with the large set of the dataset.Now here, the dataset is divided into (85%) training, development (10%), and to test set (5%) and then they split them to size 8. Now, the 3D-CNN model is developed with some padding and with max-pooling layers. They have achieved 60% of accuracy on validation.

Joyjit Chatterjee et al. [6], they have proposed an approach for PD detection on CT- scan with the help of MATLAB. In this paper, the various parameters used are precision, recall and F-Measure accuracy. The algorithm used to detect Parkinson's diseases is gey scale converter, pre-processing, anisotropic filtering, image segmentation, bounding box.

The CT-Scan dataset is collected from the UCI. The first stage in this paper is (1) the input image is the scan of CT reports - here the human brain image is in the form of CT-Scan [i.e. Computed Tomography Scan], (2) greyscale converter - the intensity of the light at a separate level are calculated by using the grayscale. These are done by using pixels in the images, (3) pre-processing of the images - this is mainly to extract the exact place of affected place in the brain [i.e., enhance the detecting chances], (4) anisotropic filtering - help to develop the texture of the scan and helps to cut off the noise in the image like blur etc., (5) image segmentation, (6) bounding box - the affected part border of Parkinson image is marked by a rectangle or square box and run with MATLAB. Here the accuracy is 70%.

Pir Masoom Shah et al. [6], they have proposed an approach to detection of PD in MRI using CNN. In this paper, the automatic detection of PD is done by a convolution neural network and the classifications are for healthy conditions and Parkinson's affected person.

Dataset are collected from the PPMI. The MRI scan is selected for this classification with the parameters of 500 of mid-brain slice and t2-weighted image for both PD patient and HC person. The hand-crafted feature can be avoided in the convolution neural network and it is an inspired technique for biological study.

They have used some stages to build the CNN model. They are the Data acquisition, Pre-processing stage and CNN model. The pre-processing stage contains slice selection, image registration, midbrain through ROI. And the sets are divided into ratios like training (70%), validation (10%) and testing (20%). Then the CNN model is built by using loss functions. The data acquisition is where we can find the dataset and can download them. The experiment setup is - the CNN started to execute on NVIDIA GeForce 940MX CUDA enabled GPU keras. In all experiments, the classification accuracy in 68%.

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Sumeet Shinde et al. [6], they have proposed an approach to detection of PD using deep neural nets on neuromelanin sensitive MRI.

In this paper, the technique they have used is the computer-based analysis technique, which is mainly in convolutional neural networks (CNN). The dataset contains 55 patients who have been affected by Parkinson's disease, 20 PD patients APS (Atypical Parkinsonian Syndromes), MSA (Multiple System Atrophy), PSP (Progressive Supranuclear palsy), and 35 healthy controls. Here the scanned images are in the format of MR images. The diffused images are acquired to eliminate the brain lesions possibility. The scanned images have obtained on a 32-channels scanner for the high resolution of contrast neuro-melanin sequence, i.e., the angle flip about 26/2.2ms is helped to achieve the SPIR. The Matrix is reconstructed and resized to 512 for the FLAIR recovery.

In this paper, 2D CNN gave an input called the axial slices of the NMS-MRI with a boxed region around the brainstem. Passing through the chain of the convolutional layer, the input images are transformed as the probability along with the vector as the output . The CNN model, developed with CNN architecture.

The CNN architecture uses liner unit i.e., ReLU activation and has a learning rate of 0.0001. Which is based on iterations. And each layer weight is updated to train the CNN model. That will help to reduce the awareness of over-fitting, as a standard practice, data augmentation was performed which increased the dataset by several folds. Then CR-ML, RA-ML, and finally training and test of the model is done. And this paper, the CNN-DL classifier performed an accuracy of 67%.

Matthew P. Adams, et.al, [9], they have analysed the prediction of the PD(Parkinson disease). PD is determined as the neuro- generative disorder which leads to the disorder in resting, trembling and various other disorders. This disorder is caused by the dopaminergic neurons in the mid brain.

The data used in the project are 254 subjects of the various reports of the progression Marker's institute database. The motor part scale value of past results has been also taken as the input data for this project. The dataset used in this project is processed for the better use. The images are also normalized.

The processed data is used for the model creation for the prediction of the PD in the early stage of the patients. After the Augmentation, the features of the images are extracted and the model is split into the train, test and for the validation. The variability in the various images are clustered together and the separate class is formed along with the motor function issues. The extracted and the processed data are fed into the model. The metrices are used to evaluate the model performance for the better prediction of the Parkinson's disease.

Yun Jung Bae, et.al, [10], they have discussed about the syndromes of the Parkinsonian disease. PD is considered has the cell loss in the mid Brain. The cell loss is due to the synuclein mediated dopaminergic cell loss in the various parts in mid brain.

The data used for the reviewing the disease, nigrosome imaging using 3 and MRI scan of the various patients along with the characteristics of the clinical effects of the PD. The main syndrome for the PD is considered as the deposition of the iron along with the dopaminergic neuronal loss in the Parkinson's patients. When this compared with the normal, they show the high diagnosis for the PD.

Other syndrome analysis is the RBD- rapid sleep behaviour disorder before the synucleinopathy syndrome. By using transfer of the he Nigrosome and dopamine the early detection of the PD can be done. The various regions and symptoms are taken has the features for analysing of the PD. The tensor imaging system is used for the edge detection in the research of the PD in the earlier stage. The edges create the marks for the improvement of the performance and the effect of the disease in the patient.

Nalini T S, et.al., [11], they discussed about the Parkinson's disease using the ANN for Classification. This study is taken for the earlier detection of the disease using the processing of image techniques and ANN. The various regions of the image are separated as the features for developing the model.

The dataset used in this project is taken with the help of the PPMI database which includes 7000 images of Parkinson's disease image and 6900 non-defective or normal images. The images taken for the detection is processed and network techniques are applied for the earlier detection. In the prodromal stage at SPECT images are used to detect the early stage of Parkinson's disease.

The algorithm of sequential grass is used to find the regions of putamen and caudate from the image. These regions are taken as the features for the further detection of the disease. The extracted features are given to the ANN of form a classification class them among the normal and Parkinson's disease. The pixel is scaled between the rage of 0 to 1 for the data factor. By detecting the edges of the region in the image, the total area of the putamen and caudate region is calculated. The person who is affected by the Parkinson's disease is observed to have the increase in both caudate and putamen region.

Anna-maija penttinen,et.al. In this Paper, Parkinson disease have been diagnosis by machine learning algorithms. The main steps used here in this article is feature selection and the classification processes. The algorithm and classification used regression trees, ANN and SVM. Data science is the identification key feature of the problem is pre-processing. Here in this paper, the PD patient are detected by using speech. There are some stages at first, the speech dataset is collected, all features are noted, the feature selection, the classification is done and then perform the evaluation.

By using the phonetic feature, the diagnosis of PD is done.22 phonetic features are present from the speech signal of both PD and HC people. The SVM and ANN methods have 13 features used and the CART uses 7 features.

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The support system based on the FS is mainly used to develop the voice signals for both PD patients and healthy people. By using the CART, SVM and ANN they determined the feature like Shimmer: APQ3, spread2, D2, Shimmer: APQ5, DFA, RPDE, spread1, Shimmer: APQ5, RPDE, DFA, spread2, PPE, D2, Jitter: DDP MDVP: APQ, HNR, NHR, MDVP:

Shimmer with the FS method like F1, RFE. They have achieved the accuracy of 78.25%

TABULATION

PAPER	AUTHOR	YEAR	DISEASE	GENDER	DATASET TYPE	TECHNIQUE /METRICS	MODEL NAME	ACCURACY (%)
1	G.Solana- Lavelle	2021	Parkinson's Disease	MALE	1.5-T MRI	Logistic	CNN	69
						RF		52
						Naive Bayes		66
						Bayesian Net		59
						KNN		63
						MLP		68
				FMALE		Logistic		79
						RF		76
						Naive Bayes		77
						Bayesian Net		77
						KNN		60
						MLP		73
						SVM		75
				MALE	3-T MRI	Logistic	CNN	77
						RF		64
						Naive Bayes		64
						Bayesian Net		70
						KNN		61
						MLP		61
				FEMALE		Logistic		78
						RF		79
						Naive Bayes		64
						Bayesian Net		70
						KNN		74
						MLP		73
						SVM		77
2	Sabyasachi Chakraborty	2020	Parkinson's Disease	BOTH	3T MRI	**METRICS**	CNN	
						Accuracy		78
						Precision		70
						Specificity		72
						Recall		72
						F1-Score		71
						ROC-AUC		74
3	Soheil Esmaeilzadeh	2018	Parkinson's Disease	BOTH	MR-Image	Precision	CNN	71
						Recall		72
4	Joyjit Chatterjee	2018	Parkinson's Disease	BOTH	CT Images	Precision	MATLAB	578
						Recall		68
						F− Measure		72
5	Pir Masoom Shah	2019	Parkinson's Disease	BOTH	MRI	SVM	CNN	78
						GA-ELM		79
						RVM		76
						Decision tree		76
						Nave Bayes		73
6	Sumeet Shinde	2019	Parkinson's Disease	BOTH	MRI	SVM	CNN	70
						VBM		72
7	Matthew P. Adams	2021	Parkinson's Disease	BOTH	DaTscan	GA-ELM	CNN	69
						Decision tree		59

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						Nave Bayes SVM		65 69
8	Yun Jung Bae	2021	Parkinson's Disease	BOTH	MRI	Logistic RF Naive Bayes Bayesian Net KNN MLP	ANN	78 56 65 66 66 71
9	Nalini T S	2020	Parkinson's Disease	BOTH	SPECT	ANN	ANN-MATLAB	77
10	Anna-maija penttinen	2020	Parkinson's Disease	BOTH	VOICE	CNN lesioned	CNN	71

Table 1: summary of studies regarding the survey.

III. CONCLUSION

The cells in the brain produce dopamine to communicate within the body. The loss of dopamine can cause neurological disease and affect brain communication with the body. So the coordination of the body can be affected, and it slows down the body movement. All the articles in the paper are from the years 2018,2019,2020 and 2021. This paper, contains various techniques and approaches are proposed for detecting Parkinson disease. The methods and systems for the detection of PD are mainly discussed in this paper. The detailed work shows the machine learning and deep learning algorithms which are generally used in detection and prediction purposes. As per the assessed contemplated the CNN technology are majorly used for PD detection. As per the analysed works, the CNN technology and deep learning algorithms provide acceptable accuracies. In addition to the better accuracy, it is mostly used in PD detection and prediction in many ways, the ways include various deep learning techniques, like Logistic, RF, Naive Bayes, Bayesian Net, KNN, MLP and SVM along with the CNN models. The neural network techniques include ensemble learning**.**

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