Classification of Parkinson's Disease using CNN and ANN with the aid of Drawing and Acoustic Feature

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***Abstract*— Parkinson's disease manifests itself in a variety of ways. slurred speech, muscle rigidity, and tremors. The condition can also affect the production of the brain's dopamine. Therapies can help treat conditions after a diagnosis, however, there is no remedy. The paper primarily analyses the many drawing evaluation methods and disease diagnoses that have been used. The AI deep learning idea was used, along with convolutional neural networks and artificial neural networks. However, this article proposes a model for detecting disease using drawings of different persons from two classes. Disease detection on photos has been accomplished using a variety of techniques such as data augmentation, sequential, and CNN. The acoustic feature data was processed using a Decision tree and ANN with GridsearchCV, and the overall accuracy on testing data was 98 percent.**

Keywords—Convolutional neural network, Artificial neural network, GridSearchCV, Decision Tree, Parkinson's disease

I. INTRODUCTION

Parkinson's disease is a neurodevelopmental disorder that mainly affects the cells that produce the anti-anxiety drug dopamine in the brain. It usually appears gradually over time. Movement, primarily at repose and characterized as the roll shaking in the hands, is a symptom of Parkinson's disease. The slowness of movement, limb stiffness, movement, and stability issues are all possible symptoms of tremor. The source is still unknown. While there is no cure, there are several effective treatments, involving medicines and surgery. Although Parkinson's disease isn't really fatal in and of itself, the consequences can be disastrous. [10][11][18]

The Motion issue signs including such shakes and stiffness are frequently connected with Parkinson's disease. These can have a visible impact on a person in the initial stages of the condition's writing and drawing. Thoroughly inspecting, or extremely small undulations in a user's writing has been said to be hard to decipher because of the diversity with one's formed writing style, speech, competence, and schooling. The dataset includes two variants of drawing namely spiral, wave. The approach we proposed was based on two different models on different data. The models we introduced to obtain better accuracy to predict PD accurately by utilizing CNN and ANN.[15] [16] [17]

Because of its high level of efficiency across a wide range of data sets, Deep Learning is quickly becoming a significant subset of machine learning. Convolutional neural networks are a wonderful method to employ deep learning for picture classification. Building a CNN[20] is a breeze with Python's Keras module. Artificial Neural Networks[21] are a number of co-completely linked nets like the figure. These layer is made up of an input layer, multiple hidden nodes, and output neurons. Each network inside a layer is connected to the units in the layer above. We can make the service stronger by exposing the hidden layers.

The following is how the rest of the article is structured. In section II, we looked at some existing papers on Parkinson's disease prediction that used a variety of data approaches. In Section III, we'll look at CNN and ANN model's performance on our data. Section IV tests different classification algorithms and discusses the results, concluded by Section V's conclusion.

II. RELATED WORK

[1] Many statistical indicators were used to assess results acquired from this technique by gender. The accuracy rates for females and males were 88.71 percent and 87.15 percent, accordingly, with the smallest amount of attributes. Furthermore, both genders' ROC and PRC area values neared the 0.9 range, indicating that the group division of ill and healthy people was practically flawless. When the level of performance and viewpoint of this investigation were matched to the findings of a single scientific report that employed the same data, the SLGS hybrid system outperformed the other.

[2] The vocal patterns of the patients are subjected to a variety of speech processing techniques, which are subsequently used as input to 2 different estimate models. The initial stage is to choose the most relevant speech features using a based scheme feature selection method called Boruta. The second stage is to nourish the chosen set of characteristics to severe gradient boosting, a decision tree–based enhancing

algorithm that has lately been used effectively in a variety of data mining algorithms due to its classification performance and speed. The vibrating structure of the vocal fold is an essential indication of PD intensity, according to the features extraction evaluation.

[3] Five prolonged tones and ten separated terms from the portable Computer database are used to test the proposed characteristics' capacity to differentiate between healthy and PD patients. With vowels, the suggested approach's average accuracy varies from 82 percent to 90 percent, whereas with words, the accuracy rate ranges from 80 percent to 91 percent. A distinct and independent dataset is used to validate the created models. The accuracy of the classification in these extra recordings ranges from 50% to 80% for vowels and 50% to 82 percent for words.

[4] We developed a potential model categorize unknown people based on their line-drawing ability using a complete machine learning methodology. We were able to predict with an accuracy level of 91% (88 percent sensitivity [TP], 95 percent specificity [N]). Our findings demonstrate that the suggested scheme is a promising contender for distinguishing among PD and healthy patients, that it has potential in remote monitoring and disease indicator monitoring using low-cost, broadly available technology.

[5] The Fast Fourier's transform component in the frequency range of 0-25 Hz is used as the CNN's input. We investigated the capacity of different orientations to discriminate during sketching motions, with the greatest findings coming from the X and Y-axis. This study used a publicly available dataset called Parkinson's Disease Spiral Drawings Using Digitized Graphics Tablet. The greatest results of this study were 96.5 percent accuracy, 97.7 percent F1-score, and 99.2 percent area under the curve.

[6] Signal and voice analysis methods are combined with ml algorithms in the early diagnosis method. During the testing and training stages, 3 distinct speech datasets including case records at various stages of PD are used to produce an estimate. The results show that using Random Forest or Support Vector Machine approaches has a possibility. Once fine-tuned, these methods give a highly accurate statistical tool for evaluating the existence of PD.

III. PROPOSED METHOD

We evaluated the dataset that included two types of drawings: spiral and wave, both of which had healthy and Parkinson's drawings. Spirals and waves are drawn by both healthy and Parkinson's sufferers. For evaluating the results of the original article, the photos are divided into testing and training groups. Each image contains 72 training and 30 testing images. The following information was taken from the paper[7]. The dataset was collected from the kaggle[8]. And the second data was collected from the machine learning repository[12]. Acoustic characteristics were collected for each of the 80 patients in the PD dataset, and 3 vocal style versions of constant speech production were generated. There were 40 of them, and 40 of them had Parkinson's disease. Since there are 240 occurrences but only 80 patients, and 46 characteristics are employed in this study, they are not consistent. In this proposed method we implemented different pre-processing techniques and models to predict the disease accurately. The suggested is depicted as a block diagram below Figure1.[13][14]

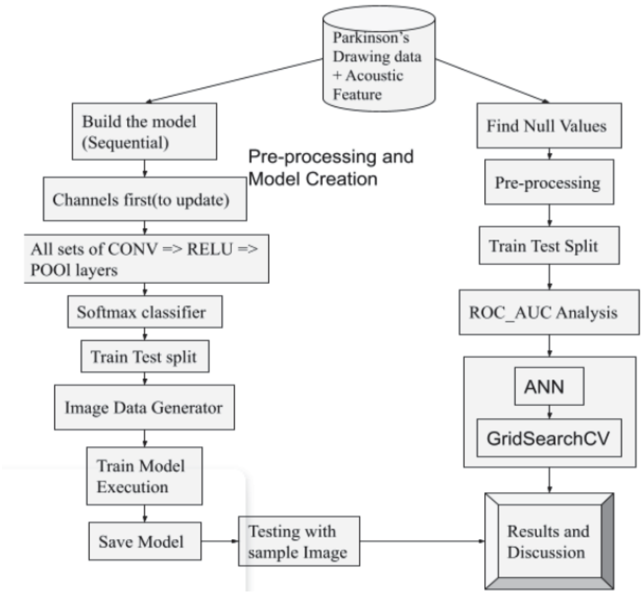

Fig. 1. Overview of the Proposed Method

First, the data is pre-processed before it is trained and tested. Pre-processing is divided into four steps. To begin, use sequential to initialize the model and 'channels first' to update the input shape. The first set of CONV to RELU to POOL [19] layers has been added, but the second set is about to be added. Following that, a new set of layers employing FC => RELU is created. The activation of the softmax classifier[23] in order to include it in the model execution. The spiral and wave data divisions were utilized twice to assess the fruitfullness of the data presented. In addition, the number of epochs to train, starting learning rate, and batch size are also set. The data and labels were added in order to load the photographs from the path we specified. The data was gathered by random shuffling techniques. Once the path generating was set, the extraction of the class label in front of the given picture path and updating the labels list took place. The raw intensities scale runs from 0 to 1. The train test separates the data 75 percent for training and 25 percent for testing.

Data augmentation refers to a variety of strategies that are used to develop "new" samples from the existing ones by using random vibrations and distortions. Our network may acquire more robust characteristics since it is continuously exposed to new, slight modification copies of the inputs. We don't use data augmentation during testing and instead analyze our training set on the raw test dataset; in most circumstances, we will notice a gain in testing efficiency at the exchange of a tiny drop in training accuracy.[24]

The categorical function is used to convert labels from integers to vectors. The picture generator was designed to enhance data by employing width shift range, rotation range, zoom range, shear range, height shift range, fill mode, and horizontal flip. The model is initialized by constructing the built-in function with width, depth, height, and classes. The Adam optimization[25] method is a stochastic gradient[26] modification that has recently gained popularity in data processing for machine learning and computer vision. The adam function defined two in-built functions: learning rate and decay. To construct the model, we need to run a few functions, including the binary cross-entropy loss function[28], which is used in binary classification applications, optimizers, and metrics with accuracy. The training network is about to be fitted into the model, and the model is about to be saved to the device.

Randomly shuffle the image selection to test using the given model. Set the location of the image testing image and import the model that we previously saved. Imported the libraries required for testing, such as image to array and TensorFlow kears[27] model load. The image loading procedure begins by reading the image with cv2 and copying it to pre-process the image for classification using resize, astype, image to an array, and extend the dimensions. The trained CNN's network loading. The classification of the input image was accomplished by guessing whether the given input was healthy or Parkinson's disease, and then creating the label to test.

The second set of data, the pre-processing step in Parkinson's disease repeated acoustic feature classification begins with identifying the null values and assigning the numeric values to the string type variables. The train test divides the data into 80 percent train data and 20 percent testing data. To standardize characteristics, use the standard scaler to eliminate the mean and scale to unit variance. Classification using decision trees and ANN on the training dataset. The optimizer requires a sequential model to build the ANN. The model was enhanced using three levels of combination: a dense layer with a normal kernel initializer, relu activation, sigmoid activation, and input dimension. The data adam optimizer, binary cross-entropy loss, and accuracy metrics were used to assemble the data. The ANN model is integrated into the Keras classifier. Batch size, epochs, and optimizer are the parameters to compile. The GridSearchCV[9] approach, in conjunction with an ANN[21] model, predicts train and test performance.[22]

IV. Results and Discussion

This research was carried out using the PD drawing data, which is divided into two classes. This is often utilized in various studies for PD Drawing examination of order to answer the enigma of PD detection at the basic level. We focused on the many approaches of how data prediction performance varies in this paper. The CNN approach was previously described, with some adjustments to existing methods. The methodology for the second data was considerably different, with ANN combined with GridSearchCV being used to diagnose the disease.

Using the model we suggested, we predicted the Parkinson's Spiral drawing. First, the sample data is identified using a random shuffle, and the photos are printed in a random order, as shown in Figure2. Using model network data from 25 epochs, the training loss and accuracy are plotted. Figure 3 depicts the graph between epochs and Loss/Accuracy. Create the label by providing a name for the testing image; if Parkinson is greater than healthy, it returns healthy; otherwise, it returns Parkinson. As illustrated in Figure 4, the accuracy of the categorized image and label was printed on the input image.

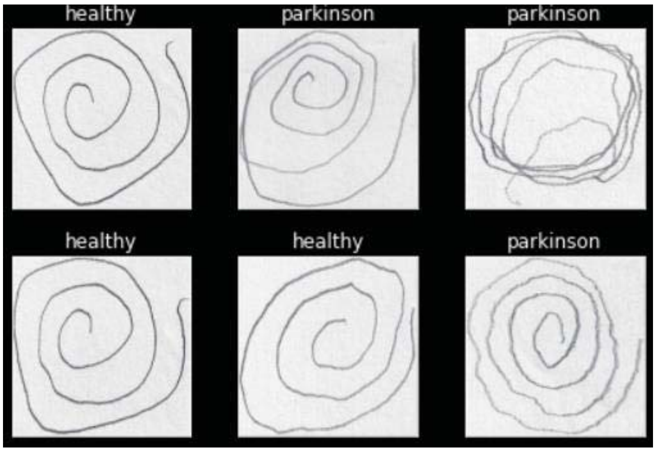

Fig. 2. Spiral Drawing of the two classes

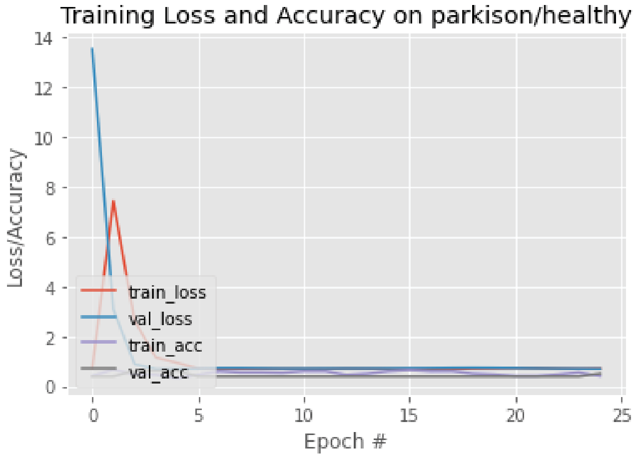

Fig. 3. Training Loss and Accuracy Curve based on the model1

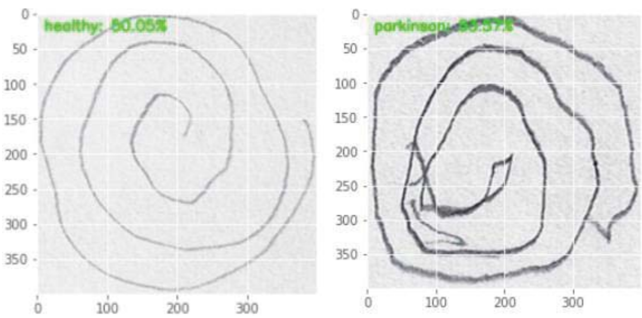

Fig. 4. PD Spiral Drawing Testing performance

Using the model we suggested, we predicted the Parkinson's wave drawing. First, the sample data is identified using a random shuffle, and the photos are printed in a random order, as shown in Figure5. Using model network data from 25 epochs, the training loss and accuracy are plotted. Figure6 depicts the graph between epochs and Loss/Accuracy. Create the label by providing a name for the testing image; if Parkinson is greater than healthy, it returns healthy; otherwise, it returns Parkinson. As illustrated in Figure7, the accuracy of the categorized image and label was printed on the input image.

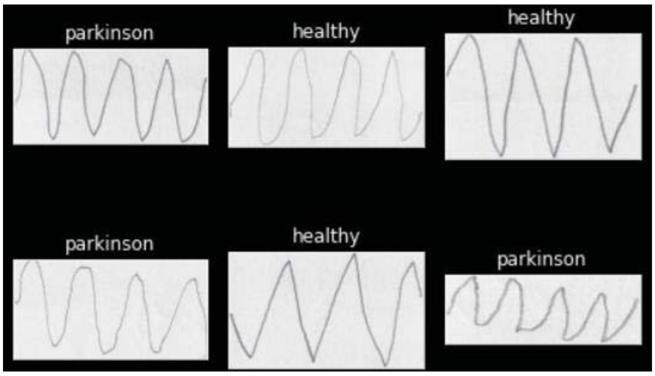

Fig. 5. Wave Drawing of the two classes

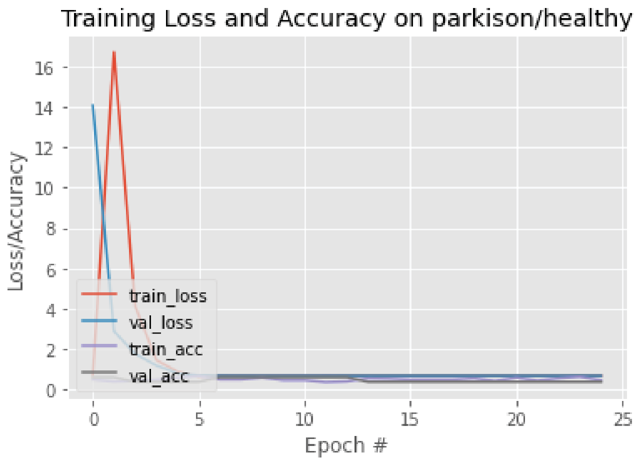

Fig. 6. Training Loss and Accuracy Curve based on the model

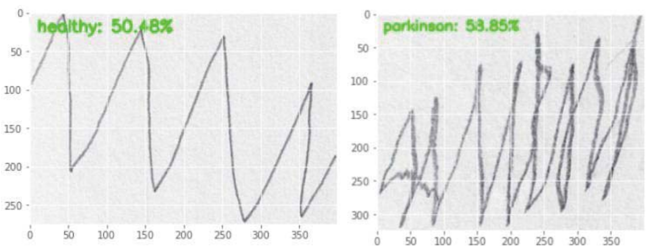

Fig. 7. PD Wave Drawing Testing performance

Another approach, utilized ANN. Input dimensions, Output dimensions, a Rectified linear unit activation model, a kernel initializer and a sigmoid are all included in the model. ANN is implemented using Keras. In addition, several parameters like epochs, batch size, and optimizer are mentioned. GridSearch In ANN, the CV tuning method is used. The parameters for the estimator model, accuracy, parameter grid, and CV parameters are all specified. Table 1 displays the accuracy and performance measures.

TABLE I. THE PERFORMANCE OF THE PD ACOUSTIC FEATURE

Algorithm	Accuracy	Precision	Recall	F1-score
Decision Tree	100%	100%	100%	100%
ANN using GridSearchCV(Training)	97%	98%	98%	97%
Testing	98%	100%	100%	98%

V. CONCLUSION

Data intellectuals believe that combining ANN with a tuning model can help us move closer to the PD. This research concentrated on two groups of PD drawings. We evaluated numerous strategies that have achieved remarkable outcomes for Parkinson's disease identification employing ML algorithms and picture inputs. The best possible approach is a clever combination of the optimization technique concept with CNN and ANN with GridsearchCV. Researchers in this field might be interested in developing such technologies. Our model performed with better accuracy on testing photos. Further, our method is fairly robust and efficient in terms of memory storage.

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