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Parkinson's Disease Detection Based on Transfer Learning

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ABSTRACT

The process of diagnosing diseases early is one of the most important goals of the tremendous development in artificial intelligence, and Parkinson's disease is one of the diseases whose symptoms are similar to many other diseases. It is a neurological disease whose symptoms develop slowly, so the process of its diagnosis is very important in order to preserve the patient's life. One of the most important symptoms is muscle stiffness as well as slow movement. In this research, a method was developed to detect Parkinson's disease using machine learning, learning transfer techniques were relied upon to extract features from handwriting images that we obtained from the NewHandPD database, and then these images were classified into two categories (Parkinson's disease and non-Parkinson's disease) by KNN classification algorithm, for being accurate and fast in calculations, the results of the training of the INCEPTION-V4 model showed a detection accuracy of up to 93%, as well as an area under the curve of 0.89 with a loss of only 0.2 , where this model can be relied on to diagnose and detect Parkinson's disease with high accuracy.

Introduction

The responsibility for the development of Parkinson's disease is the level of dopamine in the human brain and its low levels cause this disease [1]. Dopamine is the transmission of nerve signals to the basal ganglia, which is the organ responsible for controlling movement in the human brain. Among the most important symptoms of the disease are tremors, difficulty moving, lack of maintaining balance in addition to muscle stiffness [2]. The excellence in deep learning in solving classification problems as well as in extracting features has contributed greatly to the detection of complex diseases. Methods of transferring learning also contribute a lot to facilitating the construction of algorithms, as previous studies have proven the ability of deep learning to solve complex problems, especially those associated with the diagnosis of diseases [3]. The proposed model for developing a Parkinson's disease detection algorithm uses a learning transfer model by extracting features from handwritten records. There are many improvers that have been used for the purpose of improving the detection of Parkinson's disease, most notably KNN, Random Forest and Naïve Bayes, and KNN has shown high accuracy in this area, so it has been employed in our proposed method. In this study, convolutional neural network and learning transfer model were employed to select the best features extracted from the images and conduct the closest neighbor K to obtain most accurate detection different from conventional CNN methods [4].

The technology of learning transfer enables us to use pre-trained models to test current situation as well as deal with different data, which leads to resource savings and high efficiency. One of the important advantages of transferring learning is to save a lot of training time because the proposed model does not need to be trained from scratch, allows changing the dimensions of the last layers, adjusting the super parameters, and changing the weights [5]. At the same time, the architecture of the layers at the beginning of the model is fixed and locked, while the adjustable layers are the last layers. The k-nearest neighbor or k-NN machine learning algorithm has been employed for being a straightforward and uncomplicated algorithm. It is used for many purposes, most notably classification and regression. Classification problems are one of the most prominent uses of KNN. K represents the points adjacent to the data closer to the newest points of dataThe process of comparing the recent data point with neighboring points (k) is then combined with the most similar points through this algorithm. [6]. The value of K is randomly determined at the beginning of the algorithm, and its value ranges from three to five. Thus, similar data points are detected by calculating the distance between them by using the Euclidean distance law to calculate the distance between the new point and its neighboring point. The new points are determined based on the minimum Euclidean distance. Thus, KNN is used for the purpose of classifying features to obtain the best accuracy.

Related Works

There are many researchers conducted to detect Parkinson's disease, including the paper [7] where researchers relied on magnetic resonance imaging to classify the symptoms of the disease, the researchers adopted three types of symptoms: clinical step, dementia, and motor skills. [8] The researchers used convelutional neural networks techniques to detect Parkinson's disease through handwriting and utilising PaHaW and NewHandPD databases. [9] The researchers used Vision Converter (ViT) technology to detect disease symptoms from handwriting data based on spiral and zigzag graphics. [10] The study was conducted on a group of healthy patients for the purpose of classification, and the researchers created an application that helps diagnose the disease from handwritten data.[11] The researchers used electrical brain signals (EEG) to detect disease, Gabor transformations were utilised to get spectrograms from the EEG signals, spectrogram was used to diagnose disease by building a convolutional neural network and the study achieved great results. [12] A pattern monitoring system was developed in the spirals and waves drawn by Parkinson's patients to detect the disease. In [13], the researchers relied in their study on a database compiled from 34 people, who were divided into two subgroups equally each with 17 people, to classify the people into Parkinson's patients and healthy people, with an average age of 69 years, and a tablet with a pen was used to collect patient data. Deep learning was used to diagnose Parkinson's patients and trials have shown promising results in detecting Parkinson's disease.

Methodology

In this paper, experiments were conducted to detect Parkinson’s disease on the NewHandPD database [14] . It consists of a dataset entirely dedicated to handwritten samples composed by a smart tablet with pen. The data set consists of 594 images, including 160 male samples and 104 female samples, and are classified into two groups (healthy and sick), and there are 315 images of healthy samples and 279 patient samples. The dataset is divided into 3 classes: Circle, Meader and Spiral. In Figure 1 a collection of images from the NewHandPD database is displayed.

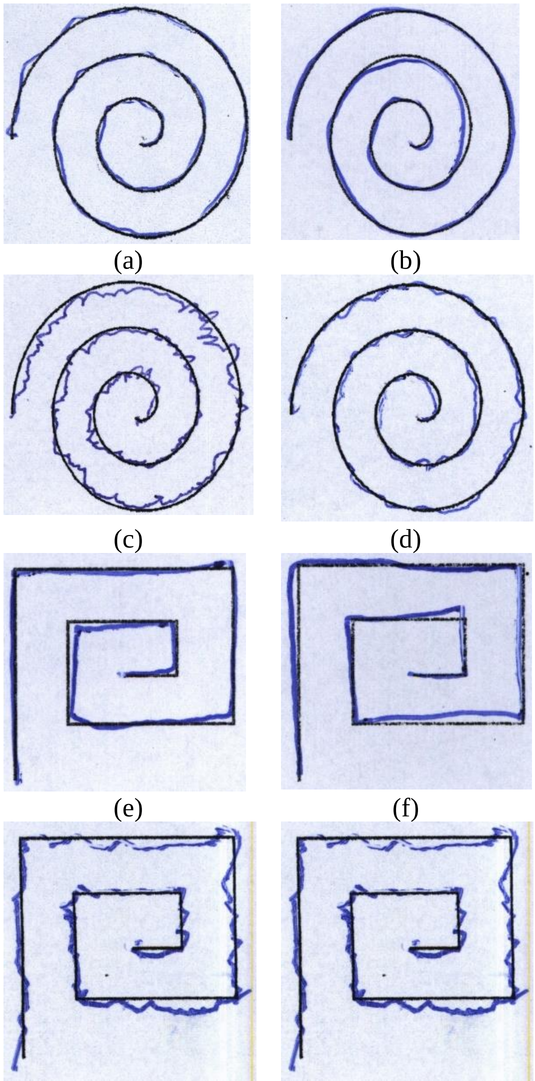

Figure 1. group of samples from HandPD dataset: [(a) older man (58) years-old and (b) weman in (28) years-old persons of control group], and [(c) older man (58) years-old and (d) older weman persons of patient group]. [(e) older man (58) years-old and (f) weman in (28) years-old persons of control group], and [(g) older man (58) years-old and (b) weman in (28) years-old persons of patient group].

For the purpose of using the learning transfer technology, the image group must be initialized to be ready for the purpose of training, at the beginning the image database is called and then its dimensions are changed to 299 × 299 because it is a requirement of the deep learning model After that, the images were normalized by dividing the pixel values by 299 so that the pixel values become between 0 to 1 because the convolutional neural network works better on this scale. Then the sample extraction phase begins, using the INCEPTION-V4 model, which its structure shown in Figure 2, this model include 48 symmetric and asymmetric layers, including convolution, assembly, dropouts, etc., make up the model.

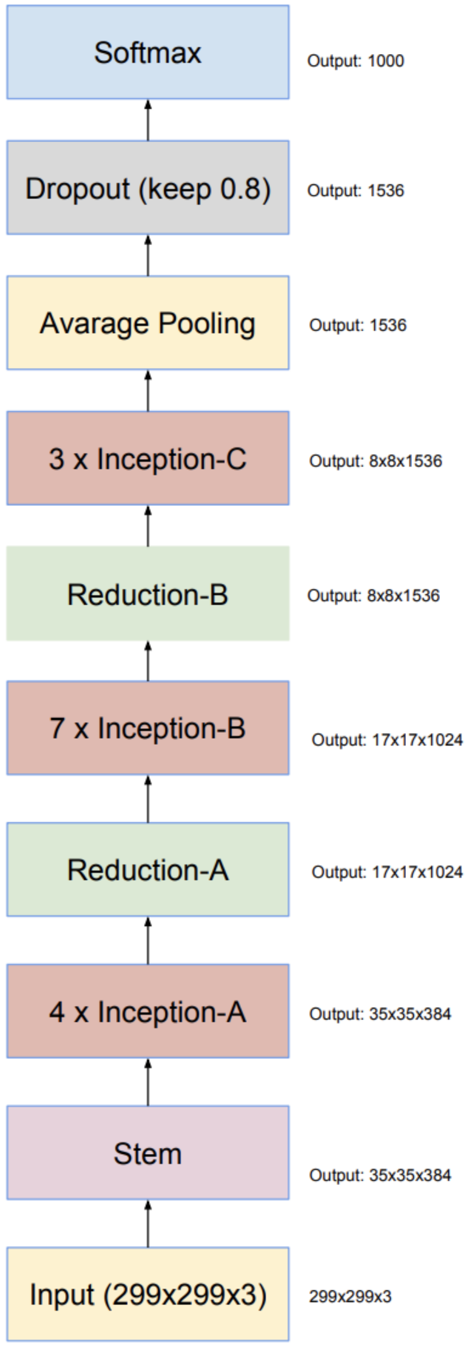

Figure 2. The overall schema of the Inception-v4 network.

This model is the third version of the INCEPTION series, which surpasses previous versions in terms of accuracy and time taken to train. After that, we froze the output layer of the model as it is a requirement for the transfer of learning, and thus we have obtained the features of the previous training of the model on the ImageNet dataset.

The KNN classifier is then trained on the features we obtained to calculate the distance between samples and classify data categories in order to obtain the final output, the flowchart of KNN classifier procedure is shown in Figure 3. The experiment evaluated the predictability of the suggested approach on the database of NewHandPD and specified how each subset of features give the overall accuracy of the classification.

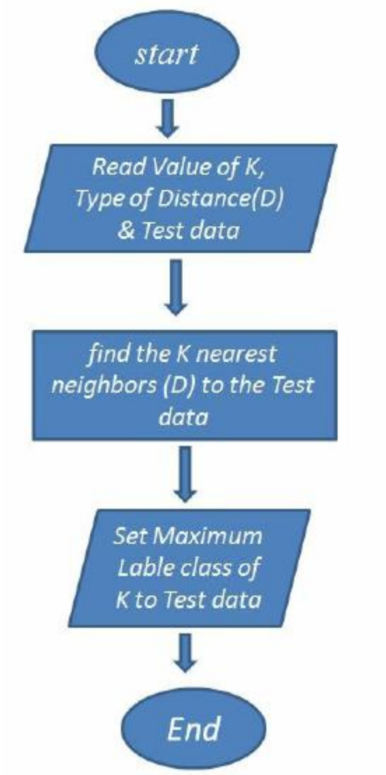

Figure 3. The flowchart of KNN classifier procedure.

KNN is one of the best choices for studying data classification in which there is no information about the way the data is distributed, in addition to being one of the most prominent lazy learning methods. This is because it depends on storing training data and then waiting until test data is produced, so it is used in classifying big data. KNN distance measures are one of the most prominent measures that are used in classifications, as the distance is set based on a specific measure to calculate the distance between the test sample and all training data samples.

Results and Discussion

The method of evaluating the algorithm is obtained by analyzing and testing the results obtained from training, through several measures designated to evaluate the performance of the proposed method, the most important of which is calculating accuracy. The proposed method achieved a maximum accuracy of 93.15% as shown in Figure 4. In addition, the area under the curve (AUC) was measured for the purpose of revealing the ability of the expected model to distinguish between layers, and the model showed the best classification, where it was able to distinguish the person with Parkinson's disease from the non-sick person, and a ratio of 0.89 was obtained as shown in Figure 5. We calculated the true positive rate via the recall function to reveal how many people we accurately identified as patients out of all the patients really achieved a ratio of 0.85. In addition, the ratio of Parkinson's patients to all patients with the disease was determined by calculating the percentage of real positives, which reached 0.97.

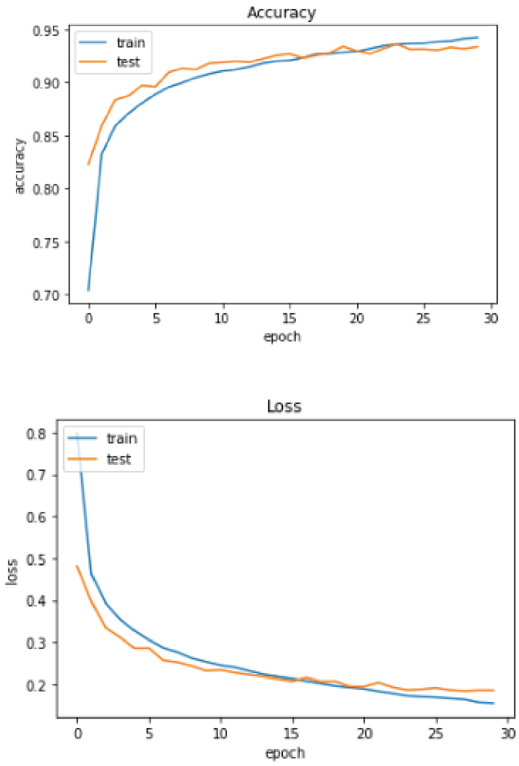

Figure 4. The model accuracy and loss results.

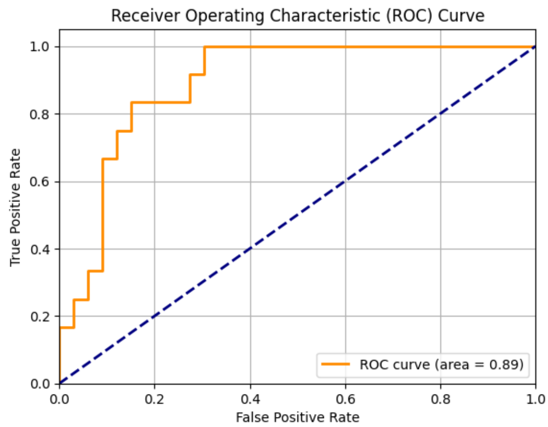

Figure 5. The model AUC results.

Conclution

In this work, a new model for accurate diagnosis of Parkinson ‘s disease was developed by training the model on handwritten records provided by the NewHandPD standard data set. The proposed approach is built on the Inception 4, a tansfer learning model, which takes little time in training. The obtained features derived from the InceptionV4 model are fed into the classification process using KNN to obtain better classification results because it is less computationally intensive compared to other methods. The performance of the proposed model was evaluated by the methods of It has been shown that this model can accurately classify the disease higher than numerous newly inspected schemes. The loss is very small. Experimental analysis and results comparison demonstrated the best performance of the suggested model in accurate detection of Parkinson's disease.

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