Ukrainian Scientific Medical Youth Journal
Issue 1 (152), 2025
Creative Commons «Attribution» 4.0

ISSN 2786-6661
eISSN 2786-667X

UDC: 616.858-037:004.85.032.26
https://doi.org/10.32345/USMYJ.1(152).2025.92-96

Received: October 12, 2024
Accepted: January 08, 2025

Parkinson's Disease Prediction Using Deep Learning Classification Algorithms

Kayacioglu Rumeysa[1], Kacar Fırat[2]

[1] School of Technical Sciences, Mus Alparslan University, Mus, Turkey

[2] Department of Electric – Electronic Engineering, Istanbul University – Cerrahpasa, Istanbul, Turkey

Address for correspondence:

Kayacioglu Rumeysa

E-mail: m.rmys@hotmail.com

Abstract: *complaints arising from neurological disorders continue to increase today. At the same time, studies on diagnosis and treatment methods in medicine are increasing as technology advances. With the increasing interest in these areas, studies have been carried out on various diagnosis and follow-up systems related to Parkinson's disease. For this purpose, in this study, we studied the classification of a data set consisting of various voice recordings for each patient with the designed deep learning architecture in order to assist in the more objective diagnosis of Parkinson's disease. Although it is important for the estimation of the study to find different sound samples of each subject in the data set, it is not known how much these recordings represent all the sound recordings of the person. Recurrent neural networks, which are a deep learning architecture, are an efficient system that can achieve high success in voice data and can be preferred in the diagnosis and follow-up of Parkinson's disease. However, this study showed that in such a network design, much larger and more diverse data are needed to increase the classification rate, to make more accurate predictions in the field of medicine, and to make remote diagnosis.*

Keywords: Neurodegenerative disorder, artificial intelligence, deep learning, classification.

Introduction

Neurological diseases have affected and continue to affect a lot of people all over the world from past to present. In addition, the number of people dying from neurological causes is increasing day by day. It is known that the frequency of encountering Parkinson's disease varies depending on factors such as age and gender. It is thought that Parkinson's disease, which occurs at an early age, is caused by genetic factors [1,2]. The symptoms of Parkinson's disease are increasing and its progression cannot be stopped [3].

Today, patients have to go to the hospital in order to diagnose the disease and follow the process, and this leads to loss of time and cost. This is because the examination needs to be repeated when the disease is active and passive. In this process, when the patients are examined by specialist doctors and the symptoms are followed, disagreements may arise due to subjective diagnoses. At this stage, it is believed that the development of a successful decision support mechanism that helps the diagnosis and follow-up of doctors will be beneficial for patients and doctors. Thus, time and workload will be saved and the cost will be kept lower due to early diagnosis [1]. A lot of research has been done on the relationship between Parkinson's disease and speech, and it has been proven how much they are related to each other [4]. In addition, it was concluded that with the progression of the disorder, the voice could not be used efficiently enough during speech [5]. In this study, it has been studied to develop a decision support system that can help doctors in diagnosing Parkinson's disease and following the disease. It is aimed that the designed deep learning network can distinguish individuals with Parkinson's disease from healthy individuals and classify them successfully. Various studies have been carried out with machine learning methods on the classification of voice data in Parkinson's disease and relevant results are presented. However, studies on the classification of audio data with deep learning architectures are extremely inadequate.

Aim

In this study, it has been studied to develop a decision support system that can help doctors in diagnosing Parkinson's disease and following the disease. It is aimed that the designed deep learning network can distinguish individuals with Parkinson's disease from healthy individuals and classify them successfully.

Materials and methods

One of the main symptoms in the diagnosis of Parkinson's disease is voice disorders. Voice disorder symptoms have an important place in the diagnosis of the disease and in the follow-up of the progress of the disease [1].

Data collected for a previous study was used in this study. Relevant data were obtained from 20 Parkinson's disease patients (14 men, 6 women) who applied to the Neurology Department of Istanbul University Cerrahpasa Faculty of Medicine and 20 healthy subjects (10 men, 10 women) who applied to the same unit.

The subjects were told 26 different sound samples and their voices were recorded. These sound samples consisted of numbers, words, continuous vowels, and short sentences.

In the study, classification was made with Recurrent Neural Networks (RNN), which is a deep learning architecture.

The connections between the units of the RNN form a directed loop. This loop allows behavior to be processed temporally and dynamically. Recurrent Neural Networks can use their input memory to process inputs randomly [6]. It is assumed that all inputs and outputs are independent of each other in systems where the data is image. On the contrary, if the system to be created depends on the time variable, there is no independence. The RNN architecture is built on sequential information processing and is called recurrent because it continues based on previous outputs for each item in the array [7].

Recurrent Neural Networks evaluate previous information and what they have learned at the moment together. In RNN, the input of the next operation is the output of the previous operation. Therefore, it differs with feedforward neural networks [8].

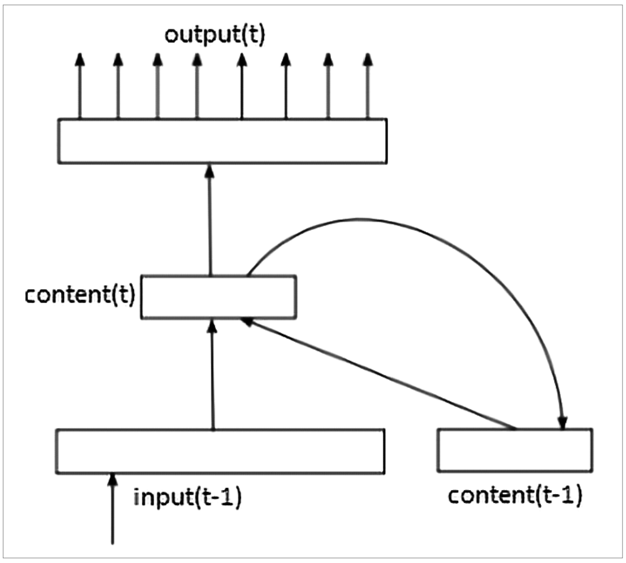

Figure 1. Recurrent Neural Network [9]

RNN architecture operates on the memory it has. This memory is required for output that needs input data with a pattern. Such datasets cannot be trained with feedforward networks. For this reason, recurrent neural networks are needed in such datasets from language, text and sensors [10].

Recurrent neural networks have produced fertile results in many natural language processing studies. At this point, the most frequently used type of RNN is Long Short Term Memories (LSTM).

ISSN 2786-6661
eISSN 2786-667X

Various application areas of RNN architecture are as follows;

- Machine translation
- Speech recognition
- Language modeling and text creation [8].

LSTM network structures, which is a type of RNN architecture, have been designed to solve long-term dependencies encountered in practice. The results of LSTM architectures in speech/text processing areas are extremely good [9]. The LSTM architecture, which was first introduced by Hochreiter and Schmidhuber, was mentioned in 1997 [11].

In the LSTM architecture, a forget gate is added to prevent memorization and reset itself, and surveillance connections have been added to make learning positioning easier [12,13].

Results

After the researches and the codes written, the success rate of diagnoses made with voice data in Parkinson's disease was examined. The training set consists of data containing 26 different voice samples from 40 subjects.

The data used in deep learning training are labeled as 1 if the subject is a patient, 0 if not. These labels are recorded in the table.

The deep learning architecture running in the background makes classification by scanning the loaded data. It makes the classification in the way he learns from the data it uses in education.

- The relevant data set was transferred to the MATLAB (Matrix Laboratory) workspace and divided into training, validation and test set.
- Network design was done through the deep network designer toolbox.
- The accuracy of the network structure was analyzed and the error-free neural network was imported. (Fig. 2)
- The training preferences of the neural network are set and the network training is started.
- The training process was followed on the graph. Accuracy and loss rates were followed and worked to get the most appropriate result.
- The accuracy, sensitivity and specificity of the trained neural network were measured.

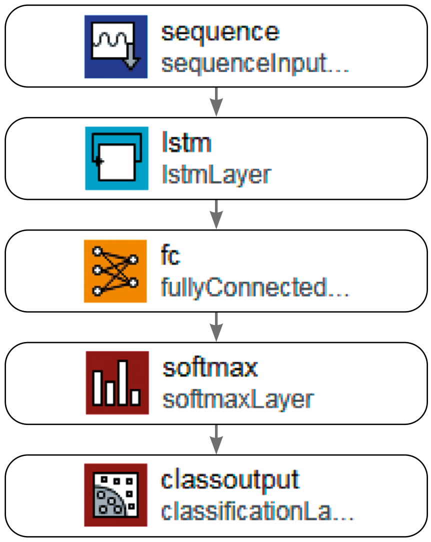

Figure 2. Deep Network Designer Toolbox-network design

The accuracy, sensitivity and specificity results obtained on the classification of sound samples are shown in Table 1.

Table 1. Accuracy, sensitivity and specificity results obtained using the k nearest neighbor algorithm

k	Accuracy (%)	Sensitivity (%)	Specificity (%)
1	57,69	57,30	58,33
2	52,40	53,00	48,00
3	53,85	62,80	51,50
4	49,04	56,80	47,40
5	52,40	49,70	73,90

Conclusions

In machine learning methods, features must be introduced to the network in order for the network to be able to classify. In deep learning, the features do not need to be introduced to the network in order for the system to perform the classification. In the study, the classification was made with a dataset in which many different sound samples were collected, thus laying the groundwork for more comprehensive research. In this respect, the related study is a good preliminary study. On the other hand, such a system should have a much larger dataset and be run with a new generation operating system with a greater amount of computing power. Thus, it will be a system that is closer to the targeted results and more helpful to the doctor. This study, which is open to development, has gained the quality of a study that can be used for new studies and can be useful for other researches based on the success rate it offers and the points it has determined.

Financing

This study is a part of the master's thesis titled «Investigation of Diagnostic Success Rate with Voice Data in Parkinson's Disease» of Istanbul University – Cerrahpasa Graduate Education Institute, Department of Biomedical Engineering. «This study did not receive external funding»

Conflict of interest

The authors certify the absence of conflicts of interest.

Consent to publish

All authors have read the text of the manuscript and have given their consent for its publication.

ORCID ID and autor contributions

0000-0003-1829-9947 (A, B, C, D) Kayacioglu Rumeysa

(A, E, F) Kacar Fırat

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of article.

REFERENCES

1. Şakar BE. Çoklu Ses Kayıtları İçeren Bir Parkinson Konuşma Veri Kümesinin Toplanması ve Analizi [Collection and Analysis of a Parkinson's Speech Dataset with Multiple Voice Recordings] [PhD thesis] [Turkish]. İstanbul: İstanbul Üniversitesi Fen Bilimleri Enstitüsü; 2014. p. 1-30.
2. Apaydın H, Özekmekçi S, Oğuz S, Zileli İ. Parkinson Hastalığı ve Yakınları İçin El Kitabı [Parkinson Disease and Handbook for Relatives] [Turkish]. İstanbul: Bayçınar Tıbbi Yayıncılık ve Reklam Hiz. Tic. Ltd. Şti.; 2013.
3. Ramaker C, Marinus J, Stiggelbout AM, Van Hilten BJ. Systematic evaluation of rating scales for impairment and disability in Parkinson's disease. Mov Disord. 2002;17(5):867-76.
4. Ho A, Bradshaw JL, Iansek R. For better or for worse: the effect of Levodopa on speech in Parkinson's disease. Mov Disord. 2008;23(4):574-80.
5. Harel B, Cannizzaro M, Snyder PJ. Variability in fundamental frequency during speech in prodromal and incipient Parkinson's disease: A longitudinal case study. Brain Cogn. 2004;56:24-29.
6. Kombrink S, Mikolov T, Karafiat M, Burget L. Recurrent neural network based language modeling in meeting recognition. In: Interspeech, ISCA; 2011 Aug 27-31; Florence, Italy. 2011. p. 2877-80.
7. Graves A, Jaitly N. Towards End-To-End Speech Recognition with Recurrent Neural Networks. In: Proceedings of the 31st International Conference on Machine Learning, PLMR; 2014 Jun 21-26; Beijing, China. 2014;32(2):1764-72.
8. Arslan M. Bir İnsan Çiz Projektif Testi Yapay Zeka Tabanlı Sistem Tasarımı [A Human Figure Drawing Projective Test Artificial Intelligence-Based System Design] [master's thesis] [Turkish]. İstanbul: İstanbul Üniversitesi-Cerrahpaşa Lisansüstü Eğitim Enstitüsü; 2020. p. 24-40.
9. Şeker A, Diri B, Balık HH. Derin öğrenme yöntemleri ve uygulamaları hakkında bir inceleme [A Review on Deep Learning Methods and Applications] [Turkish]. Gazi Mühendislik Bilimleri Dergisi. 2017;3(3):47-64
10. Poggio T, Girosi F. Networks for approximation and learning. IEEE. 1990;78(9):1481-97.
11. Hochreiter S, Schmidhuber J. Long Short-Term Memory. Neural Comput. 1997;9(8):1735-80.
12. Gers FA, Schmidhuber J, Cummins F. Learning to forget: continual prediction with LSTM. Neural Comput. 2000;12(10):2451–71.
13. Meyes R, Donauer J, Schmeing A, Meisen T. A recurrent neural network architecture for failure prediction in deep drawing sensory time series data. Elsevier. 2019;34:789-97.

Ukrainian Scientific Medical Youth Journal
Issue 1 (152), 2025
Creative Commons «Attribution» 4.0

ISSN 2786-6661
eISSN 2786-667X

Прогнозування хвороби Паркінсона за допомогою алгоритмів класифікації глибокого навчання

Kayacioglu Rumeysa[1], Kacar Fırat[2]

[1] School of Technical Sciences, Mus Alparslan University, Mus, Turkey

[2] Department of Electric – Electronic Engineering, Istanbul University – Cerrahpasa, Istanbul, Turkey

Address for correspondence:

Kayacioglu Rumeysa

E-mail: m.rmys@hotmail.com

Анотація: *скарги на неврологічні розлади сьогодні продовжують зростати. У той же час дослідження діагностики та методів лікування в медицині збільшуються з розвитком технологій. Зі зростанням інтересу до цих областей були проведені дослідження різних систем діагностики та подальшого спостереження, пов'язаних із хворобою Паркінсона. З цією метою в цьому дослідженні ми вивчили класифікацію набору даних, що складається з різних записів голосу для кожного пацієнта з розробленою архітектурою глибокого навчання, щоб допомогти у більш об'єктивній діагностиці хвороби Паркінсона. Хоча для оцінки дослідження важливо знайти різні звукові зразки кожного суб'єкта в наборі даних, невідомо, наскільки ці записи представляють усі звукові записи людини. Повторювані нейронні мережі, які є архітектурою глибокого навчання, є ефективною системою, яка може досягти високого успіху в голосових даних і може бути відданою перевагі в діагностиці та подальшому спостереженні за хворобою Паркінсона. Однак це дослідження показало, що в такій структурі мережі необхідні набагато більші та різноманітніші дані для підвищення рівня класифікації, для більш точних прогнозів у галузі медицини та для дистанційної діагностики.*

Ключові слова: Нейродегенеративний розлад, штучний інтелект, глибоке навчання, класифікація.