Correction in Diagnosis of Parkinson's Disease with Prediction

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Abstract - The aim of this work is to fasten the diagnosis of Parkinson's Disease at an early stage considering one of its symptoms which is Dysphonia (abnormal condition of producing speech) to be collected as a dataset from respective voice recordings modulated at different frequencies of respective patients ,then using machine learning model (XGBoost Classifier) predict the diagnosis of the disease with high precision and also Study the recording of muscle response with the aid of the EMG sensor module (Electromyography) with changes in muscle activity (suggested physiotherapy) in the form of an analogue signal. With this implementation we are able to diagnose Parkinson's Disease at an early stage to reduce the severity level of the disease.

Key Words: Parkinson's Disease, Dysphonia, XGBoost Classifer, EMG

1. INTRODUCTION

The hardware module EMG (Electromyography Sensor) has the respective receptors or electrodes to be mounted on the muscle to record its response, the sensor provides output in the form of an analogue signal and changes in the response of the muscle with different weights are seen with the respective physiotherapy or movement of the muscle, as a result of which we can verify the severity of the disease. Certain threshold values are considered in millivolts or milli-amps, depending on the muscle response of the EMG sensor, and based on the threshold, we can see the magnitude of the disease and start treatment at an early stage. The second methodology consists of the Machine Learning (XGBoost Classifier) model which consists of a dataset considering one of the symptoms of Parkinson's disease, based on this model study the Prediction of the disease is generated with higher precision and accuracy to diagnose Parkinson's Disease. The dataset collection consists of people having symptoms of Dysphonia , their speech recordings is modulated at different frequencies and is compared with the speech recordings of healthy people who don't have the symptoms, comparison is done with the help of machine learning model to give accuracy of the diagnosis and thus the outcome is generated.

2. LITERATURE SURVEY

2.1 Importance of voice dataset considering the symptom Dysphonia [9]

Identifying the presence of illness, speech or voice data is believed to be 80 per cent helpful in diagnosing a person. Persons suffering from Parkinson disease mainly have two problems that can be classified as dysphonia and dystonia. Dysphonia indicates irregular speech-producing disorder and dystonia indicates sustained muscle contractions that cause forced or twisted positions. So, most physicians who treat PD patients are observing dysphonia and attempting to rehabilitate to improvise vocal volume with unique therapies.

2.2 Survey regarding the diagnosis of PD with different algorithms and approaches [1][2]

Several strategies are documented for early stage detection of PD based on various ML algorithms and techniques. However, timely accuracy in diagnosis and classification is very necessary or allows further symptoms to develop. There are different types of data, brain MRI images, voice data, posture images, sintered data, handwritten data that can be used to predict whether or not a person has PD. Out of all this, speech or voice data helps to classify the PD precisely. A presentation by Max A. Little on dysphonia estimation, pitch-period entropy (PPE) and the use of kernel support vector machine enabled them to achieve a classification accuracy of 91 per cent. A different method was established by Rainer Scho' Nweiler, who used ANN voice analysis and had good results, but it was noted that cost-effectiveness remains a challenge. Satyabrata Aich suggested a novel approach by using Genetic Algorithm and PCA as a feature selection tool and by applying seven ML algorithms for classification, which saved time and efficiency when classifying patterns in two categories such as PD and not PD. Kosaka et al identified a patient who began with symptoms of dementia and parkinsonism that led to the spread of Lewy's body disease as demonstrated by a post-mortem examination. In 1919, the substanstia nigra was considered to be responsible for much of the symptoms of PD. In 2003, Braak researched the distribution of Lewy's bodies and proposed that PD begins in the dorsal motor nucleus of the medulla oblongata and that the disease then spreads to the brain stem involving the locus coeruleus and the substantia nigra and finally the cerebral cortical regions. Derya Avci and Akif Dogantekin suggested another method using Genetic Algorithm-Wavelet Kernel-Extreme Learning and obtained good results in accuracy. It is important to note that, out of all ML techniques, ANN and SVM classifiers are used by most of the proposed algorithms to help make predictions faster and more accurate. There are several different techniques and algorithms used in data mining, particularly for supervised machine learning techniques, so choosing an appropriate technique has been a challenge for researchers in developing PD diagnosis system.

2.3 EMG Signal Morphology in Essential Tremor and Parkinson Disease [3][5]

In this paper, 13/17 patients with critical tremor were discriminated against from 26/35 patients with Parkinson's disease. While experimenting with this, the EMG signal morphology analysis was conducted with the aid of histogram samples and observations were made during isometric contraction of biceps branchii muscle with varying loads. For the analysis of the shape of the EMG signal histogram, the feature dimension reduction process, the principal component analysis (PCA) and the shape parameters were used to do analysis on EMG signal histogram. This EMG signal plays a key role in distinguishing patients with ET from patients with Parkinson's disease.

2.4 WIRELESS IN VIVO EMG SENSOR FOR INTELLIGENT PROSTHETIC CONTROL[6][7][8]

In this context, the author presented a design of a wireless implantable electromyography (EMG) sensing microsystem for intelligent control of myoelectric prostheses. The implantable device is capable of transmitting digital EMG data to the external receiver wirelessly. EMG electrodes are paired with a capacitive coupled differential amplifier with a closed loop gain of 38 dB, a bandwidth of 1Hz and a square root of 78 nV/Hz input-referred noise floor. Furthermore, the digitization of the amplified EMG is carried out by an 11-bit algorithmic ADC. During the demonstration, the device achieved 9.35 ENOB under battery power in conjunction with a minimum observable EMG signal of 5.4 muVrms. In order to calculate the high-quality waveform of the EMG for real-time intelligent prosthetic control, the achievement was adequate.

3. PROPOSED METHODOLOGY

Considering the present situation, the current population over the age of 40 or 50 typically start to experience signs of Parkinson disease, which is undetectable at an early stage and thus causes severe conditions as the population age (50 to 40 years of age) rises. In order to address this chronic disease, which is a concern for much of the population, the technologies used in the project will benefit pop. The key vision of our project is to automate and diagnose early stage error in the detection of Parkinson's disease severity with the help of the required data set to be trained using the Machine Learning Model and IOT-based sensors such as the EMG muscle sensor to check UPDR (Unified Parkinson's Disease Rate). The main goal is to produce a prediction percentage of early-stage diagnosis of Parkinson's disease using the necessary dataset of Dysphonia, which is considered to be one of the symptoms of the disease, with the aid of the machine-learning model. In this project, we used a combination of the Machine Learning Paradigm, the Internet of Things and some Data Visualization concepts for study. We used the Electromyography Sensor (EMG Sensor) which allows the user to measure muscle and vocal muscle activity (thyroarytenoid). EMG is used as a diagnostic method for the identification of neuromuscular disorders, motor control disorders. Speech rating and quantified fluency are obtained using hardware for voice recording modulation. Parkinson's disease not only affects muscles, the nervous system, but it also affects speech in many aspects. People with Parkinson's disease speak softly, and in one tone, they can't articulate the message. Speech often sounds rough or harsh. People with Parkinson's may be slurting sentences, muttering or trailing off at the end of a sentence. This is a dysphonia disorder that is found in patients. So, first of all, to check one of the signs of Parkinson's disease, considering the motor muscles, we connect the receptors from the EMG sensor to the respective muscles and recommend that the patient conducts physiotherapy with various weights with the respective muscle movements. The EMP sensor then captures the electro-pulses of the respective movement (voluntary action) and shows the output in the form of an analogue signal with changes in the muscle response. Then we come to the implementation of the software component (ML model) Considering one of the symptoms of Parkinson's Disease that is Dysphonia, the dataset referred is fed to the Machine Learning Model (XGBOOST Classifier) used to train and evaluate the dataset for diagnosis of Parkinson's Disease. In the Machine Learning model, the dataset is broken down into healthy and unhealthy people affected by Parkinson's disease with their respective speech recording threshold values modulated at different frequencies. The ML model (XGBOOST Classifier) classifies the data linearly, compares and trains at each voice recording threshold, and then diagnoses the disease at high precision, after the data is fed for training and testing for analysis.

4. BLOCK DIAGRAM

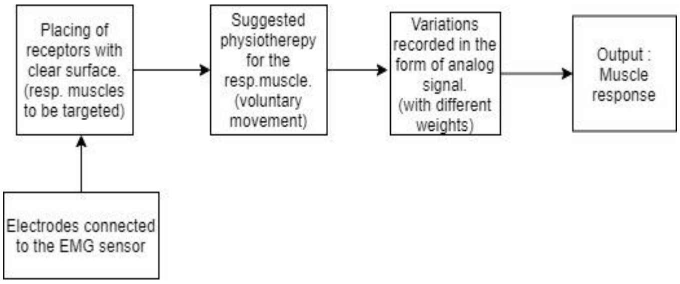


Fig –1: Block Diagram

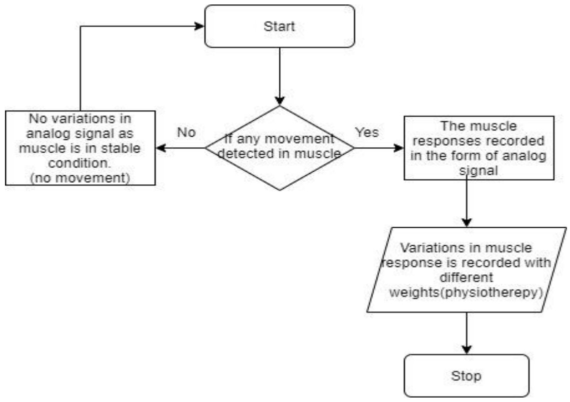
5. SYSTEM ARCHITECTURE

The respective architecture consists of three stages: first, we need to verify the response of the muscles with the aid of the EMG sensor module and review the variations in the response of the muscles with the suggested physiotherapy for the patient considering the diagnosis of the first symptom. Second, considering one more symptom of Parkinson's disease that is Dysphonia, the dataset of people affected by Dysphonia and those not affected by Dysphonia is fed into the Machine Learning Model. Respective outcomes and the prediction percentage of Parkinson's disease is generated as an outcome with high precision analysis. Third, we need an overview of the dataset referred for the review of a steady rise in total UPDRS (unified Parkinson's Disease Rate Severity) after 50 years of age to keep a check on the severity of the disease and the presiding symptoms of the disease we are able to achieve a full diagnosis of the disease.

5.1 Hardware Components

- **Electromyography Sensor (v3.1.0) with Arduino IDE(1.8.13):** The Electromyography Sensor Interfacing (EMG Sensor) is programmed with the respective Arduino microcontroller on the Arduino IDE platform version 1.8.13. The respective sensor gives output in the form of an analogue signal to study the variations in muscle response and to produce the corresponding effects.
- **Receptors (Electrodes):** Receivers are electrodes that are attached to the EMG sensor to receive signals in the form of electro-pulses from the respective muscles when some voluntary action is taken and also trigger signal variations depending on the activity of the motor muscle. The receptors are placed on the respective muscle to check the response of that region of the muscle and is placed on a clean surface for accurate reception.
- **Monitor Display:** A composite display is used to see the variations in the analog signal (displays the output in the form of analog signal).Also helps us see the variation in muscle response for suggested physiotherapy.

5.2 Flowchart for EMG module and ML module



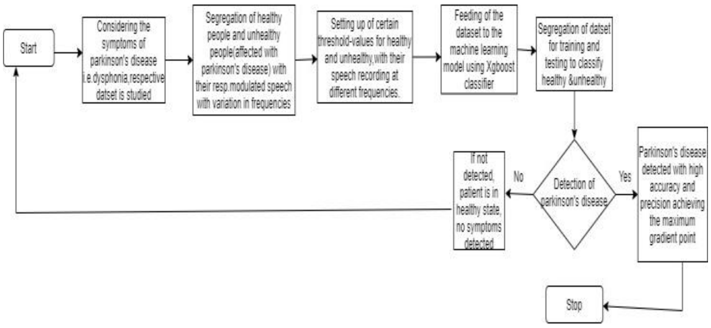


Fig -1: Flowchart for Machine Learning Model

5.2 System Description

As discussed earlier, the method consists of three stages, the main stage being the ML model, which produces reliable results from the following analysis from the dysphonia dataset. The ML model consists of an XGBOOST classifier, this classifier provides a packaged class that allows models to be treated as a classifier or regression in the SCIKIT-learn system. This means that we can use complete SCIKIT-learn library with XGBOOST models. The XGBOOST classification model is called the XGBClassifier. Models are equipped with the scikit-learn API and the model. The XGBOOST classifier is also known as the Extreme gradient booster algorithm as it is used to convert unstructured data to structured data and, with the aid of tree algorithms, is used to classify entities and create a relationship between them in order to predict an event that will occur in the future considering the respective entities. The Parkinson Disease Diagnosis Project uses this machine learning algorithm to perform the classification and achieve an accuracy rate of up to 97% (Diagnosis Disease Prediction) taking into account only one of the symptoms of the disease and their respective datasets to be fed into the machine learning model. The benefit of this classifier is that it divides data into training and testing using less data for model testing, only up to 27 per cent of data is used for performance generation, and the rest is used for model training in-order to identify and perform disease diagnostic analysis with high precision and accuracy. Considering all three stages of early diagnosis, the respective architecture also facilitates study of the incremental increase and decrease in symptoms of Parkinson's disease at the age of 50 years and above. It also demonstrates how the patient's symptoms have steadily risen with change or increased severity while preserving the threshold values or patient's history of respect. The three main stages as described before the first stage consisting of checking of the UPDRS (Unified Parkinson's Disease Rate Severity), the second stage consisting of the analysis and Prediction for the analysis done on the model for early diagnosis and the third stage analysis, gives a briefing of the steady rise and decrease of total UPDRS after the age of 50 years sum up of all three stages helped in developing the building blocks of the implementation and the system architecture.

6. CONCLUSION

6.1 Conclusion

We used an Electromyography (EMG) sensor for digital muscle movement readings. We have used XGBOOST [Gradient Classifier] for data interpretation and data visualization for data representation. So, instead of using different methods to come up with our project, we have not only learned various algorithms, but also studied variations in muscle response readings using the EMG sensor on the Arduino Platform. We have used numerous online documentation and references to enhance our project and also to expand the reach of our projects, which is why we have also listed them in this article. We also believe that our project has real scope in the near future and can be further expanded by combining this module with any computer and making life much easier for people. By automating our project, machines will automatically rectify early diagnosis of Parkinson Disease and interpret them and deliver results much faster immediately. Automated computers can also foresee this notorious epidemic, and mitigation can be achieved by understanding when and how to prevent it. By combining this project with a real-time database and a mobile application, we can generate data and get a huge dataset from real-time users, it can also send results to people on how their results are and whether they need to take any precautions about the same thing. By integrating this even further we can use the gyroscope that is in built in real time smart phone and using this in-built sensor we can take readings from the user by performing some tasks assigned to him by placing smartphone on his hand or making him hold the phone tightly and it will be captured by the app that has been made for this sole purpose. With the help of integrated app, the user can also get results faster and safety measures to prevent it.

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