Wearable Sensor based Gait Pattern Analysis for detection of ON/OFF State in Parkinson's Disease

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ABSTRACT

In the last decades patient's suffering with Parkinson's disease is increasing at a rapid rate and as per prediction it will grow more rapidly as old age population is increasing at a rapid rate through out the world. As the performance of wearable sensor based approach reached to a new height as well as powerful machine learning technique provides more accurate result these combination has been widely used for assessment of various neurological diseases. ON state is the state where the effect of medicine is present and OFF state the effect of medicine is reduced or not present at all. Classification of ON/OFF state for the Parkinson's disease is important because the patients could injure them self due to freezing of gait and gait related problems in the OFF state. in this paper wearable sensor based approach has been used to collect the data in ON and OFF state and machine learning techniques are used to automate the classification based on the gait pattern. Supervised machine learning techniques able to provide 97.6% accuracy while classifying the ON/OFF state.

Keywords
Wearable sensors, gait, pattern analysis, classification, Parkinson's disease

Ⅰ. Introduction

Parkinson's disease is very common in the old age group. If it is not detected in the early stage it can lead to severe gait related problem as well as problems in upper limbs as well as lower limbs[1]. Detection of Parkinson's disease as well as continuous monitoring was a challenge few years ago because of expensive monitoring devices such as sensors as well as difficult to perform the pattern analysis because of unavailability of proper data analysis technique as well as unavailability of sufficient data. In recent years the wearable devices are easily available and it is easier to collect huge amount of data and with combination of powerful machine learning technique it is easier to draw patterns that help to monitor the patients in real time. Aich et al., used wearable sensors and machine learning technique for prediction of freezing of gait in Parkinson's disease [2].Aich et al., using wearable sensor data to distinguish shuffling of gait patients from other Parkinson's disease patients and automated using machine learning techniques [3]. Jeon et al. used wearable sensors based approach to measure the tremor severity and automatic classification of patients using machine learning techniques [4]. In this paper we have proposed a wearable sensor based approach to detect and classify the ON/OFF state of Parkinson's disease patients and automate the classification of ON/OFF state using machine learning techniques.

II. Methodology

The framework of the methodology planned for this project is mentioned below in Figure 1. The data has been collected using wearable inertial sensors 3D motion analysis system. The data recorded in the 3D motion analysis system is the gold standard, where the data recorded using wearable accelerometers are used to extract the features and quantify the gait parameters and after fine tuning the quantified gait parameters and god standard data were fed to supervised machine learning model and also validated to check the performance of the model.

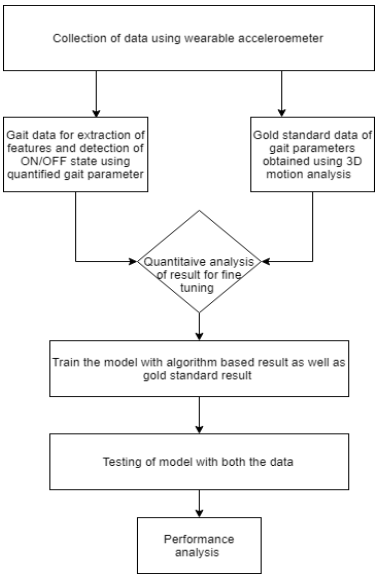

Figure 1. Framework of Methodology

III. Data Analysis and Results

In this paper supervised machine learning techniques are used and among them random forest provides highest accuracy of 97.6% shown in the figure 2.

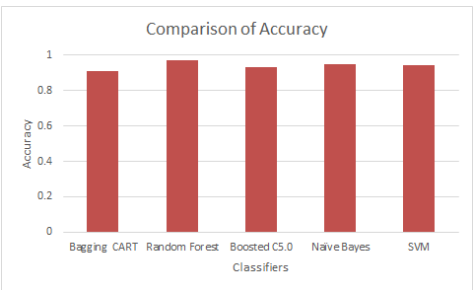

Figure 2. Comparison of Accuracy

IV. Conclusion

In this paper we have analyzed the accelerometer data of the patients which undergone ON/OFF state and then gait parameters were quantified from the data and compared to the gold standard data obtained using 3D motion analysis and then based on difference of the results fine tuning is performed in the algorithm and then these data's were fed to different supervised machine learning technique such as Bagging CART, Random forest, Boosted C5.0, Naive Bayes, and SVM and we found highest accuracy of 97.6% on random forest classifiers. This model will help the clinician to distinguish the ON and OFF state more accurately compared to manual methods.

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