Smart Glove for Tremor Detection

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Abstract. Parkinson's disease (PD) must be accurately diagnosed in the early stages. In PD, the premotor stage should be closely observed. We designed a smart glove for tremor detection, to detect whether a person is affected by Parkinson's disease or not. To detect the tremors, an accelerometer and vibration sensor is embedded in a glove. Based on the intensity of the tremor, a graph is plotted in a serial plotter which is easily understandable. The values of the accelerometer are exported to MATLAB for processing, where Power spectral Density (PSD) is applied and the peaks are determined. The peaks of the graph will help us classify the intensity of Tremors. Further, it can be used to monitor tremors also.

Keywords: Parkinson's disease · Vibration sensor · Accelerometer · Arduino

1 Introduction

Parkinson's disease, which affects the quality of life for millions of elderly people worldwide, is fast emerging as a significant central nervous system degenerative illness. Due to the variability of the disease, PD symptoms might progress differently from one person to the next. Parkinson's disease sufferers may experience tremors, primarily while at rest [7]. Numerous tremors kinds can occur, including hand tremors, limb rigidity, and issues with walking and balance. In general, there are two groups of symptoms associated with PD: those that are motor-related and those that are not (non-motor). Individuals are more negatively affected than those whose major symptoms are motor when they have non-motor symptoms [3]. Nonmotor symptoms include things like depression, irregular sleep patterns, loss of smell, and cognitive decline. The Centers for Disease Control and Prevention (CDC) has said that PD complications are the 14th most common cause of mortality in the US. In particular, it is estimated that the economic burden associated with PD, which includes treatment costs, social security benefits, and lost income, is around $52 billion per year in the United States alone. In actuality, there are more than 10 million PD sufferers worldwide. It should be highlighted that timely PD detection greatly speeds up treatment and symptom relief, as described. Therefore, detecting Parkinson's disease (PD) early on is crucial for slowing down the illness's course and may enable individuals to obtain disease-modifying therapies when they become available.

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2 Literature Survey

Numerous institutes throughout the world have conducted a significant amount of research to develop a practical and affordable tool for tremor control. Hand tremors are oscillatory movements that are rhythmic in one or more body parts. The most prevalent illness, which impacts over 3.8 million individuals worldwide, is Parkinsonian tremor. We can identify tremors in patients and administer the proper treatment with periodic tests. The Electromyography technique is the method that doctors use the most frequently to distinguish between the various forms of tremors. Since EMG is quite expensive and necessitates periodic check-ups to gauge the patient's progress, not everyone can afford to pay for repeated examinations.

The examination of tremor features under resting-state and stress-state circumstances had been suggested by Hong Ji Lee et al. Using an accelerometer on the finger, the tremor was measured during the postural tremor and rest tremor while in the stress state and resting state (doing a computation task). We compared the variations in the peak power, peak frequency, mean frequency, and power spectral density (PSD) distribution of tremor across situations [6]. A discussion centered on pathophysiology, pathology, genetics, treatments, and clinical trials had been suggested by Shill HA et al. To collect data consistently for genetic, clinical, neurophysiological, and pathological studies, the paper advises adopting common data items. Patients should be adequately investigated in 2 order to get biopsies, characterize the course of the clinical condition, and achieve patient-centered results [5]. Scales and transducers can both detect changes in amplitude that are more than random variability due to the extreme magnitude of this variability. The identification of related actions and the detection of tremors are done through data analysis. The difference in movement frequency is used to identify tremors, and voluntary activities can also be identified. It aids medical professionals in determining how a particular action and a tremor are related. Cheraghizanjani et al. have proposed a study to help neurologists gauge and categorize the amount and range of tremors in some individuals with neurological disorders. A tremor testing apparatus was created and built [4].

Postural and rest tremors, two different forms of tremor conditions were covered in this essay. (Rest Tremor: 2 to 10 Hz; Postural Tremor: 4 to 10 Hz; Action Tremor: 10 Hz or greater.) The severity of rest, postural, and movement tremors was properly assessed using least-square-estimation models. The tremor evaluation approach also incorporated a time-frequency signal analysis algorithm for tremor state detection [2]. Anto Bennet et al. suggested using portable technology to continuously measure tremors throughout everyday activities. The module is made up of a smartphone, a remote server, and a smartwatch with a triaxial accelerometer. Several ET sufferers participated in a trial. The estimated average effective time for data collection for each patient was 26 (6.05) hours [1].

3 Proposed System

Influencing the international quality of life for millions of senior citizens. Due to the variability of the disease, PD symptoms might progress differently from one person to the next. Patients with Parkinson's disease may experience symptoms, primarily tremors

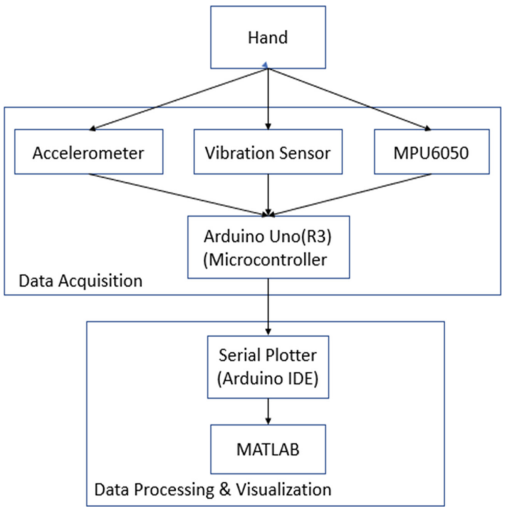

Fig. 1. Block diagram of the system

while at rest. Numerous tremors kinds can occur, including hand tremors, limb rigidity, and issues with walking and balance. Depression, sleep behavior issues, a loss of smell, and cognitive impairment are examples of non-motor symptoms. To detect Parkinson's disease (PD), a smart glove containing an accelerometer and vibration sensor is introduced. to identify resting tremors as the primary Parkinson's disease symptom. This technique allows us to identify the vibration's strength and categorize the disease's stage (Fig. 1).

3.1 Test Tasks and Compatible Parameters

Neurologists believe that some factors should be considered while determining the severity of the Parkinsonian tremor. The following parameters are acquired through sensors and shown in the GUI:

1. Parkinsonian tremor magnitude (R)
2. Parkinsonian tremor dominant frequency (F)

The primary frequency of a Parkinsonian tremor determines the size of the tremor (3.5–7.5 Hz) [1].

4 System Components

The components used in the System are:

- Arduino Uno
- Accelerometer
- MPU 6050
- Vibration Sensor
- Arduino IDE
- MATLAB

Fig. 2. Arduino Uno R3

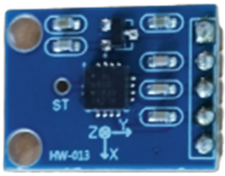

Fig. 3. Accelerometer(ADXL335)

Fig. 4. MPU 6050

4.1 Arduino Uno

Arduino Uno is a microcontroller board. It is a popular development board that is widely used for building digital devices and interactive projects. The Arduino Uno board has 14 digital I/O pins, six analog input pins, a USB connection, a power jack, and an ICSP header (Fig. 2).

4.2 Accelerometer

The ADXL335 is a three-axis sensor that measures acceleration along the 3-axes (Fig. 3).

4.3 MPU 6050

The MPU6050 sensor is a sensor that consists of both a 3-axis accelerometer and a 3-axis Gyroscope. It measures angular velocity and acceleration (Fig. 4).

4.4 Vibration Sensor

The vibration Sensor detects the back-and-forth motion of the body or object and gives the data of vibration (Fig. 5).

Fig. 5. Vibration Sensor

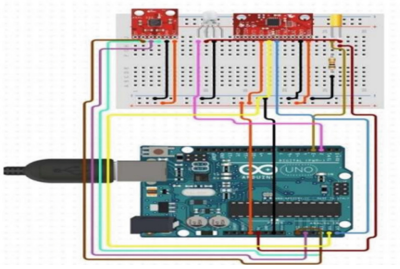

Fig. 6. Circuit Diagram

4.5 Arduino IDE

Arduino IDE software is used to program the development board in our case it is Arduino Uno. It has two output modules named serial monitor and serial plotter. A serial monitor is often used to observe the values or data whereas a serial plotter is for plotting the data in the graph.

4.6 Matlab

MATLAB software is used to process the obtained data and classify the frequencies. The PSD function is applied to the data to determine the range of frequency for resting tremors.

5 Circuit Construction

See Fig. 6.

6 Results

To detect the intensity of tremors in Parkinson's patients, a graph is plotted in a serial plotter and data is uploaded to MATLAB for processing. Applying the power Spectral Density function on obtained data from the patient, we got the intensity of the tremor. Based on the spikes the intensity of tremors can be determined. The blue graph represents the vibration of the fingers. The LED indicates the movement of the wrist (Figs. 7 and 8).

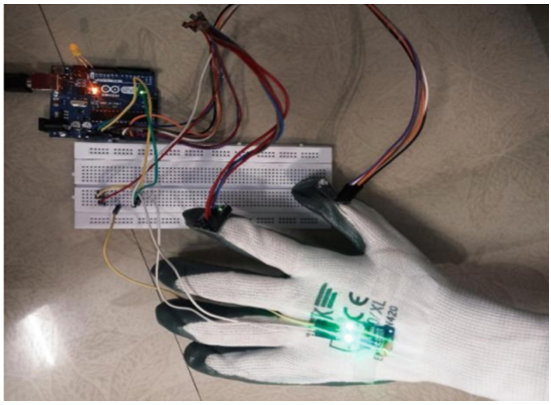

Fig. 7. Prototype

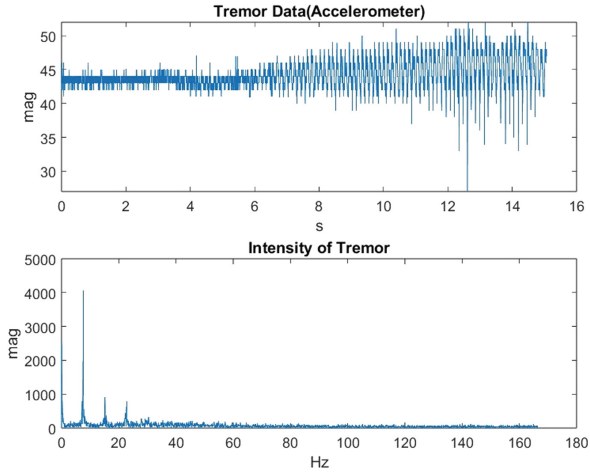

Fig. 8. Result of Proposed System

7 Conclusion

Detection of tremors using an accelerometer and vibration sensors is developed in this project. A better system to treat Parkinson's disease which can control the tremors and the rigidity in the body movements could be developed.

This project is very useful to the medical industry as it is a very practical and useful project.

References

1. Dr. AntoBennet, M, Sankaranarayanan S, SankarBabu G, " Performance & Analysis of Effective Iris Recognition System Using Independent Component Analysis", Journal of Chemical and Pharmaceutical Sciences 08(03): 571–576, August 2015.
2. Dr. AntoBennet, M, SankarBabu G, Natarajan S, "Reverse Room Techniques for Irreversible Data Hiding", Journal of Chemical and Pharmaceutical Sciences 08(03): 469–475, September 2015.
3. Houde Dai, Pengyue Zhang, 3 and Tim C. Lueth2, " Quantitative Assessment of Parkinsonian Tremor Based on an IMU" in Sensors 2015,15,25055–25071; doi:https://doi.org/10.3390/s151025055
4. Rodger J Elble, James McNames, "Using Portable Transducers to Measure Tremor Severity" 2016. Doi:https://doi.org/10.7916/D8DR2VCC.
5. Shill HA, Frosch MP, DeuschlG, "Knowledge gaps and research recommendations for essential tremor and Related Disorders", 2016. Pp.511, doi:https://doi.org/10.1016/j.parkreldis.2016.10.002.
6. aoch enZheng, Joaqu, "Detection and Analysis of Tremor Using a System Based on Smart Device and NoSQL Database" in the 6th IESM Conference, October 2015, Seville, Spain.
7. Swathy, LizyAbraham, "Vibration Monitoring Using MEMS Digital Accelerometer with ATmega and Lab VIEW Interface for Space Application" International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 5, July 2017.