ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)

Vol 7, Issue 3, March 2021

Self-Stablizizng Spoon for Parkinson's Patient & Old Aged People and Overall Tremor Detector for Recovery Monitoring

[1] Rudransh Pandey, [2] Simran Nair, [3] Diksha Raghunathan, [4] Samadrita Bhattacharjee

[1][2][3][4] B. Tech Biomedical Engineering VIT, Vellore, Tamil Nadu, India

Email: [1] rudransh.pandey2017@vitstudent.ac.in, [2] simran.nair2017@vitstudent.ac.in, [3] diksha.raghunathan2017@vitstudent.ac.in, [4] samadrita.2017@vitstudent.ac.in

***Abstract*-— Parkinson's disease, essential tremor, tremor due to age creates serious hindrance in performing daily activities like eating, holding, and any task related to grip. There are many devices in the market, which assist persons suffering from tremors by using various techniques. But all the devices are either very complex or very costly. Our aim is to do an extensive study of all possible devices helping patients suffering from tremors, in daily activities like eating, holding transporting mainly and design a low-cost assistive device that will help the patients to eat without any external help. Furthermore, we also propose some technology to extend the project to other activities like reading, buttoning shirts, holding a bowl, and other utensils. Hence, we are planning to design cost friendly and compatible device for the patients.**

***Index Terms*— Parkinson's, Stabilization, Spoon, Tremor**

I. INTRODUCTION

Parkinson's disease is a disorder which degenerates the neural functioning of the body affecting trunk and limbs resulting in slow body movements [1]. In our design we will try to cover up the major limitation and will try to make a washable, easy to hold, and use, strong, durable device at low cost. We will try to increase the range of vibration frequency that can be cancelled by the device thus making useful for many. It will be a smart system which reads and studies the patient's body movement and perform the required and necessary action accordingly which will also help in building the Patient's confidence [2]. The device design will include hardware components like Inertial Measurement Unit (IMU) – MPU6050, Arduino UNO, Servo Motor, battery, breadboard and connecting wires and Laptop screen to read the values. For the software part we are using Arduino uno interface, with processing done in MATLAB. Here we will also show the trend of change or improvement in the hand tremor, if the patient is going under any kinds of medication. These values can also be used to decide the amount of dose to be given to the patient for his stabilizing. In this examination, we researched the adequacy of different recurrence space and nonlinear boundaries to measure fundamental quake. The goal is to build up a prescient model dependent on a mix of refined straight (recurrence) and non-direct highlights got from the sensor signal which has not been recently investigated in the writing. Parkinson's illness is a developing worry in 21st century. It is the second most pervasive neurodegenerative problem after Alzheimer illness on the planet. Ongoing information from the World Health Organization shows that the quantity of patients with PD has stretched around 4 million out of 2009. An expected seven to 10 million individuals overall are living with Parkinson's infection as of now. Essential tremor is a neurological disorder that causes involuntary and rhythmic shaking specially in hands when doing regular tasks. Both the diseases have one thing in common which is tremors. These tremors disallow them to perform basic daily tasks like eating, writing & lifting.

II. COMPONENTS

Following are the various components required in the proposed device.

A. Hardware Components

Inertial Measurement Unit (IMU) an electronic device which measures and reports the specific acceleration and angular rate of a body. It Consists of gyroscopes (measures rotational position in reference to an arbitrary chosen coordinate system) and accelerometers (measures inertial acceleration). It is used to detect whether the object is in space or if its tilting. Arduino is an open-source microcontroller board consisting of both circuit board and programmable software piece [3]. It read inputs, through computer code and processing output can be implemented on the physical board. Servo motor is a very high precision in position feedback – can tell by how many degrees the motor shaft has rotated. The potentiometer which is connected to the output shaft which register every degree of rotation.

B. Software Components

The vibrations (tremors) is created on MATLAB platform, by immigrating the physiological vibratory signal using combination of standard signal like sinusoidal wave or pulses with desired frequency, the signal can be given as input to the circuit (designed using MATLAB). Output is studied to assess the performance of vibration canceller and depending on the output parameter, canceller circuit can be modified. And in future we will try for passive method for minute shock absorption.

III. METHODOLOGY

We have tried to achieve self-stabilization here using motorized systems to create a stable platform along with one planar axis. The servo is initially calibrated at 90 degrees and kept at a base level [4]. The MPU6050 motion sensor takes the value of roll and pitch using the embedded accelerometer and gyroscope. When the gyros are rotated about any of the sense axes, the Coriolis Effect is caused which leads to a vibration that is detected by a MEM inside MPU6050. This voltage is digitized using 16-bit ADC to sample the axis. This data is then converted into digital motion data by the Digital Motion
Processor embedded on our sensor module. Finally, these values are stored in the respective registers. Then, we use our micro-controller to access these registers and read the values from them. The values obtained from the respective registers of accelerometer and gyroscope are very noisy since gyroscope loses its angular velocity with time, therefore it doesn't give accurate measurement after a certain time while accelerometer is initially very noisy and give stable values after a certain point of time. Therefore, a Kalman filter has been used to filter out the noise in the values and give an optimal state of the hand position. The filtered values of roll and pitch are then written in the servo motor with an increment of 90 degrees. The reason being is explained in the motor configuration.

IV. FIGURES AND DIAGRAMS

Following are the figures and graphs obtained during our research work.

A. Block diagram:

Figure 1 displays the block diagram of our system. The microcontroller is powered via 5v supply. The MPU6050 motion sensor communicates with the microcontroller via I2C bus which is a bi directional bus consisting of two lines i.e. Serial Clock (SCL) and Serial Data (SDA). The SCL line is the clock line and the clock signal is generated by the Master Device i.e. Arduino Uno in our case. This line synchronizes the data transfer between the two devices. The SDA line is used for the data reading and writing to the slave i.e., MPU6050 in our case. The Digital Motion Processor (DMP) embedded on the MPU6050 processes the signal from the accelerometer and gyroscope and converts it into motion data and stores it into respective registers. Then we access these registers by our master to read the accelerometer and gyroscope values. These raw values are then converted into meaningful angles of yaw, pitch and roll in degrees by performing specific mathematical operation on this raw data by our microcontroller. These values are then fed into respective motor and suitable motion to achieve stabilization.

B. Circuit Diagram:

As we can see in *Figure 2*, the circuit consists of Inertial Measurement Unit (IMU) – MPU6050, Arduino UNO, and Servo Motor, battery, breadboard and connecting wires [5]. The configuration is done on the basis of the connectivity and the ease of approachability to the result.

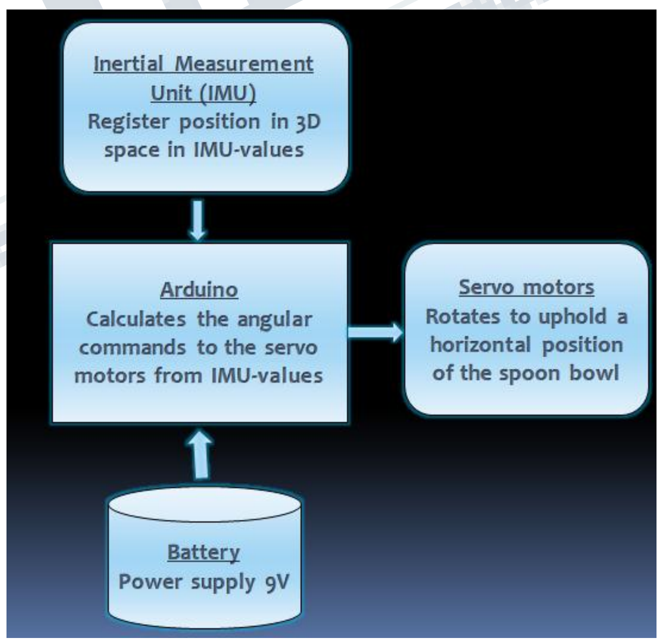

Fig. 1 Block diagram of the system

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)

Vol 7, Issue 3, March 2021

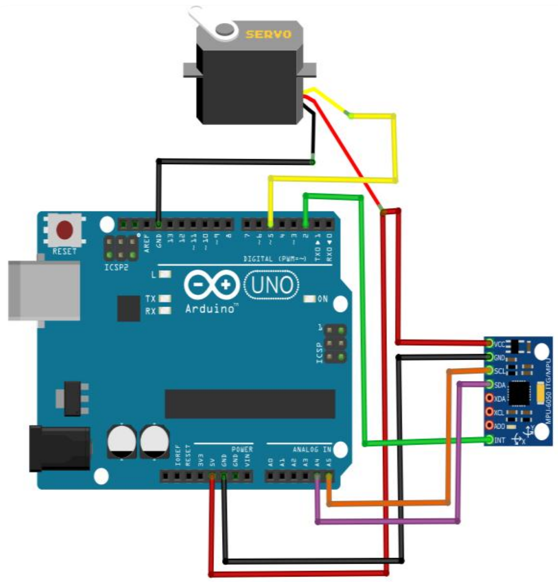

Fig. 2 Circuit diagram of the system

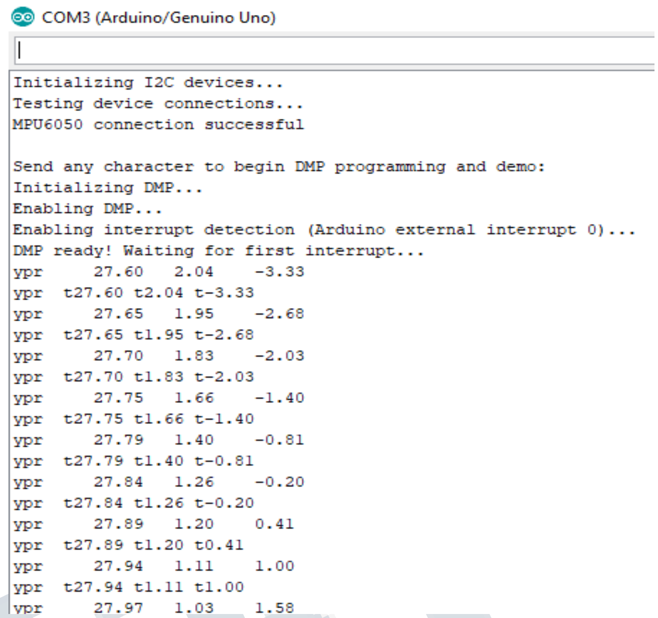

Fig.3 Output obtained on the serial monitor screen

C. Output:

Figure 3 displays the output obtained on the serial monitor. The following was obtained using the Tera term software. The baud rate was set at 115200 for faster data transmission and COM4 was selected as our Arduino UNO was connected to the COM4 port. The values of pitch and roll (in degrees) are being printed on the serial monitor in real time. The servo moves accordingly and the servo angles (in degrees) are printed on the serial monitor as well. As it's quite relevant from the values above, our motors are moving in exact opposite direction. One of the roll values in fig. is 20.16 degrees, which after filtering becomes 19.27 which means our hand rolls 19.27 degrees in x-z plane. So, our servo horn moves from 90 degrees (which was set to be ground level position parallel to the Y-axis initially) to 108 degrees, thereby making a net motion of 18 degrees towards the positive Z-axis. This stabilizes any roll motion generated due to the tremor.

D. Software Output:

As mentioned earlier, we used MATLAB software to create a raw signal in the form of tremor. Now using various filters, like Kalman and Butterworth, we removed the high frequencies as we can see in *Figure 4*. Now after removal of the high frequencies, we also removed the unwanted noise by applying in-built functions and hence getting a desired output as we can see in *Figure 5*. Now this is used to study the various methods to cancel out the unwanted tremor and het the opposite stabilizing motion for the device. After this a reverse filter is applied to the overall signal, to show the cancelling frequency which we need to apply to the device so that we can get an overall cancelling and stabilizing motion for the diseased person.

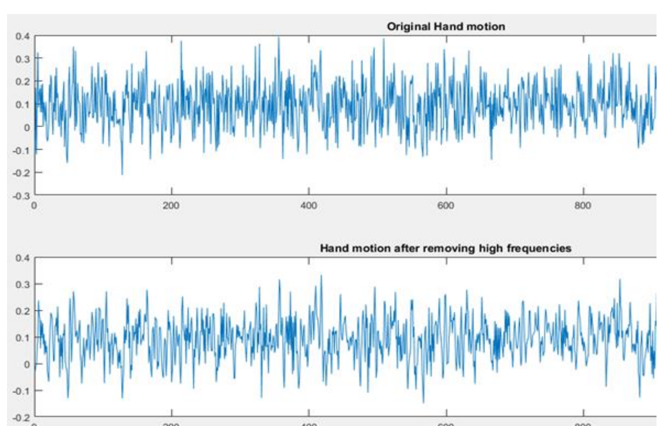

Fig. 4 MATLAB graphs for the original signal obtained and with the high frequencies removed.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)

Vol 7, Issue 3, March 2021

One the software platform, vibrations (tremors) would be provided to MATLAB, by immigrating the physiological vibratory signal using combination of standard signal like sinusoidal wave or pulses with desired frequency, the signal can be given as input to the circuit (designed using MATLAB). Output would be studied to assess the performance of vibration canceller and depending on the output parameter, canceller circuit can be modified and better results can be obtained.

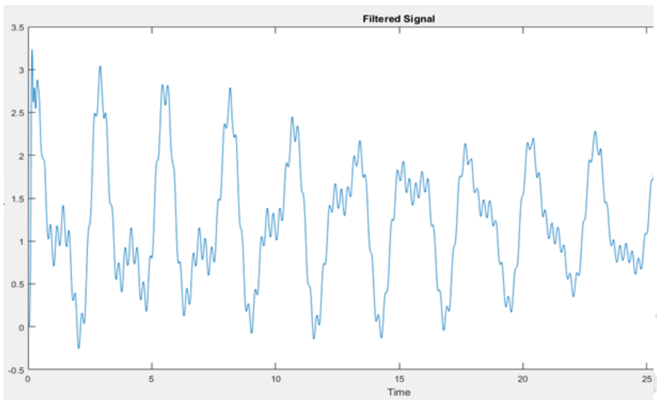

Fig. 5 Overall filtered signal using in-built Kalman filter and then feeding it to the monitoring system.

V. RESULTS

The result we got from our prototype was a stabilized spoon as shown in the respective figure. *Figure 6* shows the picture of our model spoon kept at base position. The model has been powered using the laptop, when the Arduino UNO is connected to it. The sensor and Arduino UNO (controller) have been mounted on the breadboard. The sensor reads 0 degree of roll and pitch at this position while the servo read 90 degrees each and positioned in a manner to keep the spoon flat.

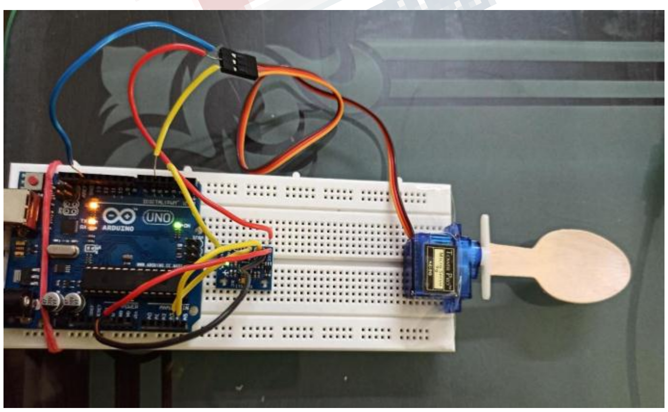

Fig. 6 The resulting prototype of the proposed spoon

The resulting working and the procedure can be seen in the video link uploaded on YouTube for further references. It is uploaded by one of the authors on their personal account. https://youtu.be/U2NFaVMVeg4.

As we can see in the working, the board (or the proposed handle of the spoon) when tilted towards a particular direction, the tip of the spoon tilts in exactly opposite direction and hence nullifying the motion in the handle of the spoon. For now, in this prototype, we have not used any costly or high-quality parts, but still, it works very accurately.

With the MATLAB results we obtain we can clearly monitor the overall activity of the diseased person. We can monitor the improvement and dosage of the medicine given to him each day based on the hand tremor obtained. It will also help the doctor and the patient to be in the house and check for the patient and take care of him/her sitting remotely. This is the main reason we can also include IoT based software in future.

VI. FUTURE WORK

Following will be the strategies used in the future to make our product popular and more available for the masses.

A. Market Strategy:

We are planning to use thermosetting plastics which can be used to design any required shapes. Use of plastic will be a good insulator and will prevent rusting due to moisture thus increasing the longevity of the device. As the spoon is disposable and can be changed there is no need to buy special spoons along with the device as in the case of already existing devices. In existing devices five types of spoon have to be bought along with the device, but here the existing wooden spoons can be used easily, thus making the cost half.

B. Disinfectant Packing:

Ultraviolet ray box can be designed to disinfect the device for preventing the spread of any germs. Using UV rays will avoid moisture or leakage of water into the device giving it a long life. It will effectively disinfect the device and can be rubbed with a cloth before the next use. The UV box will be a case inside which the device will reside. UV emitting sensors will be embedded in it. The controlling switch will be on the outer surface. One pressed the UV rays emitted will disinfect the device effectively.

C. Marketing Places:

In nursing home these devices can be easily used where a large number of patients suffering from tremors and PD needs to be cared for. A better life can be given to the old peoples at home so that they can enjoy their meal without any other help.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)

Vol 7, Issue 3, March 2021

Stay in the hospital can be made easier by using such assistive spoons. Tremors are not only a problem of Parkinson and ET. It can be temporary problems in many due to muscle weakness, operation, neurological disorder, medication, and many more. Almost all people after an age suffer from the problem of decreased hand control and tremors. Thus, such devices will be having a great demand ahead.

VII. CONCLUSION

It can be concluded that the self-stabilizing technology used for auto-leveling in quad-copters and airplanes can be easily used to create health care products like self-leveling spoon which counters the tremors and let the patients enjoy their meal without any worry of spilling. Now, such spoons have been available in market and are manufactured by two companies i.e., Gyenno and Liftware but both of them are priced around 35,000 in Indian Rupees which makes them quite unaffordable for most of the Indian patients. Our goal was to achieve a similar performance at a quite low price of just 1,000 Indian Rupees.

REFERENCES

[1] Franklin Parrales Bravo, Alberto A. Del Barrio Garcia, Mercedes Gallego de la Sacristana, Lydia Lopez Manzanares, Jose Vivancos and Jose Luis Ayala Rodrigo. Support system to improve reading activity in Parkinson's disease and essential tremor patients. Published: 3 May 2017

[2] Sreekanth Rudraraju and The Nguyen. Wearable Tremor Reduction Device (TRD) for human hands and arms. Published: 14 June 2018

[3] Anupam Pathak, John A. Redmond, Michael Allen and Kelvin L. Chou. A non-invasive handheld assistive device accommodate essential tremor. Published: 27 Dec 2013

[4] Erika Rovini, Carlo Maremmani and Filippo Cavallo. How wearable sensors can support Parkinson's diagnosis and treatment: A systematic Review. 6 Oct 2017

[5] Johan Abrahamsson and Johan Danmo. The stabilizing spoon. Published: Sweden 2017