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SELF STABILISING UTENSIL FOR PATIENTS WITH IMPAIRED MOTOR SKILLS

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Abstract - Nowadays, there is a substantial increase in the number of people getting affected by Parkinson's Disease. The degradations of motor skills severely affect the daily activities of patients such as eating, writing, dressing, etc. This project basically proposes a non-invasive device that helps the patient to eat and perform day to day chores independently using the given attachments. This device consists of Arduino which directs the two stepper motor to cancel the tremors detected by the Inertial Measurement Unit (MPU6050) containing 3 axis gyroscope and 3 axis accelerometer which senses these tremors.

Keywords—parkinson, tremors, stabilising spoon, patient, gyroscope, accelerometer, Arduino, active cancellation, neuromuscular disorders, degenerative, impaired motor skills

I. INTRODUCTION

If you hold your hand in front of you and if you try to keep it steady you will notice something known as “tremor” which is common to happen unless you are a surgeon. These slight tremors are harmless. but there are many deadly diseases like Parkinson's and various neurological disorders where these tremors are so high that he/she is not even capable of doing daily chores such as eating, cleaning, combing which limits their independence.

They will also have deep-rooted psychological issues. As a result, people get ashamed because they fail to do simple things causing that individual to avoid all types of social gatherings etc thereby reducing the quality of life.

In this project, we are trying to help people afflicted with diseases such as Parkinson's and other neurological disorders be as independent as possible. We have come up with a self-stabilizing utensil that will counteract i.e. cancel these tremors. This device will effectively reduce unintended motions like tremors to a bare minimum.

We have used a microcontroller and servo motors to do the needful. Using these tremor compensating devices, people can execute some day-to-day tasks. With the help of our device, a person can eat independently, or use drill bits such as a screwdriver to do simple things and would not require help from others.

II. PROBLEM ANALYSIS

Parkinson's symptoms usually begin gradually and get worse over time. As the disease progresses, people may have difficulty walking and talking. They may also have mental and behavioral changes, sleep problems, depression, memory difficulties, and fatigue.

Both men and women can have Parkinson's disease. However, the disease affects about 50 percent more men than women. So, the chance of occurrence of this disease is more likely for men compared to women.

One clear risk factor for Parkinson's is age. Although most people with Parkinson's first develop the disease at about age 60, about 5 to 10 percent of people with Parkinson's have "early-onset" disease, which begins before the age of 50. Early-onset forms of Parkinson's are often, but not always, inherited, and some forms have been linked to specific gene mutations.

For many decades, doctors couldn't treat Parkinson's disease effectively, and thought it was a terminal illness. The drugs used to treat the symptoms of tremor in the late

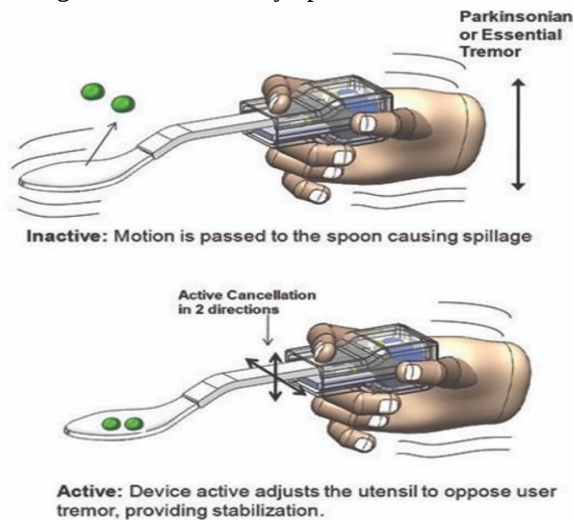


Fig 1: Principle of working

1800s included arsenic, morphine, hemlock, and cannabis, according to Chrisopher Goetz's review published in September 2011 in Cold Spring Harbor Perspectives in Medicine.

Today, most Parkinson's disease patients are first treated with Sinemet, a combination of levodopa and carbidopa; the drug combination can reduce some of levodopa's side effects. These therapies are usually effective for 5 to 10 years, but eventually stop working and lead to adverse effects such as involuntary movements and tics (dyskinesia).

Though these medicines were highly used at that point of time it still contained substances which would numb the tremors but could cause major side-effects at later stages of life. People needed a solution which did not require tablets to be ingested. In other words, we noticed a dire need for a non-invasive solution to fight against such diseases.

III. PRINCIPAL OF WORKING

Our solution Is a Self-stabilizing Utensil/tool That Counteracts Hand tremors. This is a Non-invasive, Assistive and rechargeable Device which includes a holding bar, Rechargeable Battery, And many Attachments like

A Soup Spoon, Everyday Spoon, fork, screwdriver extensions, IMU (Inertial measurement unit) placed in The Handle Act as A Sensing Mechanism. (Active Cancellation Of Tremor Technology) It also includes FSR (force sensing resistor) which changes its resistance when a force or pressure is applied. FSR detects the Direction of Tremor And Moves Utensil In The Opposite Direction.

As the spoon is portable and quite light, It can be used in Diners, at Social events, As Well As At Home. The Rechargeable Battery Can Run approximately For 3 hours.

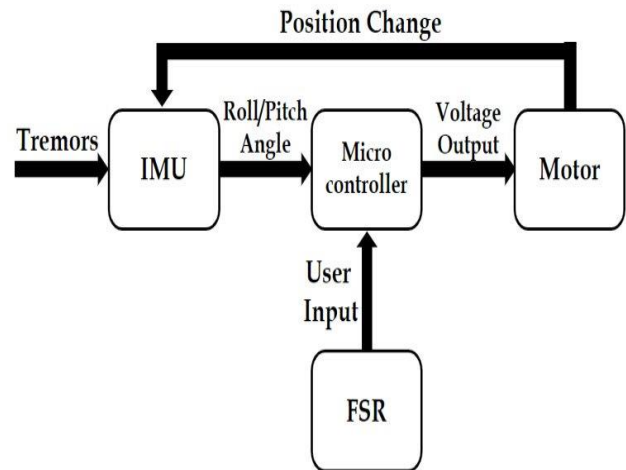


Fig 2: Block Diagram of the device

IV. METHODOLOGY

A. Components

- Arduino Nano is a friendly board that is small, complete and breadboard with dimensions 45x17mm and its thickness is approximately 10mm with pins attached. This breadboard is based on ATmega 328 microchip and it is equipped with fourteen digital pins and eight analog pins also among that six are PWM enabled.

Programming this Arduino board is done with the help of Arduino IDE where a mini-USB port is used for programming purposes as well as a power source. It supports both types of communications, that is I2C and SPI communication.

- MPU-6050 is the IMU unit used in our device for Motion Tracking. This combines both 3-axis gyroscope and 3-axis accelerometer on a silicon die and with an onboard Digital Motion Processor which processes complex 6-axis motion fusion algorithms.

It has an auxiliary I2C master bus which gives access to external magnetometers or some sensors. MPU-6050 has analog to digital converters which are 16-bit and three in number for digitizing both the outputs of the gyroscope and accelerometer. It enables tracking of fast and slow motions precisely by allowing user-programmable gyroscopes and accelerometers.

- Micro 9g servo FS90 is the servo motor used in our device to balance and stabilize as it is one of the powerful and small motors. It provides approximately 0.127Nm of torque as output and can rotate about 180 degrees. This motor has only three pins where one pin is for input voltage, another pin for signals, and the last one for electric ground.

The operating voltage range for this motor is 4.8V - 6V, so it gives a good torque output of 1.5Kg cm as higher torque can be achieved if the voltage is higher, so it is chosen to be used in a variety of projects. Since this servo motor has a universal S-type connector, it fits almost all kinds of receivers.

- A 9V battery for power supply, some connecting wires, and a breadboard.

V. HARDWARE IMPLEMENTATION

The 9V battery supplies the operating voltage to the device, so the voltage, which is Vcc pin of Arduino, MPU6050 and Servo motor are connected to the positive terminal of the battery. Similarly the ground, which is the GND pin of Arduino, MPU6050 and Servo motor are connected to the negative terminal of the battery.

Table 1. shows the connections between the Arduino Nano microcontroller and the IMU unit that is MPU6050. Table 2. shows the connections between Arduino Nano and the two servo motors.

A. Working of Device

During the normal situation, stabilising a spoon will work like any other ordinary spoon and won't interfere in day to day chores but the moment the FSR detects force or

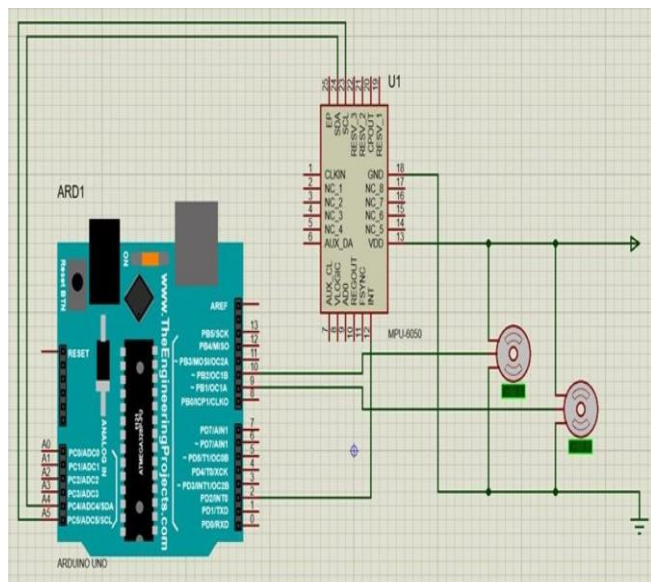


Fig 3: Circuit diagram

TABLE 1. CONNECTION BETWEEN ARDUINO NANO AND MPU6050

Arduino		MPU6050	
Pins	Function	Pins	Function
A4	Serial Data line that supports I2C communication	SDA	I2C Clock pin where Master Bus supplies the timing signal
A5	Serial Clock line that supports I2C protocol	SCL	I2C Data pin where this line receives as well as transmits
Pin 2	External Interrupt pin which can configured to trigger an interrupt	INT	The Interrupt Output which can be programmed to raise interrupt

pressure it sends a signal to activate IMU (MPU6050) which determines the magnitude of angle and whether it is Roll or Pitch angle.

Then the readings will go to the Arduino Nano console where input and output pins are connected which will in turn send directions to the motor to rotate according to the phase of angle. The spoon cannot cancel the full effect of tremor but it can reduce the effect by 70% which is quite helpful for the patient.

fig (5) demonstrates the 3-D model of our device in which we can see that all the mechanical parts are combined and encapsulated in a cylindrical container to make the device compact. So, when observed from left to right first is

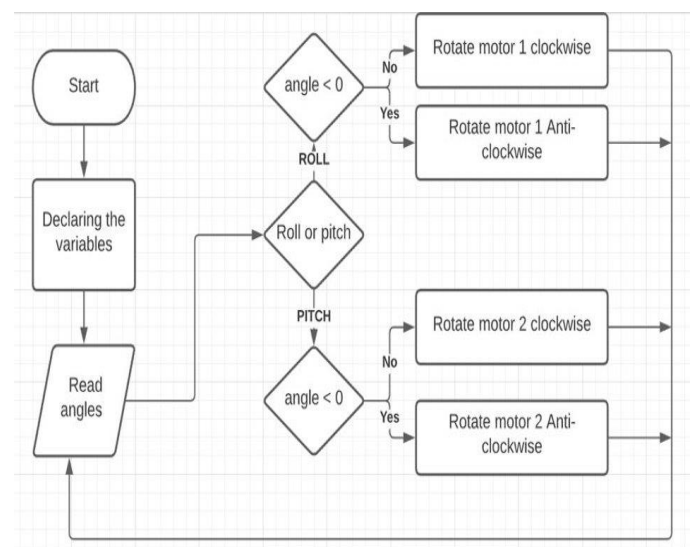


Fig 4: Flowchart of code

TABLE 2. CONNECTION BETWEEN ARDUINO NANO AND SERVO MOTOR

Arduino		Servo Motor	
Pins	Function	Pins/Wires	Function
Pin 9	Digital I / O Pin.	Signal	Signal is given through this to drive the motor 1
Pin 10	Digital I / O Pin	Signal	Signal is given through this to drive the motor 2

MPU6050 which is connected to the Arduino Nano towards the right. At the end is the 9V battery connected which supplies power to our device. One motor is towards the left of MPU6050, counteracts one direction and another motor which is visible outside the device counteracts the direction perpendicular to the first one.

In fig (6) 3D models of attachments are shown. These Attachments are detachable. It contains a soup spoon, fork, pen and screwdriver etc. In other words, all the handheld devices.

VI. SOFTWARE IMPLEMENTATION

figure (4) shows flowchart of code which we used for arduino interfacing. So initially we declared the variables and read angles (detected by IMU in hardware) and applied an if condition to determine whether the tremor angle is a roll or pitch. Depending on the angle whether it is positive or negative the Arduino microcontroller directs the motor in respective directions (clockwise/anticlockwise)

The spoon is intended to have two degrees of freedom, rotational movement around the x-axis, roll, and rotational movement around the y-axis, pitch. The z-axis which is orthogonal both to the x- and y-axis, will have no motor for counteracting motion since two degrees of freedom will be satisfying enough for this project.

If the angle is Roll (horizontal direction) motor 1 will rotate whereas if the angle is pitch (vertical direction) motor 2 will rotate to cancel the effect of the tremors.

VII. RESULT AND OBSERVATION

In the (fig 7), observe the two servo motors' position is stationary. The IMU will read the tremors and Arduino will counteract these tremors by changing the position of motors.

In the (fig 8), the motor position is changed, and notice the reading before and after which is displayed below

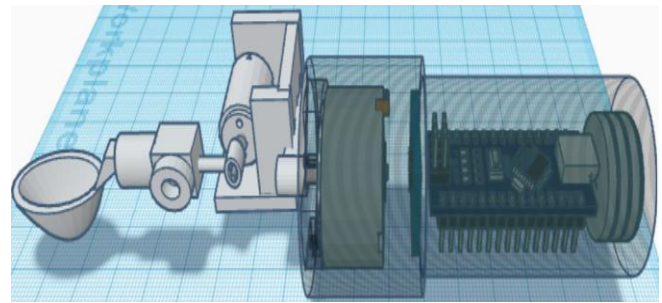


Fig 5: 3D model of spoon

the motor. The two motors counteract each direction movement i.e motor 1 counteracts Y-direction tremors and motor 2 counteracts X-direction tremors. There by it restores balance.

VIII. FUTURE SCOPE

We believe we have room for improvement and that would be to design a more sensitive and one-time-calibrated device with minimum intervention by medical specialists. Our model is a very specific approach for tackling the problem. We can have a more generalized approach to tackle the problem addressed, to name a few we can have self stabilizing gloves where one can perform all the action with his/her hands. We can also have a self-stabilizing pen, vest, or walking stick. This will be a ray of hope for people suffering from Parkinson's and other similar diseases. All of these use the same technology, with an extension from the design.

A. Improvements in the existing device

Also an IMU occasionally presents values that are incoherent and vary unreasonably to one another. To get proper values, i.e. clear values, a filter is needed. A complementary filter consists of one low pass filter and one high pass filter. We can also use high speed servo motors for better accuracy.

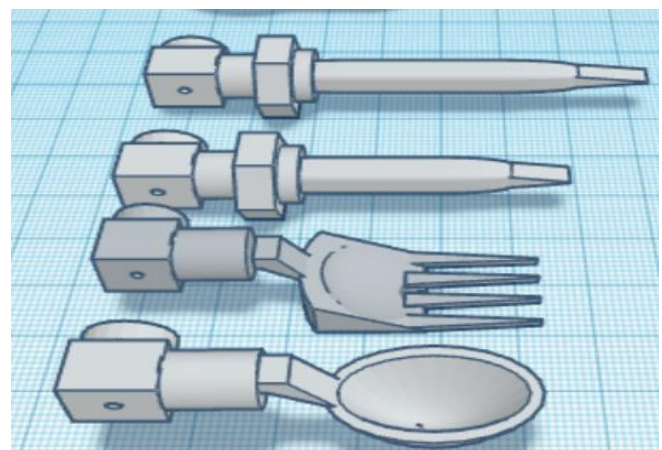


Fig 6: 3D model of attachments

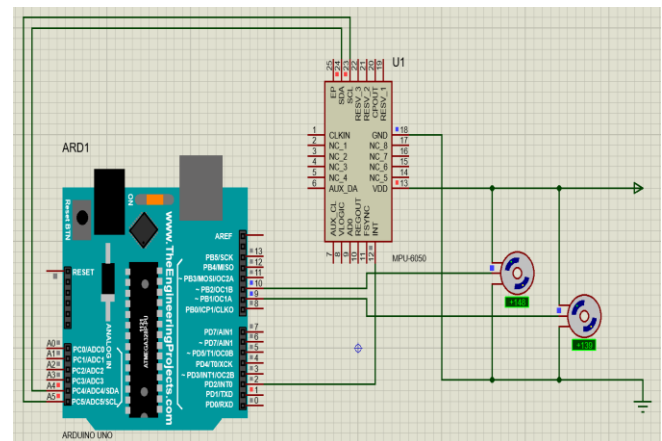


Fig 8: Simulation output after MPU6050 readings



many tasks. So, users can use them happily without worrying about its longevity and finish their work and tasks with ease.

Users will have a social boost as they used to feel seclusion and social anxiety as their impaired motor skills, tremors used to make them unable to do their basic tasks. Hence they will have both a moral and social boost and become more socially active.

Our solution can make them socially active and prevent them from being isolated, so we believe this technology helps to mitigate their isolation. Since our solution helps them with their everyday chores they need not worry about awkwardness.

The designed utensil model is easy to handle as well as safe. This designed model has pretty tough resistance for breakage, flexible to use. Also it's easily washable and no worries about leakage of water on components as the design takes care of these. The detachable technique is simple and can be done whenever required.

B. Disadvantages

Some of the users who are under continuous monitoring like patients who have pacemaker or other medical electronic device implants need to use this utensil with care. Since, the self stabilizing utensil has small magnets which have magnetic strength similar to the magnetic strength of ordinary household magnets. These magnetic strength may influence the working of implants so its better to hold the utensil far as possible.

The Self stabilizing utensil is designed to handle moderate essential tremors. If the user experiences severe tremors then the utensil's performance in stabilizing may not be that effective. In case of severe tremors, recognizing them might be not so efficient. Thus balancing or stabilizing effects may not be so influential and users might experience the effects of tremors on objects held in hand.

X. APPLICATIONS

Self-Stabilizing utensil are mainly used by people suffering from impaired motor skills and also patients suffering from hand tremors due to Parkinson's disease. The optional attachments offered, helps to use different attachments during different situations and it follows an easy detaching technique.

Users can use this utensil while eating, as an effect of hand tremors leads to spilling of food. So this can be avoided, and users can peacefully enjoy their food without worrying about spillage. A regular spoon as well as soup spoon are available as attachments. So while having soups, a soup spoon can be easily attached and used, similarly while eating a normal spoon can be used.

Users can also make use of the fork attachment while eating, like while having fruits, salads, noodles, etc. They can easily attach the fork and use it whenever required.

Users can make use of the self-stabilizing utensil even while writing. The pen attachment feature extends the application to writing, drawing, etc. Users can also write or draw or do tasks using this pen attachment.

Another attachment extension is screwdriver, users can also make use of this attachment while doing tasks using drill bits.

XI. CONCLUSION

The self-stabilizing utensil as observed from the previous section gave good performance thus it is satisfying the needs. It recognizes essential tremors and counteracts to stabilize the tremor action.

The device was designed with a cylindrical handle that fits most adult people's hands and it is also lightweight and easy to handle. The attachment options offered also add to advantages as they are simple to detach and use as well as helpful to perform basic tasks, like while eating they can use it as a spoon, fork, or while writing they can use it as a pen and in similar situations it is helpful for them.

This concludes that The Self-Stabilizing Utensil can be utilized by people with impaired motor skills, to a certain extent, which contributes for betterment of their life.

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