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Spoonie: Self-Stabilizing Feeding Spoon for Tremored Hands

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Abstract—

People with Parkinson's disease, the elderly, and infants who have trouble holding their hands steady while eating might benefit from the Spoonie, a self-stabilizing feeding spoon. The spoon's one-of-a-kind design ensures that the head stays put, eliminating the need to worry about shakiness or other undesirable motions that might ruin an otherwise elegant feeding experience. An accelerometer sends real-time data to a microprocessor, which in turn regulates servo motors to keep the spoon head from moving around unexpectedly or shaking the user's hand. Users' quality of life is enhanced since they can self-feed with this spoon. A game-changer in assistive technology, the self-stabilizing spoon allows persons with motor control impairments to tackle real-life problems with ease. In order to make the gadget more tailored to each user's requirements, future improvements might include adjusting the settings for various levels of stability.

Independent Eating, Motor Disabilities, Tremor Control, Self-Stabilizing, Assistive Technology.

INTRODUCTION

Most persons with motor skill deficits have trouble eating, and those with tremors from conditions like Parkinson's also have a harder time eating [1]. These impact their mental and physical well-being in addition to disrupting mealtimes. A few number of methods exist for reducing the severity of these tremors[2], and the vast majority of them involve the assistance of other people or the use of specialized tools that are ineffective. To help individuals with tremors eat independently, we came up with Spoonie, a self-stabilizing feeding spoon [3]. To make eating more pleasant and less messy, Spoonie employs an accelerometer to record information on involuntary hand movements[4] and servo motors to continuously maintain the spoon head. This article details the process of creating and testing Spoonie, with an emphasis on the device's ergonomic characteristics and technical design elements [5], as well as user input. People with motor limitations may eat independently with the help of the Spoonie, a simple and effective device that improves their quality of life.

METHODOLOGY

There are a number of precautions taken during development of the Spoonie to guarantee that it can securely grip the spoon head, making it useful for users with tremors or shaky hands. This is one way to present the methodology: Selected Components (A) Finding the right parts is the first thing to do while making Spoonie. Since accurately detecting angular motion is crucial for stabilizing the spoon, the MPU6050 accelerometer[6] has been used for this prototype development. The Arduino Nano microcontroller receives data on the spoon's orientation and movement in real-time from the sensor. To counteract the motion induced by tremors, the chosen SG90 servo motors were accurate and quick enough to allow for rapid modifications to the spoon's position.

TABLE 1: THE OPERATION TABLE OF ACCELEROMETER FOR THE DESIGNED SPOON[7]

Parameter	Configuration Option	Sensitivity	Resolution (per LSB)	Application in Spoonie
Accelerometer	±2g	16,384 LSB/g	0.000061 m/s²	Suitable for users with minor tremors
Accelerometer	±4g	8,192 LSB/g	0.000122 m/s²	Ideal for general use.
Accelerometer	±8g	4,096 LSB/g	0.000244 m/s²	Suitable for pronounced movements
Accelerometer	±16g	2,048 LSB/g	0.000488 m/s²	Suitable for severe tremors
Gyroscope	±250°/s	131 LSB/°/s	0.00763 °/s	For detecting slow, precise movements
Gyroscope	±500°/s	65.5 LSB/°/s	0.0153 °/s	Suitable for moderate hand rotations
Gyroscope	±1000°/s	32.8 LSB/°/s	0.0305 °/s	Detects faster hand movements
Gyroscope	±2000°/s	16.4 LSB/°/s	0.061 °/s	Best for very rapid hand movements

Control System Design

A microcontroller is the brains of the control system, which runs the whole operation. To change the spoon head's angle, the microcontroller receives data from the MPU6050 accelerometer and interprets them in real time before sending commands to the servo motors [8]. The control system's algorithm is quick and flexible enough to allow the spoon level to stay in that motion. The goal of the testing was to find an algorithm with a good balance of responsiveness and non-jerkiness, with minimal abrupt changes that might disrupt the user's flow.

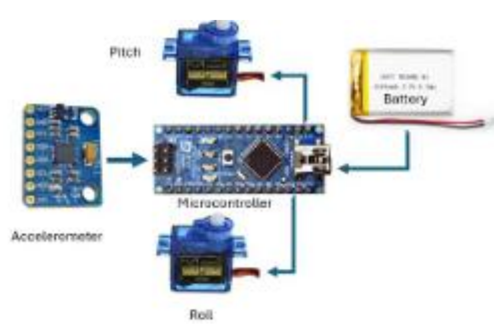

Fig. 1: Schematic Diagram of the Self-stabilized spoon

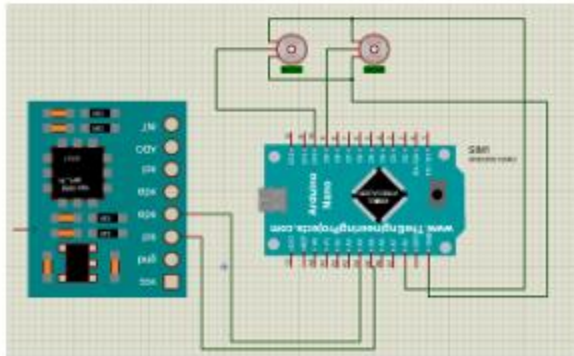

Fig. 2: Connection Diagram of the Self-stabilized spoon

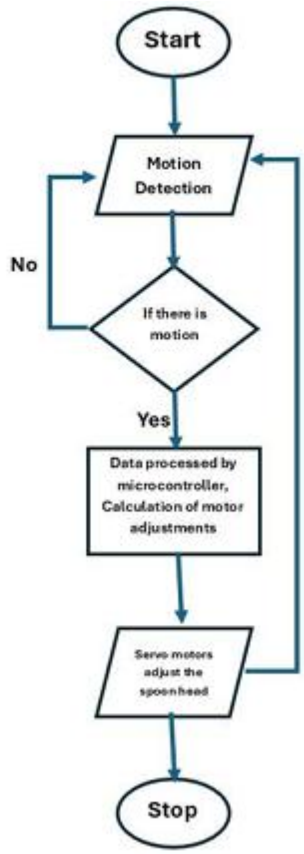

Fig. 3: Flow Chart of the Self-stabilized spoon

Structure and Ergonomic Design (C) Because of its ergonomic design, Spoonie is user-friendly for all ages, including kids and the elderly. An ergonomic design philosophy went into making this spoon's handle, so it's quite comfortable to hold and uses with very little effort. In order to keep it from becoming cumbersome, but small enough to be used on a regular basis, lightweight materials with high strength were chosen. D. Verification and Adjustment There is no scenario that Spoonie has not been tested against. Several users with varying degrees of tremors participated in the testing phase. The purpose is to guarantee the device's efficacy. The system has been calibrated to ensure that it responds appropriately to different hand movement scenarios, and that the spoon remains still in every case [9]. The stabilizing system's sensitivity and reaction time are fine-tuned based on user input. E. Feedback and the User Interface The device's settings may be easily adjusted by users or caregivers with the help of a straightforward user interface. Because of these features, Spoonie can adjust to the specific demands of each user, including adjustments for the sensitivity of the spoon to varying degrees of tremors [10]. To further reassure customers, the spoon has an integrated feedback system that sends either visual or audible indications while it is actively stabilizing. F. Last Touches and Optimization Assembling the parts into a unified whole is the final step in development. In order to ensure that all parts are ergonomically sound and do not compromise the spoon's performance, we will optimize its design[11, 12]. Stability and dependability during prolonged usage can only be achieved with further firmware fine-tuning.

RESULT ANALYSIS

Specifics of the Spoon's model: The system's components include an accelerometer (MPU6050), two servo motors (one for pitch and one for roll), and an Arduino Nano. When fed real-time angle data from the MPU6050, Proteus 8 Professional's simulation mimics the action of a spoon stabilizer. The spoon maintains its equilibrium position even when held tilted because the Arduino Nano interprets the angle inputs from the MPU6050 and assigns them to the appropriate servo settings. The position of the pitch servo motor is set within the range of -49° to 49°, and the roll servo motor is adjusted within the range of -59° to 55°. While the Arduino Nano's internal voltage regulator outputs close to 5V, the servo motors and MPU6050 use their own regulated power supply. The battery powering the Arduino Nano is 7.4V lithium. Input and output voltages, as well as graphical representations of the servo motions they generate, are some of the sophisticated capabilities of Proteus that allow for the measurement of electrical activity. In order to ensure that the servo is accurate when used in the spoon situation, this simulation is useful. Process Management:

TABLE 2: THE OPERATION TABLE FOR THE DESIGNED SPOON

State	Pitch Angle (X)	Roll Angle (Y)	Pitch Servo Position	Roll Servo Position	Input Voltage (V)	Output to Servos (V)	MPU 6050 Voltage (V)	Remarks
Neutral (Level)	0°	0°	90 (± Offset)	90 (± Offset)	7.4 V from battery	5V	5V	Spoon is stable
Tilt Forward	Positive (0° to 49°)	0°	Map to [25, 155]	90 (± Offset)	7.4 V from battery	5V	5V	Spoon tilts forward
Tilt Backward	Negative (0° to -49°)	0°	Map to [25, 155]	90 (± Offset)	7.4 V from battery	5V	5V	Spoon tilts backward
Tilt Left	0°	Negative (0° to -59°)	90 (± Offset)	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts to the left
Tilt Right	0°	Positive (0° to 55°)	90 (± Offset)	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts to the right
Forward-Left Tilt	Positive (0° to 49°)	Negative (0° to -59°)	Map to [25, 155]	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts forward-left
Forward-Right Tilt	Positive (0° to 49°)	Positive (0° to 55°)	Map to [25, 155]	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts forward-right
Backward-Left Tilt	Negative (0° to -49°)	Negative (0° to -59°)	Map to [25, 155]	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts backward-left
Backward-Right Tilt	Negative (0° to -49°)	Positive (0° to 55°)	Map to [25, 155]	Map to [40, 120]	7.4 V from battery	5V	5V	Spoon tilts backward-right

TABLE 3: TABLE OF SERVO MOTOR CALIBRATION

Pitch Angle (°)	Pitch Servo Position	Roll Angle (°)	Roll Servo Position
-49	155	-59	120
-40	141	-50	112
-30	126	-40	104
-20	111	-30	96
-10	97	-20	88
0	90	0	80
10	83	10	72
20	69	20	64
30	54	30	56
40	39	40	48
49	25	55	40

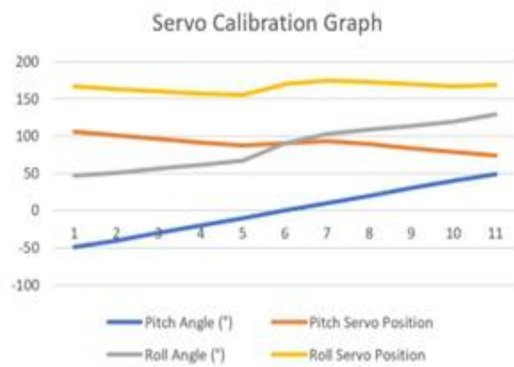

Fig. 4: Graphical Plot of the servo motor calibration C. Effective Stabilization:

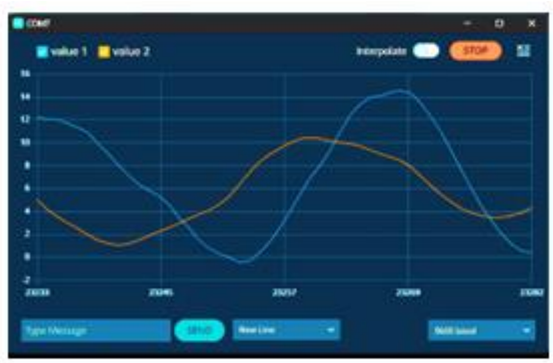

Fig. 5: Graphical Plot of the servo motor movements

Figure 5 shows a graph showing the behavior of the pitch and roll servos over time. The blue line in Figure 5 represents Value 1. Here you may get the pitch servo motor's value. You may use this to make the spoon's up-and-down action easier. Pitch servo motor pitching to stabilize user's hand tremors is shown by the oscillating line. Value 2: The servo motor that enables the spoon to roll, or move laterally, is shown by the orange line in Figure 5. This line's oscillatory movement indicates that the roll servo motor is constantly adjusting to maintain the spoon's level as the user changes their hand motions. The user's independence and quality of life were enhanced since they could feed themselves without assistance. D. Adjustable Parameters: People with varying needs were able to find the optimal level of stability by adjusting the parameters of the workflow algorithm.

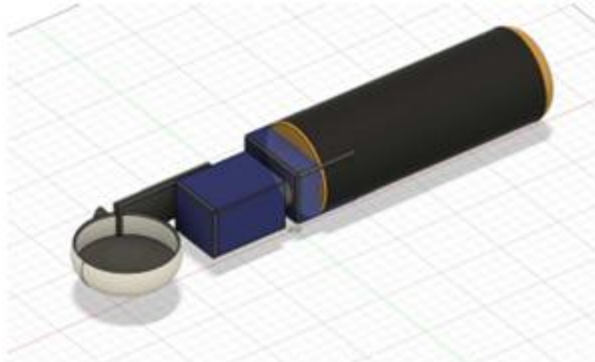

Fig. 6: Final 3D structure of the prototype

Fig. 7: Developed Prototype Presentation

CONCLUSIONS

By offering a practical answer to a widespread issue, Spoonie signifies a significant advancement in assistive technology. The involuntary trembling of the hands that may be a nuisance while eating for infants, the elderly, and those with Parkinson's disease. Spoonie literally stabilizes the spoon head using real-time data from an accelerometer and powerful servo motion control. This allows users to feed themselves without any reliance. This breakthrough paves the path for other innovations in adaptable kitchenware and improves the lives of those who use them. One of the gadgets that will help people with motor skill challenges live independently is Spoonie, which has the potential to grow even better in the future with features like enhanced customization and the ability to attach to different eating utensils.

FUTURE SCOPES

Depending on real-time input, users will be able to fine-tune Spoonie's stabilizing settings in later and more advanced versions. As time goes on, adaptive algorithms understand each user's unique tremor patterns and tailor their experience accordingly. Users might have a smooth experience with Spoonie by integrating it with current smart home systems. To create an even more accommodating eating space, it can communicate with smart dining tables and other assistive gadgets. This would greatly improve the user's comfort and convenience while eating. An full variety of self-stabilizing tools might be developed using Spoonie's core technology, including forks, knives, and writing implements. This would provide those with motor control impairments the ability to live independently.

REFERENCES

[1]. V. V. Pattankar, B. Y. Sikhara Sai, D. Muzammil And H. Ahamed S, "Parkinson's Disease Detection & Self-Stabilizing Spoon With Health Analysis", 2023 International Conference On Computational Intelligence For Information, Security And Communication Applications (Ciisca), Bengaluru, India, 2023, Pp. 126-131.

[2]. A. Jackson, "Aids For Activities Of Daily Living In People With Parkinson's Disease"(2019), British Journal Of Community Nursing, 24(5), 229-232.

[3]. J. Abrahamsson, & J. Danmo, (2017), "The Stabilizing Spoon: Self-Stabilizing Utensil To Help People With Impaired Motor Skills", Medicine, Engineering.

[4]. Z. M. Ripin, P. Y. Chan And I. Alisah, "Preliminary Evaluation Of Active Tremor Cancellation Spoon For Patients With Hand Tremor", Iop Conference Series: Materials Science And Engineering, Vol. 815, No. 1, 2020.

[5]. W. Ren, Q Qiao, K Nie, Y Mao, "Robust Dobc For Stabilization Loop Of A Two-Axes Gimbal System", Ieee Access, Vol. 7, Pp. 110554-110562, 2019.

[6]. D. Chowdhury, S. Sahu, & M. Chattopadhyay, (2016), "Development Of Mems Accelerometer Based Hand Tremor Stabilization Platform", Int. J. Biotechnol Biomed Sci, 2(2), 142 145.

[7]. Invensense.Com(2015).Mpu6050 Datasheet.Url: Https://Www.Invensense.Com/Products/Motion-Tracking/6 Axis/Mpu-6050/ (Accessed On January 25, 2024).

[8]. A. S. Adhavi Shri, S. Kumar, T. Aravind, "Design Of Mems Gyroscope To Detect And Monitor Parkinson's Disease-A Study. In International Conference On Smart Structures And Systems ", Engineering, Medicine, International Conference On Smart Structures And Systems - Icsss'13. (2013, March). Icsss'13 (Pp. 77-81). Ieee.

[9]. W. Wang, X. Lv, & F. Sun, (2012), "Design Of Micromachined Vibratory Gyroscope With Two Degree-Of-Freedom Drive-Mode And Sense-Mode", Ieee Sensors Journal, 12(7), 2460-2464.

[10]. S. Chandrasekaran, & R. Veeran, (2020), "Assistive Device For Neurodegenerative Disease Patients Using Iot. In Innovative Data Communication Technologies And Application: Icidca", 2019 (Pp. 447-452). Springer International Publishing.

[11]. A. Jones, P. Morgan-Jones, M. Busse, V. Shepherd, & F. Wood, (2021), Conducting Focus Groups In Neurodegenerative Disease Populations: Ethical Considerations. Bmj Open, 11(1), E041869. And Methodological

[12]. D. K. Jaswanth, C. Lenord, S. L. Pavan, & C. Nagaraju, (2020), "Self-Stabilizing Spoon For Parkinson's Ailment", Int. J. Eng. Manuf, 10, 38.