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FABRICATION OF AUTO STABILIZING SPOON USING 3D PRINTER

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ABSTRACT

This research focuses on the development of an Auto Stabilizing Spoon, a low-cost, self- stabilizing assistive device designed to help individuals with hand tremors eat more easily and independently. Hand tremors, often associated with neurological conditions such as Parkinson's disease and essential tremor, significantly hinder daily activities like eating, impacting quality of life and dignity. The primary objective of this project is to minimize food spillage during consumption, thereby improving the eating experience for affected individuals. To achieve this, the spoon was designed using advanced 3D modeling software, which allowed precise customization of dimensions and mechanical features to accommodate the specific needs of users. The prototype was manufactured through Fused Deposition Modeling (FDM) 3D printing technology using PLA filament. This method was selected due to its advantages in producing lightweight, durable, and cost-effective prototypes, while also offering ease of iteration for future design improvements. After fabrication, the prototype underwent functional testing with a patient diagnosed with hand tremors. The tests focused on evaluating the spoon's ability to stabilize against involuntary hand movements during eating activities. Results demonstrated that the Auto Stabilizing Spoon effectively reduced food spillage and enhanced the patient's ability to eat independently. The findings suggest that this design offers a promising, affordable solution for individuals with tremor-related disabilities. Future work will focus on refining the stabilization mechanism, integrating smart sensors for adaptive control, and expanding the design to other eating utensils to further support independent living among patients with motor impairments.

1. Introduction

Auto Stabilizing Spoon is a tool that stabilizes the tip of the utensil to a fixed axis. It compensates for hand tremor, enabling people with mild to moderate tremor due to conditions such as essential tremor, Parkinson's disease (PD) is a progressive movement disorder of the nervous system (NINDS, 2025), or other neurological disorder to eat independently.

Parkinson's disease is a neurological degenerative disease that cause uncontrollable shaking (DeMaagd, 2015) and makes it difficult for the affected person to eat. Patient took plenty of

time to carve their meal and already tired because of energy loss in their muscled vibration. The objective of this project is to produce a prototype of stabilizing spoon and to minimize the amount of spillage of the food so that the quantity of food consumed by patient can be maximize. Patients will feel ergonomic and more comfortable because minimal food spillage makes the patient's dining area cleaner. The patient's eating time also becomes shorter due to the patient feeling full with food in larger quantities than a normal spoon.

2. Methodology

A spoon is a kitchen utensil (Philip, 2016). It consists of a small bowl (known as the head) that is oval or round in shape and has a handle at the end. The spoon functions to measure, stir, scoop, and mix ingredients, especially food items. Most spoon are made of metal (particularly silver), stainless steel, wood, porcelain, or plastic. Spoons come in various types and shapes, and are used according to their specific purposes.

Auto Stabilizing Spoon used the concepts of a gyroscope is that it is a device or instrument used to measure or maintain the orientation and angular velocity of an object. A gyroscope operates based on the principle of conservation of angular momentum. This can help reduce shaking when the hands tremble while holding a spoon. This spoon is specially designed for Parkinson's patients who experience difficulties eating independently without assistance. Patients often take a long time to scoop food into the spoon, and frequently, the food spills due to continuous hand tremors. This results in a reduced amount of food being consumed, which can lead to increased fatigue and the patient only managing to eat a small quantity. Emphasis was placed on ergonomic to ensure ease of use for individuals with weak grip strength

Auto Stabilizing Spoon is made from Polylactic Acid (PLA) filament which is a recyclable, natural thermoplastic polyester that is derived from renewable resources such as corn starch or sugar cane. It is environmentally friendly and decomposes under industrial composting conditions. It very good strength, good rigidity, smooth finish and hardness. The filament use is sized 1.75 mm. The steps to make a prototype Auto Stabilizing Spoon is shown in Figure 1 below.

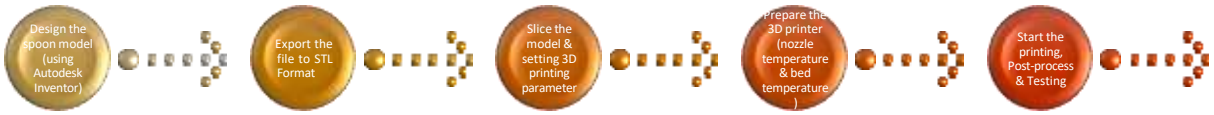

Figure 1. Steps to make spoon prototype.

The first steps are drawing 2D and 3D modelling of four main parts of Auto Stabilizing Spoon. These are bowl, handle, ring and neck drawing using AutoCAD Inventor due to powerful parametric, direct edit and freeform modelling tools as shown in Figure 2. Second step, once

the design is complete, export the model in STL format which is the standard for 3D printing. Meshmixer is use to check the model errors or mesh issues.

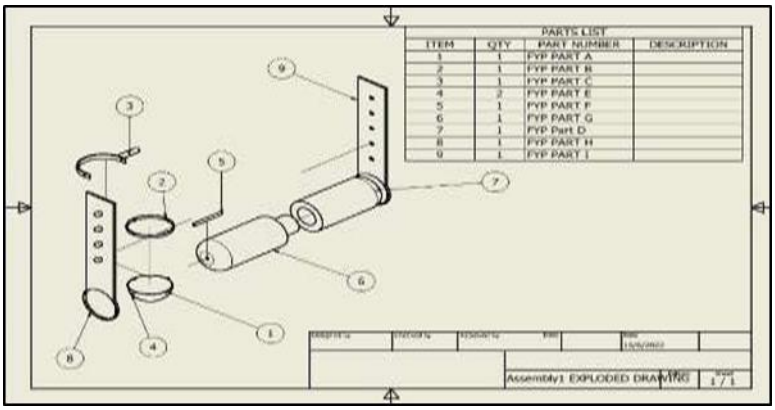

Figure 2. Explode drawing using Autodesk Inventor

Third step is slicing the model with Creality print software. Slicing is a critical step in the 3D printing process where a digital 3D model is converted into a set of instructions that a 3D printer can understand. These instructions are typically in G-code format. Slicing translates design intent into precise machine instruction, bridging the gap between CAD modelling and physical printing. Then the fourth steps are set the printing parameter as 0.2 mm layer height, 60% infill density and 50 mm/s printing speed.

Figure 3. Printing 3D Spoon

Once printing is complete, carefully remove the spoon from the print bed. Trim excess material using cutter and smoothing the surface using sandpaper for better surface result. And the last step is testing the prototype Auto Stabilizing Spoon. This study uses the method of an interview, observation and testing on how the spoon functions base on spilling quantities. The level of Parkinson's disease studied is at level two, which is that the tremor or vibration has already affected the movement of the patient's body.

3. Results

A test was made which tremor simulation with capability to fully scooping the meal as a dependent variable and meal as an independent variable. Three attempts were made to take

capability scooping capacity data and recorded in Table 1. Three measurements, in seconds, were taken to compare the performance of this spoon with a standard spoon.

Table 1. Full scooping capability.

	Auto Stabilizing Spoon (s)	**Standard spoon (s)**	**Time difference (s)**
Time 1	5	8	3
Time 2	4	7	3
Time 3	4	7	3

From the data obtained it can be seen the difference for the time test which is the time required to deliver the food until the food enters the patient's mouth is shorter compared to using a regular spoon. The time difference becomes more and more noticeable when the patient repeats the feeding without any food spillage.

The observation data was taken on the frequency of the quantity of food spilled out of the spoon. Food spillage was categorized as no spillage, minimal, or extensive. Five trials were recorded in Table 2.

Table 2. Spilling frequency

Time	**Spill**
Time 1	Minimal
Time 2	No spillage
Time 3	No spillage
Time 4	No spillage
Time 5	No spillage

From the observation of the data above, the frequency of minimal spilled food occurs 2 times and no spillage food occur in 3 times. But no extensive food spillage was recorded.

4. Discussion

Based on the testing data comparing the Auto Stabilizing Spoon with a regular spoon, it was found that the time taken for a patient to bring food from the spoon to the mouth was shorter when using the Auto Stabilizing Spoon. This is because the spoon remains more stable while holding the food in its bowl. Patient uses minimal energy to control hand tremor when bringing the weighted spoon to the mouth. Weighted spoon that approximately one-half pound help counteract and stabilize tremors. Build-up handle spoon have long and wide handles that support easier grasp when an individual has difficulties with grip or hand and finger control (Pringle, 2022), steady spoon and weighted spoon with standard handle (Sabari et al., 2019). As a result, the amount of food does not decrease due to spillage caused by hand tremors.

From the observation data of frequency scooping food without spilling, it found that the amount

of food that can be scooped into the bowl of the spoon is three times. This is because the curved design of the bowl can hold food from spilling. More specifically, the gyro concepts can detect and measure the rotational movement or change in orientation of an object relative to the inertial reference frame.

The main principle behind the working of the gyroscope is the conservation of angular momentum. When an object rotates, it has angular momentum that tends to maintain its direction of rotation in space. This means that in the absence of an external force, the axis of rotation of the gyroscope will still point in the same direction. A high-precision gyroscope is an important tool for accurate positioning, and the amplitude stability (Chen et al., 2021).

5. Conclusion

In conclusion, the successful development of the Parkinson's spoon using 3D printing technology and the gyroscope concept demonstrates that the patient-centered designs can be realized in a cost-effective and practical manner. The prototype not only function effectively in reducing food spillage caused by hand tremors, but also holds great potential in improving the quality of life for individuals with Parkinson's disease. This success serves as a solid foundation for the future development of more innovative assistive daily living devices.

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