AISSMS
COLLEGE OF ENGINEERING
ज्ञानम् सकलजनहिताय
Accredited by NAAC with "A+" Grade

DEPARTMENT OF ELECTRONICS

AND TELECOMMUNICATION ENGINEERING

MINI PROJECT REPORT

On

Arduino-Based Spoon Stabilizer for Tremor Assistance

A report submitted in partial fulfillment of the requirements for the Award Degree of

BACHELOR OF ENGINEERING (THIRD YEAR OF ENGINEERING)

In

ELECTRONICS AND TELECOMMUNICATION

By

Mohammad Sahil Rafique Shaikh - 21ET057

Vaishnavi Vishwas Patil – 21ET047

Atharva Sanjay Ardhapurkar – 21ET003

UNDER SUPERVISION OF

Dr. Kirtimalani B. Chaudhari

Vision of Department: Society Growth and Welfare through Competent Electronics and telecommunication Engineering Graduates.

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CERTIFICATE

This is to certify that the "**Mini Project report on Arduino-Based Spoon Stabilizer for Tremor Assistance**" is submitted by: -

Mohammad Sahil Rafique Shaikh - 21ET057

Vaishnavi Vishwas Patil – 21ET047

Atharva Sanjay Ardhapurkar – 21ET003

of **TE-E&TC** during 2023-2024 academic year, in partial fulfillment of the requirements for the award of the degree of **BACHELOR OF ENGINEERING (THIRD YEAR ENGINEERING) in ELECTRONICS & TELECOMMUNICATION.**

Signature	**Signature**	**Signature**
Dr. K. B. Chaudhari	**Mrs Vaishnavi Navale**	**Dr. S. B. Dhonde**
Mini Project Guide	**Mini Project Coordinator**	**Head of Department**

ACKNOWLEDGEMENT

I would like to convey my heartfelt gratitude to Dr. K. B. Chaudhari for her tremendous support and assistance in the completion of my project. I would also like to thank our Mini Project Coordinator Mrs. Vaishnavi Navale, for providing me with this wonderful opportunity to work on a project with the topic Arduino-Based Spoon Stabilizer for Tremor Assistance. The completion of the project would not have been possiblewithout their help and insights. The Spoon Stabiliser is an intelligent piece of tableware specially designed for patient suffering from hand tremor conditions to help them avoid awkwardness and inconvenience while eating. It can recognize and actively offset hand tremor to provide them an easierand more stable dining solution. It helps with independent eating and increased hand arm control.

Mohammad Sahil Rafique Shaikh - 21ET057
Vaishnavi Vishwas Patil – 21ET047
Atharva Sanjay Ardhapurkar – 21ET003

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1. VISION AND MISSION OF INSTITUTE

Vision of Institute:

- Service to society through quality education

Mission of Institute:

- Generation of national wealth through academics and research
- Imparting quality technical education at the cost affordable to all strata of the society
- Enhancing the quality of life through sustainable development
- Carrying out high quality intellectual work
- Achieving the distinction of the highest preferred engineering college in the eyes of stake holder

2. VISION AND MISSION OF DEPARTMENT

Vision of Department

- Society Growth and Welfare through Competent Electronics and Telecommunication Engineering Graduates

Mission of Department

- To facilitate E & TC graduates with sight of innovation.
- To provide stimulating learning environment with modern tools & technologies.
- To produce dynamic graduates with ethics and moral values.
- To impart quality education in the field of E & TC engineering to solve societal and industrial problem

3. LIST OF PO's, PEO's, PSO's

List of Program Outcomes (PO's)

- **Engineering Knowledge**: A graduate student will apply knowledge of mathematics and engineering fundamentals to design electronic circuits and systems such as logical circuits, analog circuits, electrical machines, control and communication systems, digital systems etc. and test the results.
- **Problem Analysis**: A graduate student will be able to identify, formulate, solve electronics engineering problems.
- **Design/Development of Solutions**: A graduate student will demonstrate the ability to design, implement and evaluate a system, process, component and program to meet the specified needs with appropriate considerations for public, health and safety, society and environment.
- **Conduct Investigations of Complex Problems:**A graduate student will investigate, formulate, analyze and provide appropriate solution to simple and complex engineering problem
- **Modern Tool Usage**: A graduate student will provide the solutions by using the Modern electronic and IT Engineering Tools and Technologies for practicing electronic Engineering problems
- **The Engineer and Society**: A graduate student will demonstrate the ability to learn the impact of industries on society by visiting different industries and understand the importance of industrial products for analog and digital circuits and systems.
- **Environment and Sustainability**: A graduate student will understand the importance of environmental issues and will design sustainable systems.
- **Ethics**: A graduate student will understand the professional and ethical responsibilities to meet the socio economic challenges.
- **Individual and Team Work:** A graduate student will function effectively as an individual, member or leader of a team in multidisciplinary setting.

- **Communication:**A graduate student will be able to communicate effectively at different technical and administrative levels.
- **Project Management and Finance**: A graduate student will demonstrate knowledge and understanding of engineering and management principles to manage projects.
- **Life-long Learning**: A graduate student will recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

List of Program Educational Objectives (PEO's)

- To build strong fundamental knowledge among graduates required to pursue their higher education and continue professional development in Electronics & Telecommunication field.
- To enable graduates to identify, analyze and solve Electronics Engineering problems by applying basic principles and modern techniques.
- To enable graduates to innovate, design and develop hardware & software components and groom their ability to succeed in multidisciplinary & diverse field.
- To inculcate in graduates professional attitude, effective communicational skills, team work skills for becoming a responsible, cultured human being.

List of Program Specific Outcomes (PSO's)

An E & TC engineering graduate will be able to:

- **PSO1**: **Systems Development**: Design and develop prototype or system using hardware and software skills for multi-disciplinary applications.

- **PSO2: Adaptability:** Demonstrate an ability to adapt emerging technologies in the field of Artificial Intelligence machine learning, Internet of things and Robotics to solve the real life problems.
- **PSO3: Skill Development:** Develop technical and management skills through student clubs and industry interactions.

4. LIST OF COURSE OUTCOMES OF PROJECT

CO1: Describe various tools to do market survey and to decide the topics and work as team member.

CO2: Apply an appropriate EDA tool for PCB artwork design. Troubleshooting etc.

CO3: Implement the simulated design using various components with good soldering technique and

CO4: Demonstrate the abilities to transmit technical information clearly through seminar.

CO 5: Justify the importance of document design by compiling Technical Report on the Mini Project work carried out.

5. INTRODUCTION & APPLICATION

Parkinson's disease is a neurodegenerative disorder that produces excessive involuntary shaking in the limbs, making it difficult to lift food with a spoon. People who have hand tremors may have Parkinson's disease, whereas those who are functionally impaired may have Cerebral palsy. We intend to create this gadget first and foremost to assist persons with tremors and those who are functionally challenged due to neurodegenerative disorders such as Parkinson's disease and have difficulty moving their hands causing tremors. Parkinson's disease has no established origin, however, it is believed to be caused by both hereditary and environmental factors. The signs of Parkinson's disease generally appear gradually. Other signs include slowed mobility, stiffness, and a lack of balance. Parkinson's disease is an illness that affects the central nervous system and causes cell death in various parts of the brain. One of these areas is the substantia nigra, which contains dopamine, a neurotransmitter that provides impulses to improve movement regulation. Nerves pulse irregularly without dopamine, making it difficult for patients to maintain control of their motions. Physicians classify Parkinson's disease as a mobility illness since it affects a patient's capacity to move. The purpose of this research is to develop a stabilising spoon capable of correcting undesired movements such as tremors. With a limited budget, the goal is to develop a super-efficient prototype primarily comprised of a microprocessor and servo motors. The self-stabilizing spoon will be connected with a sensor that uses gyroscopes and accelerometers to determine which side of the device's handle is tilted and how quickly its position changes. To create a two-degree-of-freedom system, two servo motors will be positioned orthogonally to each other. The spoon is designed to keep its spoon bowl horizontal in this configuration.

The production of affordable solutions that include sensor networks and controlled systems has been made possible by recent developments in IoT (Internet of Things) technologies. Deploying an IoT-based infrastructure that can track, manage, and observe your devices has become simpler as a result. With the most recent developments, we have observed a significant advancement in intelligent biomedical support technology. With innovative technology, like bio-mechatronic components that replace human limbs and AI (artificial intelligence)-based object classification systems for the visually impaired, people with functional disabilities can now utilise these technologies to enhance their own quality of life. By utilizing these technologies and associated protocols, we have created a stabilizing mechanism and integrated it intoa spoon which can be used by patients requiring assistance.

A patient with Parkinson's disease experiences excruciating discomfort when using a plate or spoon to eat due to the neurodegenerative disorder's uncontrollable tremors in their limbs. Depending on the individual, the disease's symptoms may be disregarded for extended periods of time if they are moderate. Over time, the patient's condition deteriorates and may even negatively impact breathing and speaking. There is currently no recognized cause for the Illness, meaning there is no definitive treatment. The potential of these biomedical aid devices holds potential for improving the lives of people with functional disabilities.

In order to offset the unwanted motion and vibration, stabilizing mechanisms are used in a variety of settings, including photography (gimbals) and airplanes. Our approach in this study is to incorporate these sophisticated controlled stabilizing mechanisms into a low-cost prototype in order to manufacture,, a self-stabilizing spoon that maintains its balance even when the user's hand shakes or trembles.The aim of this project is to produce a stabilizing spoon that will compensate for unintended motions, suchas tremors. With a low budget, the goal is to make a highly efficient prototype that consists mainly of a microcontroller and servo motors. There are several different technological assisting spoons on the market today, but the products are unfortunately quite expensive. With results from this project, further research could be able to continue developing cheaper and better stabilizing spoons.

6. LITERATURE SURVEY

In the year 1971, Johan Abrahamson & Johan Danmo made a research on this technology for assisting people who are functionally challenged has improved over the recent decades. With today's technology, people with Parkinson's disease can, with a device on their wrist, be able to draw pictures. Human limbs lost due to accidents can be replaced with bionic limbs and with help from smartphones, blind people can by audio be informed what kind of object that appear in front of them. These are a few examples where technology has eased everyday life for people with impaired functionality. The purpose of this thesis is to analyze how an Arduino microcontroller can be utilized to help people with impaired motor skills during their eating process. A prototype of a stabilizing spoon was constructed to work under real circumstances and intended to be a complement for people who are in need of assistance during their eating process.

To make this possible, a sensor with gyroscopes combined with accelerometers was used to identify which direction the device's handle was being tilted, as well as how fast its position was changed. Two servo motors were placed orthogonally to each other to establish a system of two degrees of freedom. With this setup, the spoon was intended to maintain its spoon bowl in a horizontal position. Experimental results of the spoon showed promising performance with some limitations. If the handle of the spoon is tilting an angle with α degrees, actuators in the spoon's construction will compensate with the same angle α and put the spoon bowl in its initial horizontal position. A prototype of the device was built using a gyroscope to measure the angle of the motions, paired with an accelerometer to measure the speed of these motions, to assist patients' eating process. Another part of the holistic product is a mobile application for the doctor to monitor the patient's progress. The spoon will send all relevant sensor readings to server set up by us.

7. BLOCK DIAGRAM & CIRCUIT DIAGRAM

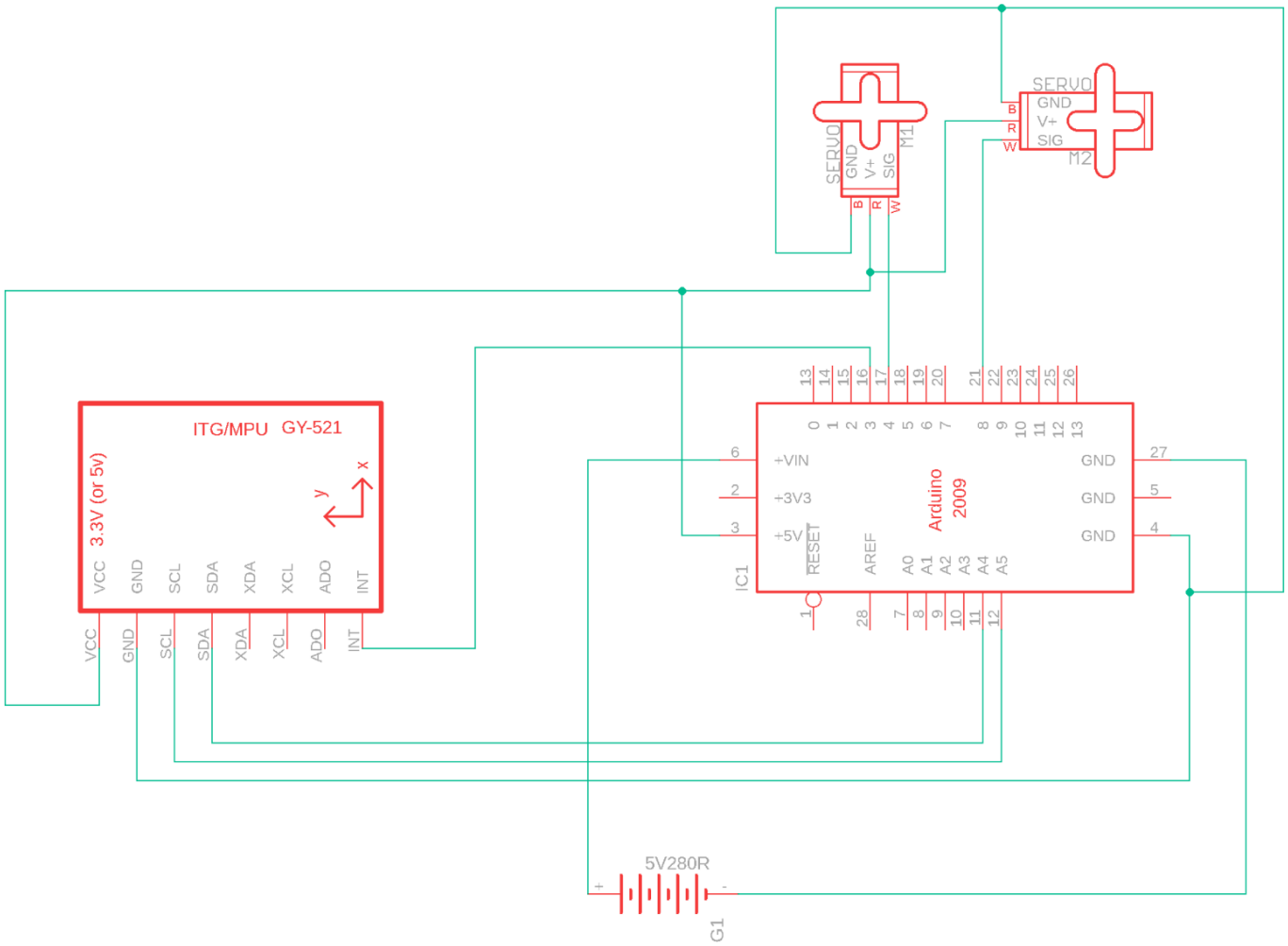


Fig 1.1 Circuit Diagram for Spoon Stabilizer

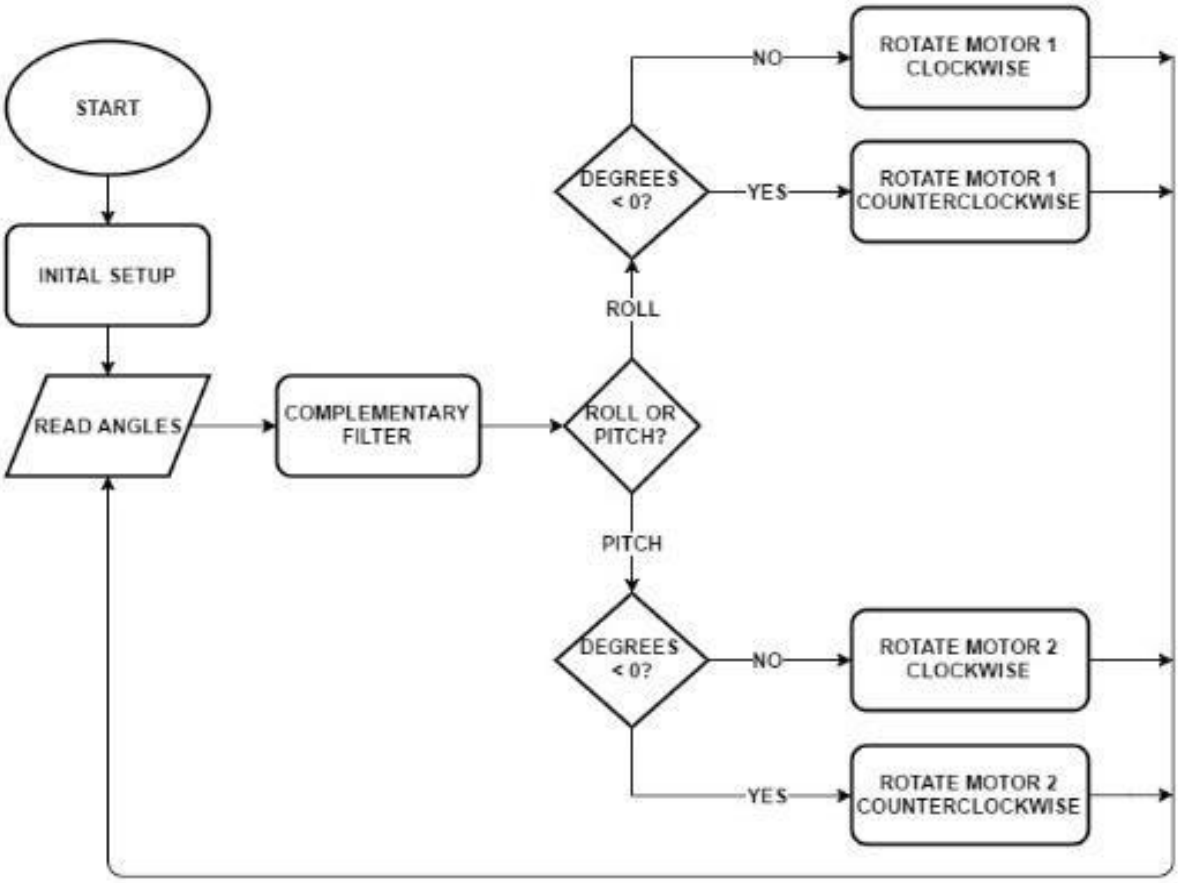


Fig 1.2 Flowchart for spoon stabilizer

8. SELECTION OF COMPONENTS & SPECIFICATIONS

- **Servo Motor 9G**

Micro 9g servo FS90 is a small yet powerful servo motor with the ability to rotate approximately 180 degrees with a torque output of approximately 0,127 Nm. The dimension of the servo motor is 23.2 x 12.5 x 22.0 mm and weighs 9 grams as the name states. The motor has 3 pins in total, one for the signals (PWM), one for the input voltage (VCC) with an operating voltage of about 4.8 V or 6 V and one for electrical ground (GND).

Fig 1.3 Servo Motor

SPECIFICATION	VALUE
Rated output power (kW)	1.5
Rated Voltage (V)	220
Rated speed (r/min)	2000
Maximum speed (r/min)	3000
Rated torque (N-m)	7.16
Maximum torque (N-m)	21.48
Rated current (A)	8.3
Maximum current (A)	24.81
Encoder Type	17bit
Motor Frame Size (mm)	130
Shaft Type	Keyway

- **Arduino Uno**

The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010. The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.

Fig 1.4 Arduino Uno

PARAMETER	**VALUE**
Input voltage (operational)	7 – 12 V
Input voltage (limit)	6 – 20 V
Digital I/O pins	14
Analog inputs	6
Maximum current per pin	40 mA
Flash memory	32 kB
SRAM	2 kB
EEPROM	1 kB
Clock	16 MHz
Dimensions (flat plane)	68.6 × 53.4 mm
Height	25 g

- **MPU 6050**

  The MPU6050 combines a three-axis gyroscope and a three-axis accelerometer on the same board, along with an onboard Digital Motion Processor™(DMP™) it can accurately track user motions. With the gyroscope and the accelerometer, which both are triple axis Micro Electrical Mechanical Systems (MEMS), it can provide information of the boards angular position and acceleration.

Fig 1.5 MPU 6050

PARAMETERS	
Chip model	MPU - 6050
Power supply	3 – 5 V
Communication protocol	I2C
Gyroscope range	+/- 250, 500, 1000, 2000 ^{0}/s
Accelerometer range	+/- 2, 4, 8, 16g

9. PCB ARTWORK, HARDWARE DETAILS & ENCLOSURE DESIGN

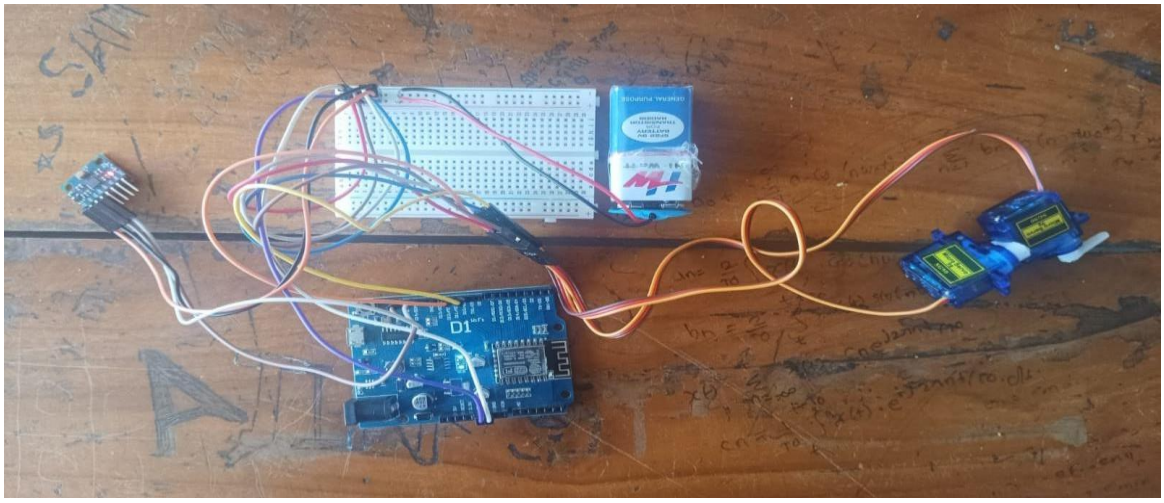


Fig 1.8 Hardware Connections

The self-stabilizing spoon adjusts its spoon head position according to the patient's tremors. It begins with calibrating itself and taking an initial reading of the angle it is at. Now every time there is a change in that angle, it sends a signal to the motors to adjust the position. The stabilising spoon adjusts for the user's involuntary tremors or shakes by balancing its head against such forces, maintaining the spoon steady at all times. This spoon can move at a rate of 500 degrees per second, essentially stabilising the spoon. We have taken a power supply from a 9V – 1 Amp adapter which is then converted to 5V by using a voltage regulator (7805). Then this supply is given to both Arduino and reference circuitry. The gadget will not only make it easier for users to take food from a plate/bowl, but it will also aid their recovery by allowing them to communicate with a designated doctor in an economical and detailed manner.

10. SIMULATION RESULTS

Appendix A

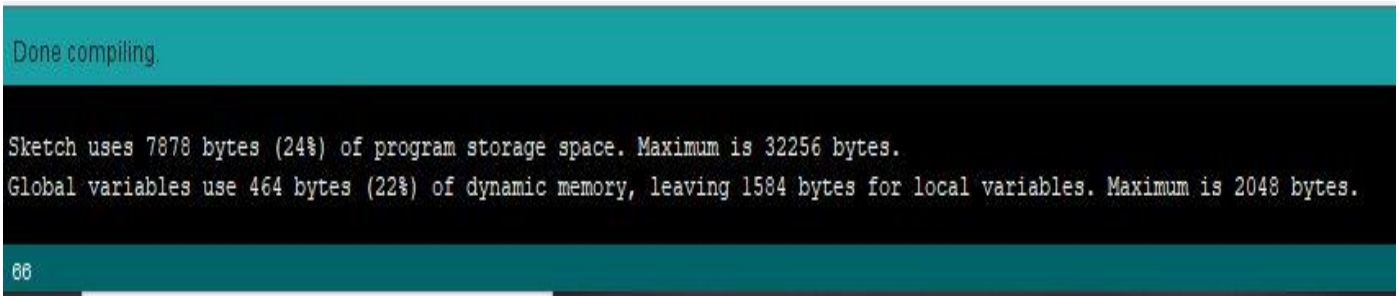
The project's own developed code

```
/*
  Arduino-Based Spoon Stabilizer for Tremor Assistance
  -------------------------------------
  Arduino UNO + MPU6050 + 2 Servos
*/

#include <Wire.h>
#include <Servo.h>

#define MPU 0x68

Servo servoRoll;
Servo servoPitch;

int16_t ax, ay, az;
int16_t gx, gy, gz;

float roll = 0, pitch = 0;
float rollAcc, pitchAcc;

float dt = 0.005;     // around 5ms loop time
float alpha = 0.98;   // complementary filter factor

void setup() {
  Wire.begin();
  Serial.begin(115200);

  // wake up MPU6050
  Wire.beginTransmission(MPU);
  Wire.write(0x6B);
  Wire.write(0);
  Wire.endTransmission(true);

  servoRoll.attach(9);
  servoPitch.attach(10);

  delay(200);
}

void loop() {
```

```
  readMPU();
  computeAngles();
  moveServos();
  delay(5);
}

// read raw accel + gyro
void readMPU() {
  Wire.beginTransmission(MPU);
  Wire.write(0x3B);
  Wire.endTransmission(false);
  Wire.requestFrom(MPU, 14, true);

  ax = Wire.read() << 8 | Wire.read();
  ay = Wire.read() << 8 | Wire.read();
  az = Wire.read() << 8 | Wire.read();
  gx = Wire.read() << 8 | Wire.read();
  gy = Wire.read() << 8 | Wire.read();
  gz = Wire.read() << 8 | Wire.read();
}

// calculate pitch + roll
void computeAngles() {
  float gyroRoll  = gx / 131.0;
  float gyroPitch = gy / 131.0;

  roll  += gyroRoll * dt;
  pitch += gyroPitch * dt;

  // accel angles
  rollAcc  = atan2(ay, az) * 180.0 / PI;
  pitchAcc = atan2(-ax, az) * 180.0 / PI;

  // blend gyro + accel
  roll  = alpha * roll  + (1 - alpha) * rollAcc;
  pitch = alpha * pitch + (1 - alpha) * pitchAcc;
}

// servo control
void moveServos() {
  int r = map(roll,  -45, 45,  0, 180);
  int p = map(pitch, -45, 45,  0, 180);

  r = constrain(r, 0, 180);
  p = constrain(p, 0, 180);

  servoRoll.write(r);
```

```
  servoPitch.write(p);
}
```

Output: -



11. RESULTS & CONCLUSION (GRAPHS, SNAPSHOTS or TABLES)

The last constructed prototype followed the desired movements as it was intended with the thesis. However, the results and performance of the device are not satisfying enough to meet the project's initial demands when looking at the discrepancy. Concerning high frequency tremors, the device can be improved a lot and a possible solution for this problem would be to use faster servo motors. Where slow motions were applied, the spoon was struggling to hold a horizontal position, but although the spoon was not strictly holding a horizontal position, the deviation was not highly critical. With that being said, one can discuss the usability of the device for people with impaired motor skills. Even though the device would not be helpful for people who suffer from high frequency tremors, it might be helpful for people with loss of physical motor function. These people could be physically disabled or perhaps elderly people who have reduced motor skills.

The spoon does not react fast enough to be useful for people with high frequency tremors. The reason to this is that the motors are too slow to react for these motions. As the motors have a definite speed of rotation that is less than required for high frequency tremors (or shaking in general), faster motors must be used to satisfy this requirement.

The device was constructed with a cylindrical handle with a diameter of 40 mm. This would likely fit most adult people's hands. The device weighs around 130 grams in total, which is a reasonable weight considering what the spoon is intended to be used for. After having the two sub-questions discussed, the main research question can be taken into consideration. The existing setup of the prototype with its limitation of not being able to handle high frequency tremors, might still be of use for people with impaired motor skills during their eating process. By looking at the discrepancy, slow motions do get counteracted by the spoon with an acceptable deviation, and if food is placed on the spoon it would likely remain in the spoon bowl during these motions. This concludes that The Stabilizing Spoon can be utilized by people with impaired motor skills, though to a certain extent.

11. INDIVIDUAL CONTRIBUTION & WEEKLY EXECUTION PLAN

Week No	Date	Task Done	Contributor
1	15/01/2024	Gone Through a detailed research and decided the title of project	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil
2	22/01/2024	Discussed the title with the guide	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil
3	29/01/2024	Bought the required components	Mohd Sahil Shaikh Atharva Ardhapurkar
4	5/2/2024	Assembled the circuitry	Mohd Sahil Shaikh Atharva Ardhapurkar
5	12/02/2024	Soldering	Mohd Sahil Shaikh
6	27/02/2024	Coding/Simulation	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil
7	4/03/2024	Removed Errors In Code	Vaishnavi Patil
8	11/03/2024	Solved The Problems In Hardware	Atharva Ardhapurkar
9	17/03/2024	Created Report And PPT	Mohd Sahil Shaikh
10	01/04/2024	Making a proper model	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil
11	08/04/2024	Logbook Preparation	Atharva Ardhapurkar
12	15/04/2024	Discussion of advancements in project with guide	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil

13	22/04/2024	Finalising The Project	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil
14	29/04/2024	Submitting The Project	Mohd Sahil Shaikh Atharva Ardhapurkar Vaishnavi Patil

12. GROUP PHOTO WITH GUIDE & PROJECT

Fig 2.1 Review Activity with Guide

13. REFERENCES

[1] Ren, Wei, et al. "Robust DOBC for stabilization loop of a two-axes gimbal system." IEEE Access 7 (2019): 110554-110562.

[2] Pathak, Anupam. "Stabilizing unintentional muscle movements." U.S. Patent No. 9,925,034. 27 Mar. 2018.

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[10] [liftware.com, 2020] liftware.com (2020). liftware.com URL: https://www.liftware.com/steady/.

[11] [Gyenno.com, 2020] Gyenno.com (2020) Gyenno Spoon URL: https://www.gyenno.com/spoon-en

WEBLINKS:

1. www.arduinouno.com - Acted as a source of Arduino codes used for the project.
2. https://www.ijraset.com/research-paper/self-stabilizing-parkinsons-spoon
3. https://www.diva-portal.org/smash/get/diva2:1200521/FULLTEXT01.pdf
4. https://www.irjet.net/archives/V8/i7/IRJET-V8I7106.pdf
5. https://www.mdpi.com/2673-4591/59/1/150