Active Stabilization Mug

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CHECK US OUT!

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INTRODUCTION

For the past 7 months, the TRMRTK team has worked hard to create an Active Stabilization Mug for our capstone project. The development of the mug is showcased on this page, as well as prototypes and models that go with it!

PROBLEM STATEMENT

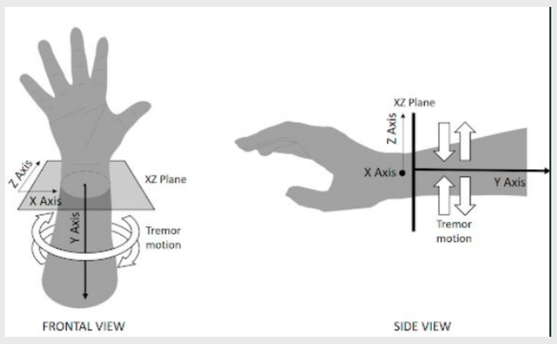
Hand tremors are a symptom of Parkinson's Disease, negatively impacting a person's ability to drink in a 'typical' manner. TRMRTK created the intelligent Active Stabilization Mug to restore independence and confidence in affected individuals.

PROJECT STRUCTURE

- **Phase 1:** Initial Research & Planning
- **Phase 2:** Initial Prototype Design
- **Phase 3:** Final Prototype Design
- **Phase 4:** Validation & Final Assembly

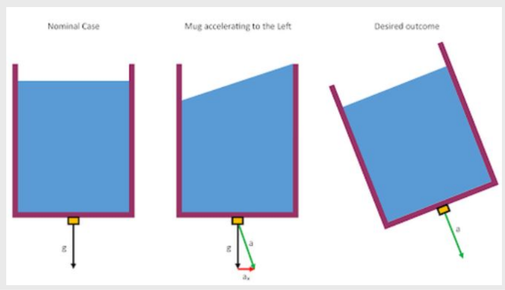
OUR SOLUTION

Following initial research, we focused our concept on correcting tremors about the x-axis as shown below.



We planned to develop a system capable of overcoming the mug's own inertia, which is up to 0.6g of acceleration due to tremors, and capable of filtering these tremors along the x and y axes in the range of 1-10Hz.

The control system is simple: keep the acceleration vector orthogonal to the x-y plane of the mug. In theory, this would allow the mug to 'cradle' the contained liquid during rotational and translational movements, much like a lacrosse player 'cradling' the lacrosse ball.



INITIAL PROTOTYPE

➢ **Goals:**
- Design and validate hardware to allow development of active stabilization features
- 3D print initial mug design and plan next steps through testing
- Begin development of motor control system and tilt feature

➢ **Results:**
- Power and sensory modules met desired performance
- Motor control strategy resulted in insufficient motor torque performance (Fig. 2)
- Control system and tilt feature development was delayed

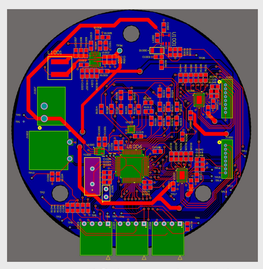


Figure 1: PCB Layout on Altium

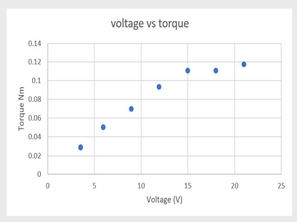


Figure 2: Voltage-Torque Plot

FINAL PROTOTYPE

➢ **Goals:**
- Re-design power module and use FOC control to improve torque performance
- Design and implement motor control system and tilt feature
- Utilize Kalman Filtering to tackle sensory data noise issues
- Implement battery charging
- Finalize mug design through testing

➢ **Results:**
- Motor torque met desired performance
- Active stabilization feature achieved through PID control (Fig. 3)
- Tackled noise in sensory data (Fig. 4 and Fig. 5)
- Battery charging implemented (Fig. 6)
- Final prototype PCB (Fig. 10) made 36% smaller than initial prototype PCB (Fig. 11)

Figure 3: Tested Transfer Function

Figure 4: Sensor Data Before Filtering

Figure 5: Sensor Data After Filtering

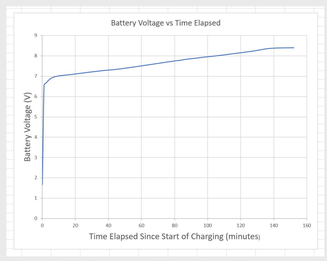


Figure 6: Battery Charging Test

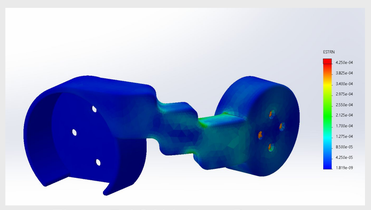


Figure 7: XY Linkage Design

Figure 8: Mug In Its Natural Environment

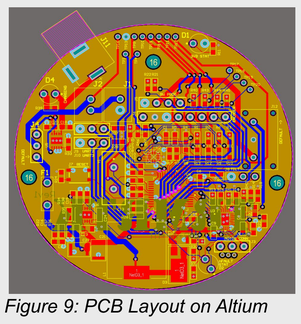


Figure 9: PCB Layout on Altium

PCB REV0

Figure 10: Physical Final Prototype PCB (36% Smaller!)

PCB REV1

Figure 11: Physical Initial Prototype PCB

FUTURE IMPROVEMENTS

- Include intentional mug tilting
- Add active y-axis stabilization
- Address battery life
- Increase mug rigidity
- Improve mug aesthetics
- Reduce cost per unit
- Optimize current hardware (connectors, harness, charging system, heat management)

CONCLUSIONS

For those with Parkinson's, a steady hand is hard to find. Spills and drops are a common sight, with frustration left behind.

But fear not, there's a solution, a mug that cannot spill a drop. Designed with care and ingenuity, its creation will never stop.

With a unique shape and style, and a steady grip to hold, it brings back joy to those in need and turns the story bold.