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THE FISCHELL DEPARTMENT of BIOENGINEERING

UNIVERSITY OF MARYLAND

Team B12: Semi-Automatic Positioning Device for Magnetic Resonance Neuroimaging System

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Motivation

- Small animal magnetic resonance imaging (SA-MRI) machines allow for in-vivo imaging
  - Current system involves homeostasis parameters
- Functional magnetic resonance and tractography tensor imaging measures blood flow discrepancies
- Manual positioning of mouse to the isocenter of magnet leads to imaging inconsistencies

Goal: Design a semi-automatic device to that aligns subject within SA-MRI to reduce time consumption and inaccuracies due to human error

Methods

Circuit Components

- A4988 Stepper Motor Driver
- Arduino MEGA
- Nema 17 Stepper Motor

Software Components

- Python
- Arduino

Hardware Components

- Cradle modified with SOLIDWORKS
- Fit within 80mm diameter bore
- Rod extension to motor center

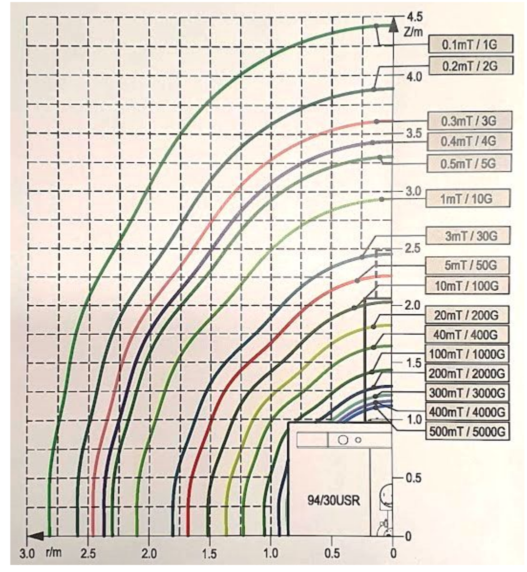

Figure 1. Minimum motor distance analysis.

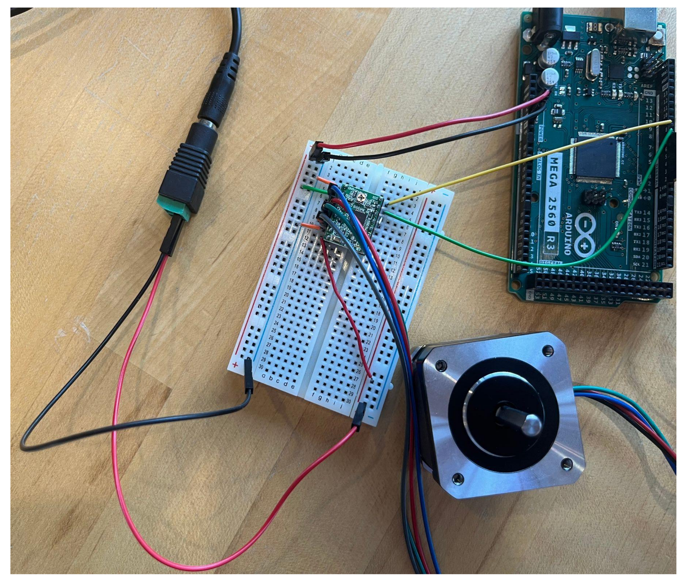

Figure 2. Circuit schematic for one A4988 stepper motor driver and Nema 17 motor.

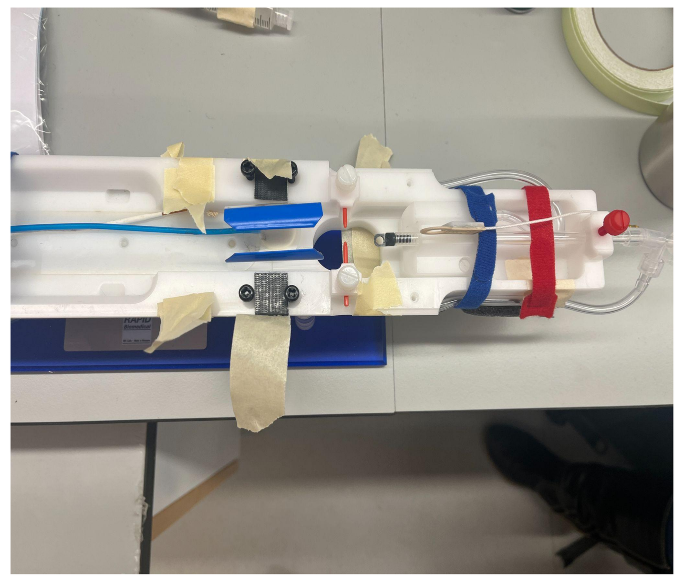

Figure 3. Pre-existing cradle with components needed for anesthesia and maintenance of homeostatic conditions.

Final Design and Results

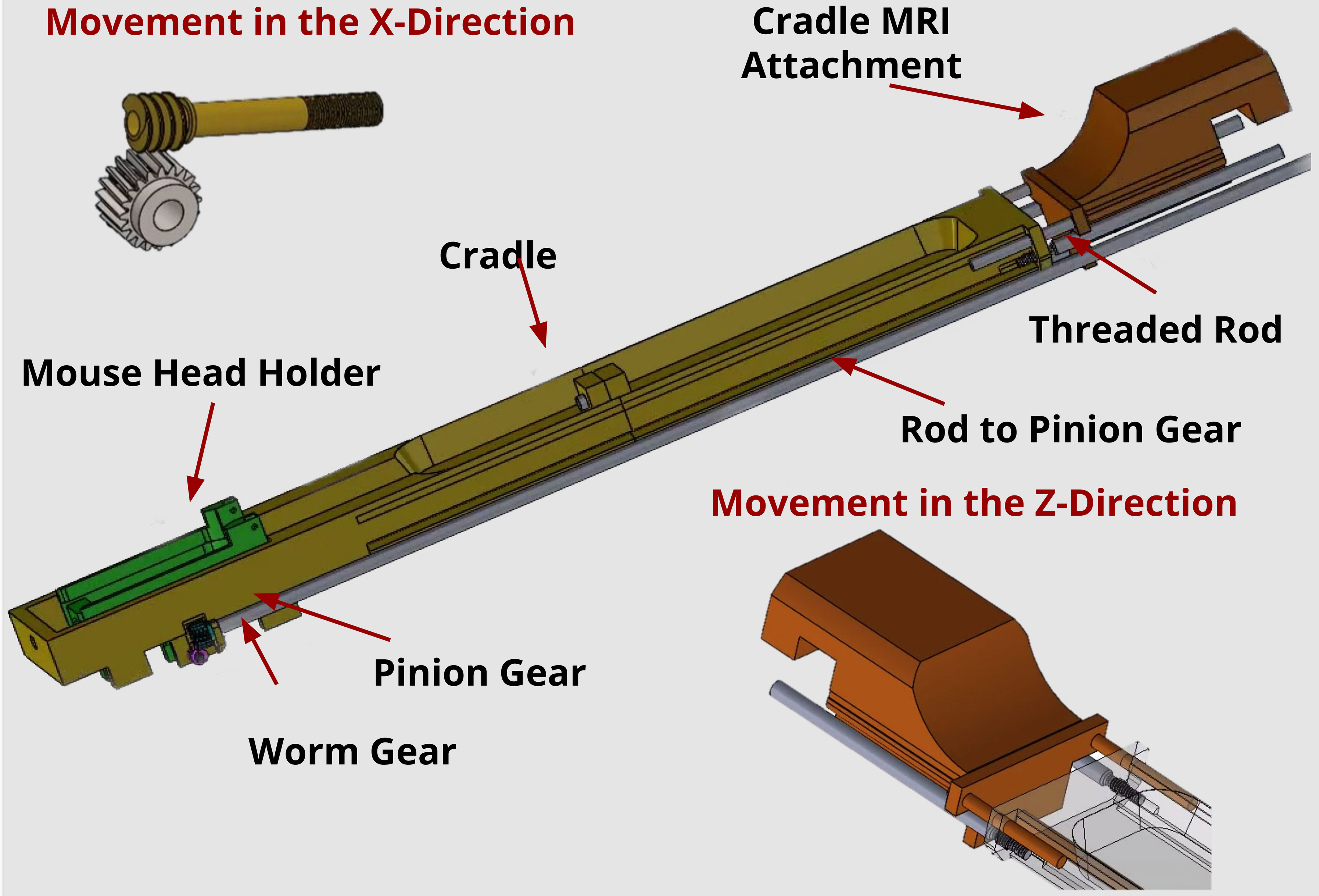

Figure 4. SOLIDWORKS image of semi-automatic positioning system for small animal use.

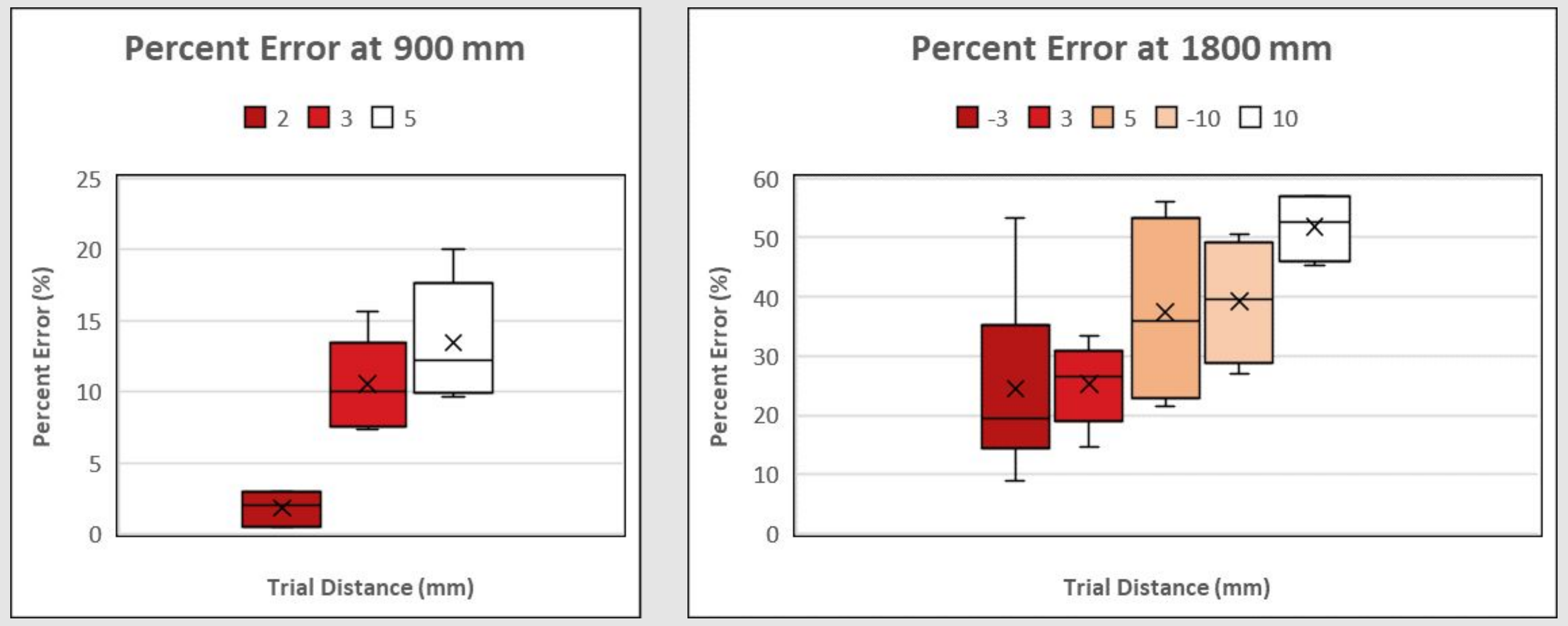

Figure 5. Graphical representation of distance in x-direction (at mouse head holder) at 900 and 1800mm.

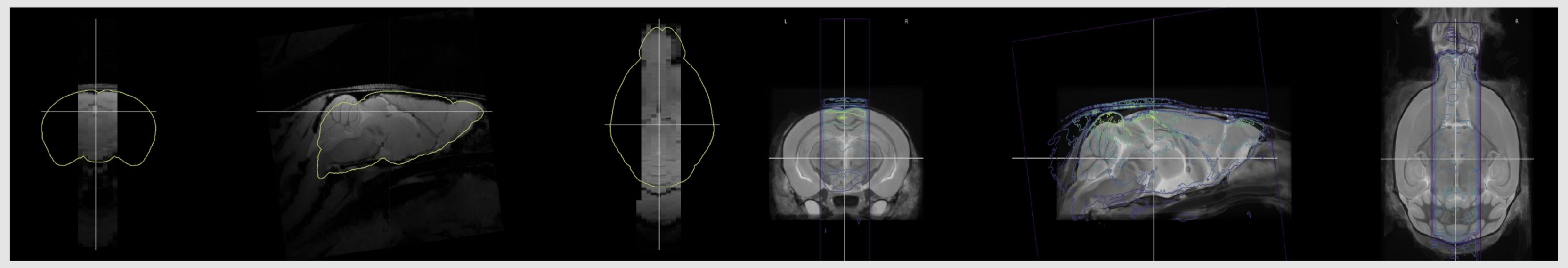

Figure 6. MRI images of transformational positioning using registration software programs.

Conclusions

- The cradle achieved semi-automatic positioning in the x- and z- directions
- Incorporated device with pre-existing MRI procedure
- Shorter distance between the motor and site of translation provides a more accurate distance moved

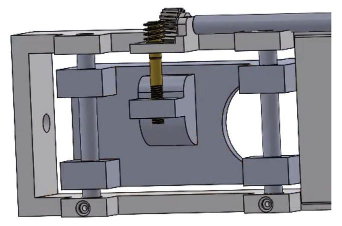

Figure 7. SolidWorks model of Mouse Head Holder.

Future Work

Mechanical Simplification

Removing **excess rods**, reducing **motor vibrations**, and improving **cradle support** will provide maintenance ease

Directional Implementation

Accommodating for **all six degrees of freedom** with translational and rotational shifts will optimize positioning

Enhanced Sensitivity

Alter gear ratio to **account for additional length** between motor in order to move < 1.2 mm

Bioethical Implications

Animal safety by using micrometric neck movement on mice during procedure

Minimal pain and discomfort for the small animal by reduce the required anesthesia time and maintenance

Reduced technician fatigue by minimizing the need for repeated manual positioning

References

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