

# MRI compatible motion platform

Date: 02/02/2024 – 02/08/2024

Client: Jiayi Tang

Advisor: Dr. Trevathan

Team:

Maxwell Naslund

Caspar Uy

Kendra Besser

Jamie Flogel

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## Problem statement

MRI phantoms used to test and calibrate MRI's are often static models of the human body. These static models don't give a good representation of the constant motion created from natural processes such as respiratory and digestive functions. To solve this, our team will work on a MR compatible device that will hold a phantom and simulate the movements found within the human body.

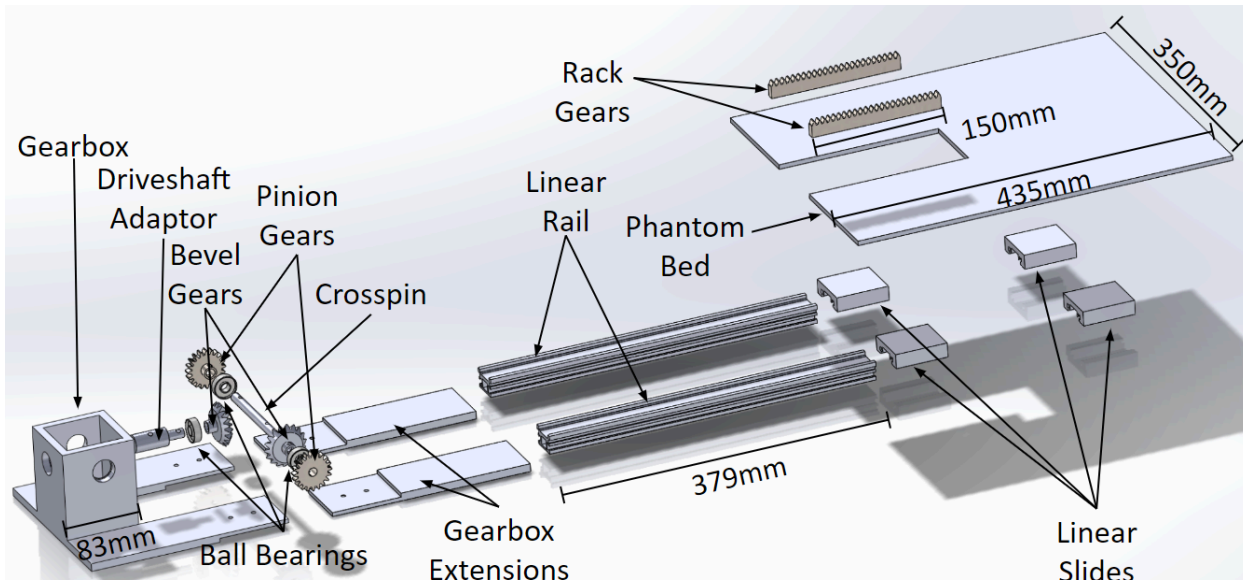
## Brief status update

The team has begun the first steps of this semester's design project. The team met with the client to clarify semester goals. The team met Friday with Dr. Trevathan to relay the new semester goals and to realign on upcoming deadlines. The team met briefly to assign components of the upcoming preliminary presentation. The team will meet once more this week to prepare for preliminary presentations this Friday.

## Difficulties / advice requests

N/A

## Current design



## Materials and expenses

| Item                       | Description   | Manufacturer | Part Number | Date       | QTY | Cost Each | Total   | Link |
|----------------------------|---|--------------|-------------|------------|-----|-----------|---------|------|
| <b>Component 1</b>         |   |              |             |            |     |           |         |      |
| Ultimaker PLA (37.0 g)     | 3D printed gears to translate and facilitate motion | Ultimaker    | RAL-9010    | 10/26/2023 | 3   | \$2.96    | \$2.96  | N/A  |
| Ultimaker PLA (325.0 g)    | 3D printed gears and gearbox                        | Ultimaker    | RAL-9005    | 11/03/2023 | 1   | \$26.00   | \$26.00 | N/A  |
| Bamboo Labs PLA (127.34 g) | 3D printed gearbox extension pieces                 | Bambu Lab    | #000000     | 11/15/2023 | 1   | \$12.19   | \$12.19 | N/A  |

|                       |   |           |                |            |   |          |          |                      |
|-----------------------|---|-----------|----------------|------------|---|----------|----------|----------------------|
| Ultimaker PLA (118 g) | 3D printed support for the driveshaft       | Ultimaker | RAL-9005       | 11/17/2023 | 1 | \$9.44   | \$9.44   | N/A                  |
| Ultimaker PLA (27 g)  | 3D printed racks                            | Ultimaker | RAL-9005       | 11/29/2023 | 1 | \$2.16   | \$2.16   | N/A                  |
| Ultimaker PLA (126 g) | 3D printed Motor Stand                      | Ultimaker | RAL-9005       | 12/01/2023 | 1 | \$10.08  | \$10.08  | N/A                  |
| <b>Component 2</b>    |   |           |                |            |   |          |          |                      |
| Linear Rails          | 400 mm linear rails                         | igus      | CWS-06-30-400  | 11/13/2023 | 2 | \$167.69 | \$335.38 | <a href="#">Link</a> |
| <b>Component 3</b>    |   |           |                |            |   |          |          |                      |
| Linear Slides         | Slides to support platform on linear slides | igus      | WWPL-06-30-06  | 11/13/2023 | 2 | \$18.25  | \$36.50  | <a href="#">Link</a> |
| <b>Component 4</b>    |   |           |                |            |   |          |          |                      |
| Driveshaft            | Connection piece between motor and gearbox  | Grainger  | H0400075PW1000 | 11/16/2023 | 1 | \$8.00   | \$8.00   | <a href="#">Link</a> |
| <b>Component 5</b>    |   |           |                |            |   |          |          |                      |

|  |  |           |  |            |   |         |         |     |
|--|--|-----------|--|------------|---|---------|---------|-----|
| Platform   | 1/4 black acrylic sheet provided by Makerspace         | MSC       | MSC# 63391700 (no part number given similar example) | 11/17/2023 | 1 | \$20.00 | \$20.00 | N/A |
| <b>Component 6</b>   |  |           |  |            |   |         |         |     |
| Glass Ball Bearings  | Glass ball bearings to allow for frictionless rotation | Grainger  | MSN0459939   | 12/1/2023  | 5 | \$17.07 | \$85.35 | N/A |
| <b>Component 7 - unused features due to reprints/redesigns</b> |  |           |  |            |   |         |         |     |
| Ultimaker PLA  | 3D printed Gearbox                                     | Ultimaker | RAL-9005   | 10/26/2023 | 1 | \$19.36 | \$19.36 | N/A |
| Ultimaker PLA  | Motor to driveshaft adapter piece                      | Ultimaker | RAL-9005   | 12/1/2023  | 1 | \$1.12  | \$1.12  | N/A |
| Ultimaker PLA  | Motor to driveshaft adapter piece reprint              | Ultimaker | RAL-9005   | 12/4       | 1 | \$2.84  | \$2.84  | N/A |
| Ultimaker PLA  | Motor to driveshaft adapter piece reprint              | Ultimaker | RAL-9005   | 12/5       | 1 | \$2.65  | \$2.65  | N/A |
| <b>TOTAL:</b>  | <b>\$574.03</b>  |           |  |            |   |         |         |     |

## Major team goals for the next week

1. Prepare and present preliminary presentation
2. Continue research for the redesign and prototype improvement
  - a. Kendra and Amber - transfer function incorporation
  - b. Max, Jamie, and Caspar - mechanical improvements to limit friction

## Next week's individual goals

- Max
  - Continue research into gear ratios for improved linear motion
  - Research flexible 3D printable materials for motor to drive shaft adaptor
  - Research potential torsional displacement in drive shaft
- Amber
  - Test new conversion factor
  - Test sinusoidal voltage output on oscilloscope
  - Begin editing and implementing PID control algorithm
- Jamie
  - Research gear ratios to improve friction of the device
  - Work on MRI screening checklist
- Kendra
  - Complete a code with a transfer function and appropriate proportion control
  - Work on Checklist 1 to get prepared for MRI screening
- Caspar
  - Research additional screw and nut compatibilities
  - Research available flexible 3D printed materials

## Timeline

| Task                   | Jan | Feb |   |    |    | March |   |    |    |    | April |    |    |    | May |    |
|------------------------|-----|-----|---|----|----|-------|---|----|----|----|-------|----|----|----|-----|----|
|                        | 26  | 2   | 9 | 16 | 23 | 1     | 8 | 15 | 22 | 29 | 5     | 12 | 19 | 26 | 3   | 10 |
| <b>Project R&amp;D</b> |     |     |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Empathize              |     | X   | X |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Background             |     | X   | X |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Prototyping            |     |     | X |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Testings               |     |     |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| <b>Deliverables</b>    |     |     |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Progress Reports       |     | X   | X |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Prelim presentation    |     |     | X |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Final Poster           |     |     |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| <b>Meetings</b>        |     |     |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Client                 |     | X   |   |    |    |       |   |    |    |    |       |    |    |    |     |    |
| Advisor                | X   | X   | X |    |    |       |   |    |    |    |       |    |    |    |     |    |

|                |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |
|----------------|---|---|---|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <b>Website</b> |   |   |   |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Update         | X | X | X |  |  |  |  |  |  |  |  |  |  |  |  |  |

Filled boxes = projected timeline  
 X = task was worked on or completed

## Previous week's goals and accomplishments

- Max
  - Met with Jamie and Caspar to discuss future redesigns
  - Preliminary design for swappable gear ratios
  - Finished assigned segment of preliminary presentation
- Amber
  - Met with Kendra to review new motor documentation
  - Calculated & implemented a new RPM to AnalogOut conversion factor
  - Improved clock management in sinusoidal function using wait\_us
  - Brainstormed preliminary PID algorithm
- Jamie
  - Met with Caspar and Max to discuss potential redirections
  - Finished assigned sections of preliminary presentation
- Kendra
  - Prepared for preliminary presentation and completed assigned slide
  - Redownloaded Mbed and import necessary files to have a functioning workspace
- Caspar
  - Met with Max and Jamie to discuss future redesigns
  - Preliminary design discussion
  - Worked on Preliminary presentation

## Activities

| Name  | Date    | Activity                                    | Time (h) | Week Total (h) | Sem. Total (h) |
|-------|---------|---|----------|----------------|----------------|
| Max   | 1/26/24 | Semester planning with team                 | 1.5      | 5              | 7              |
|       | 1/31/24 | Client meeting                              | 0.5      |                |                |
|       | 2/2/24  | Team meeting to review future fabrication   | 1.0      |                |                |
|       | 2/2/24  | Team presentation assignments               | 0.5      |                |                |
|       | 2/6/24  | Modeled future design in solidworks         | 1.5      |                |                |
|       | 2/6/24  | Worked on preliminary presentation          | 1.0      |                |                |
|       | 2/7/24  | Reviewed preliminary presentation with team | 1.0      |                |                |
| Amber | 1/26/24 | Semester planning with team                 | 1.5      | 4.0            | 7.0            |
|       | 1/31/24 | Client meeting                              | 0.5      |                |                |
|       | 2/1/24  | Controls research                           | 1.0      |                |                |
|       | 2/2/24  | Review Motor Documentation                  | 1.0      |                |                |
|       | 2/2/24  | Create preliminary presentation slides      | 0.5      |                |                |
|       | 2/5/24  | Implement changes to code                   | 1.0      |                |                |
|       | 2/6/24  | Draft PID algorithm                         | 0.5      |                |                |
|       | 2/7/24  | Review and practice preliminary             | 1.0      |                |                |

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|        |   | presentation w/ team   |  |     |      |
|--------|---|--|--|-----|------|
| Jamie  | 1/26/24<br>1/31/24<br>1/31/24<br>2/2/24<br>2/5/24<br>2/6/24<br>2/7/24<br>2/8/24 | Semester planning with team<br>Client meeting<br>Researched organ motion<br>Worked on Preliminary presentation<br>Completed budget slide<br>Completed timeline slide<br>Review and practice prelim presentation<br>Researched Plastic Screws | 1.5<br>0.5<br>0.5<br>0.5<br>0.5<br>1.0<br>1.0<br>0.5 | 3.5 | 6.0  |
| Kendra | 1/26/24<br>1/31/24<br>2/1/24<br>2/2/24<br>2/5/24<br>2/7/24                      | Semester planning with team<br>Client meeting<br>Researched transfer function<br>Review motor documentation<br>Edited preliminary slides<br>Review and practice prelim presentation  | 1.5<br>0.5<br>0.5<br>1.0<br>0.5<br>1.0               | 2.5 | 5.0  |
| Caspar | 1-26-24<br>1-31-24<br><br>2-2-24<br>2-7-24                                      | Semester planning with team<br>Client Meeting<br>Researched organ movement in MRIs<br>Team Meeting<br>Preliminary Presentation team meeting  | 1.5<br>0.5<br>0.75<br>1<br>1                         | 2   | 4.75 |