

# MRI compatible motion platform

Date: 03/22/2024 – 04/04/2024

Client: Jiayi Tang

Advisor: Dr. Trevathan

Team:

Maxwell Naslund

Caspar Uy

Kendra Besser

Jamie Flogel

Amber Schneider

## 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

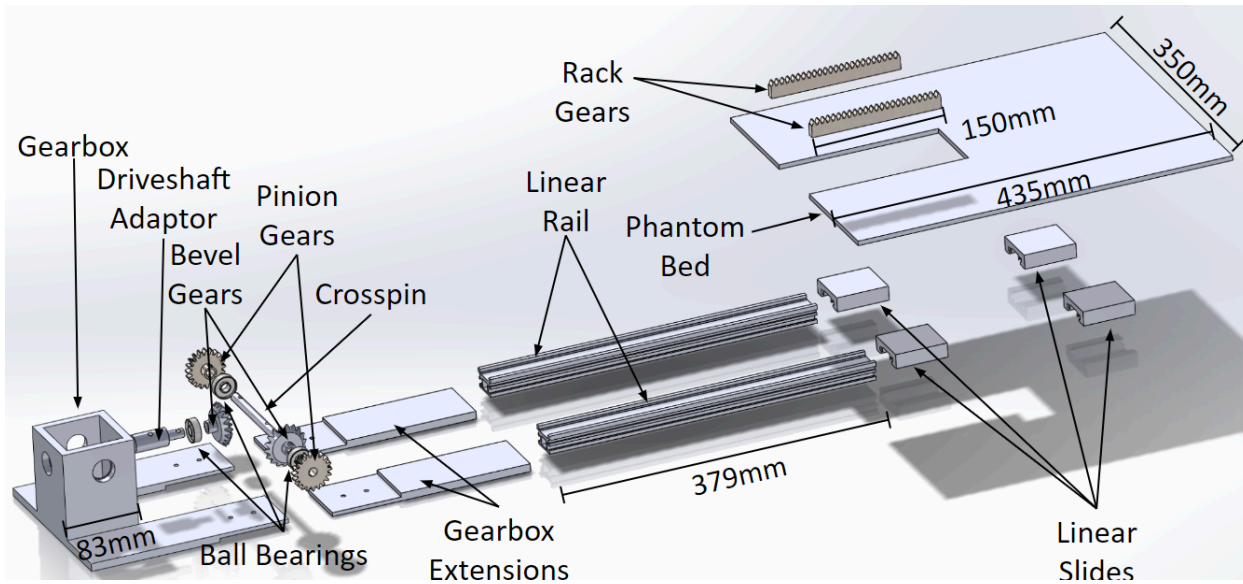
The team spent the week diagnosing problems with the software aspect of the motor assembly. Some team members met with the client regarding these issues, and have been in communication with Tekceleo in hopes of resolution. The team also met briefly to assemble the signal filter circuit, and the new negative rail circuit.

## Difficulties / advice requests

The team is having difficulty with getting an accurate signal from the microcontroller to the motor controller. Currently, we are speaking with Tekceleo to determine the best solution for this issue.

The team is having initial difficulty assembling the negative rail circuit. Some aspects of the diagrams are slightly unclear. The team will follow up with James Trevathan in hopes of resolution.

## Current design



## Materials and expenses

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
<b>Component 1</b>								
Ultimaker PLA	3D printed gears and gearbox	Ultimaker	RAL-9005	2/23/24	1	\$14.60	\$14.60	N/A
Ultimaker PLA (126 g)	3D printed gearbox extension pieces	Ultimaker	RAL-9005	2/27/24	1	\$6.30	\$6.30	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</b>								

M5 Plastic Screws	Used to assemble final prototype	Grainger	50M050080 H016	2/15/24	1	\$1.65 per package of 25	\$1.65	<a href="#">Link</a>
M4 Plastic Screws	Used to assemble final prototype	Grainger	50M040070N 035	2/15/24	2	\$5.92 per package of 25	\$11.84	<a href="#">Link</a>
Plastic Screws and Nuts	Plastic hardware from the makerspace	Makerspace	N/A	3/6/2024	1	\$1.30	\$1.30	N/A
<b>Component 8 Power Components</b>								
Power Inverter	Power supply inverter to improve circuit	DigiKey	PDM1-S5-D3 -S	3/22/24	2	\$5.12	\$10.24	<a href="#">Link</a>
<b>Component 9 - 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
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	3	\$10.08	\$10.08	N/A
<b>TOTAL:</b>	<b>\$619.96</b>							

## Major team goals for the next week

1. Continue research for the redesign and prototype improvement
  - a. Kendra and Amber - finalize re-design of circuit and test
  - b. Max, Jamie, and Caspar - finalize prototype

## Next week's individual goals

- Max
  - Join Motor software aspect of design
  - Work to improve motor accuracy
- Amber
  - Continue working on improving motor accuracy
  - Program motor to accommodate gearbox ratio
- Jamie
  - Continue working to increase motor accuracy
  - Test out new prototype with motor
- Kendra
  - Problem solve the negative rail circuit
  - Begin testing and reevaluation
- Caspar
  - Begin testing and reevaluation
  - Work on motor accuracy

## 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	X	X											
Background		X	X													
Prototyping			X	X	X	X	X	X	X		X					
Testing																
<b>Deliverables</b>																
Progress Reports		X	X	X	X	X	X	X	X		X					
Prelim presentation			X		X											
Final Poster																
<b>Meetings</b>																
Client		X					X				X					
Advisor	X	X	X	X	X	X										
<b>Website</b>																
Update	X	X	X	X	X	X	X	X	X							

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

## Previous week's goals and accomplishments

- Max
  - Helped assemble new electronic circuitry

- Draft executive summary
- Amber
  - Discuss motor issues with Tekceleo
  - Build circuit with new electronic component
  - Draft executive summary
- Jamie
  - Helped build circuit to incorporate electronic component
  - Draft executive summary
- Kendra
  - Discuss motor issues with Tekceleo
  - Build circuit with new electronic component
  - Draft executive summary
- Caspar
  - Draft executive summary
  - Help the electronics team

## Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	2	33.5
	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		
	2/12/24	Reidentified desirable producible sinusoid	1.0		
	2/14/24	Met with team to order screws, and calculate gearing ratio	2.0		
	2/16/24	Team meeting to clarify torque transmission	1.0		
	2/20/24	Gearbox outputs algorithm	1.0		
	2/22/24	Watched MRI Safety Video	1.0		
	2/22/24	Solidworks modifications to gears	2.5		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/26/24	Wrote 'MRI-Compatible Motion Platform' section in 'Methods' & 'Results & Discussion' for Preliminary Journal entry	1.0		
	2/27/24	Edit Preliminary Journal with team	2.0		
	2/28/24	HIPPA Training	1.0		
	2/28/24	Reprint Gearbox	0.5		
	3/1/24	Checklist I Screening	1		
	3/6/24	Meeting to start gearbox assembly	2		
	3/7/24	Rack Solidworks redesign	1		
	3/11/24	Client Meeting	0.5		
3/13/24	Team meeting to assemble gearbox	0.5			
3/13/24	Gearbox redesign	2			
3/15/24	Voltage divider design testing	2			

	3/20/24 4/3/24	Gearbox Assembly Negative rail assembly	2 2		
Amber	1/26/24 1/31/24 2/1/24 2/2/24 2/2/24 2/5/24 2/6/24 2/7/24  2/14/24 2/15/24 2/15/24 2/15/24 2/16/24  2/19/24  2/20/24 2/21/24 2/21/24 2/22/24 2/22/24 2/23/24  2/24/24 2/25/24 2/25/24 2/27/24 2/27/24 2/28/24 2/29/24 3/1/24 3/5/24 3/8/24 3/11/24 3/11/24 3/15/24 3/19/24 4/2/24 4/3/24  4/4/24	Semester planning with team Client meeting Controls research Review Motor Documentation Create preliminary presentation slides Implement changes to code Draft PID algorithm Review and practice preliminary presentation w/ team Started MRI certification Ran motor code test Analyzed results Updated code Team meeting to clarify sinusoidal motion equation (Velocity & Position) Meeting with Dr. Nimuncar to discuss sinusoidal motion function Edited sinusoidal motion function Tested & edited sinusoidal motion function Watched GEHC MRI safety video Test sinusoidal motion function Background research on Journal Article Drafted report and printed prototype with team HIPPA Training Wrote Motor and Testing sections of report Competing Design Journal Research Circuit Design Meeting Edit Preliminary Report Circuit Calculations MRI Safety Book Checklist I Screening Circuit Testing Circuit Testing w/ Team Client Meeting Circuit Redesign Voltage Divider Circuit assembly & testing Conversation with Tekceleo Meeting with Client Meeting with Team (executive summary & circuit construction) Communication with Tekceleo	1.5 0.5 1.0 1.0 0.5 1.0 0.5 1.0  0.50 0.50 0.50 0.50 1.0  0.5  1.0 2.0 1.0 1.0 1.0 1.5  0.5 0.5 0.5 0.5 2.0 1.0 1.5 1.0 2.0 1.5 1.0 2.0 1.5 1.0 2.0 0.5 0.5 2.0  0.5	4.0	37.0
Jamie	1/26/24 1/31/24 1/31/24 2/2/24 2/5/24 2/6/24 2/7/24 2/8/24 2/14/24  2/16/24	Semester planning with team Client meeting Researched organ motion Worked on Preliminary presentation Completed budget slide Completed timeline slide Review and practice prelim presentation Researched Plastic Screws Met with team to order screws, and calculate gearing ratio BPAG meeting	1.5 0.5 0.5 0.5 0.5 1.0 1.0 0.5 2.0  0.5	2.0	32.0



	2/16/24	Team meeting to clarify torque transmission	1.0		
	2/21/24	Researched potential journals	1.5		
	2/21/24	Watched MRI Safety Video	1.0		
	2/22/24	Solidworks modifications to gears	2.5		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/26/24	Wrote characterization of motion and sinusoidal motion test sections of report	0.5		
	2/27/24	HIPPA Training	0.5		
	2/27/24	MRI safety reading	0.5		
	2/27/24	Edit preliminary report	2.0		
	3/1/24	Checklist I Screening	1.0		
	3/6/24	Meeting to start gearbox assembly			
	3/8/24	Circuit Testing w/ Team	1.5		
	3/11/24	Client Meeting	0.5		
	3/13/24	Began assembly of new prototype redesigned motor stand	1.5		
	3/14/24	Updated expense table	0.5		
	3/15/24	Voltage divider design testing	2.0		
	3/20/24	Gearbox Assembly	2.0		
	4/3/24	Meeting with Team (executive summary & circuit construction)	2.0		
Kendra	1/26/24	Semester planning with team	1.5	3.5	27.5
	1/31/24	Client meeting	0.5		
	2/1/24	Researched transfer function	0.5		
	2/2/24	Review motor documentation	1.0		
	2/5/24	Edited preliminary slides	1.0		
	2/7/24	Review and practice prelim presentation	1.0		
	2/14/24	HIPPA training	0.5		
	2/26/24	Caught up on meetings	0.5		
	2/26/24	Downloaded, read, and ran new code	0.5		
	2/26/24	Wrote introduction to preliminary report	1.0		
	2/27/24	Circuit design meeting	0.5		
	2/27/24	Edited preliminary report	2.0		
	2/28/24	Watched MRI safety video	1.0		
	2/29/24	Read MRI safety manual	1.5		
	2/29/24	LP non inverting amp circuit equations and circuit draft	1.0		
	2/29/24	Completed design journal research	2.0		
	3/1/24	MRI checklist screening	1.0		
	3/4/24	Gathered materials & built LP/ amp circuit	1.0		
	3/5/24	Circuit Testing	2.0		
	3/12/24	Catch up on meeting notes	0.5		
	3/14/24	New circuit calculations	1.0		
	3/15/24	Voltage Divider Circuit assembly & testing	2.0		
	3/19/24	Conversation with Tekceleo	0.5		
	4/2/24	Meeting with Client	1.0		
	4/3/24	Meeting with Team (executive summary & circuit construction)	2.0		
	4/4/24	Communication with Tekceleo	0.5		
Caspar	1-26-24	Semester planning with team	1.5	1.5	27.63
	1-31-24	Client Meeting	0.5		
		Researched organ movement in MRIs	0.75		
	2-2-24	Team Meeting	1		

	2-6-24	Worked on Presentation Slides	1.25		
	2-7-24	Preliminary Presentation team meeting	1		
	2-8-24	Researched Plastic Screws	0.75		
	2-14-24	Finalizing Plastic Screw and Nut Research, Met to work on gearbox	1.25		
	2-16-24	Team Meeting	1.0		
	2-17-24	Journal Types Review	0.33		
	2-25-24	Preliminary Report	1.0		
	2-29-24	Watched MRI Safety Video	1.5		
	2-29-24	MRI Checklist Readings	1.0		
	3/1/24	MRI checklist Screening	1.0		
	3-6-24	Meeting to work on gearbox assembly	2		
	3-8-24	Circuit Testing and Screw modifying	2		
	3-11-24	Client Meeting	0.5		
	3-13-24	Began Assembly for next prototype	1.5		
	3-14-24	Worked on Driveshaft	2.5		
	3-20-24	Gearbox assembly	1.75		
	3-22-24	Worked on Driveshaft	2		
	4-5-24	Get briefed on Tekceleo and electronics team	1.5		