

MRI compatible motion platform

Date: 03/15/2024 – 03/21/2024

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.

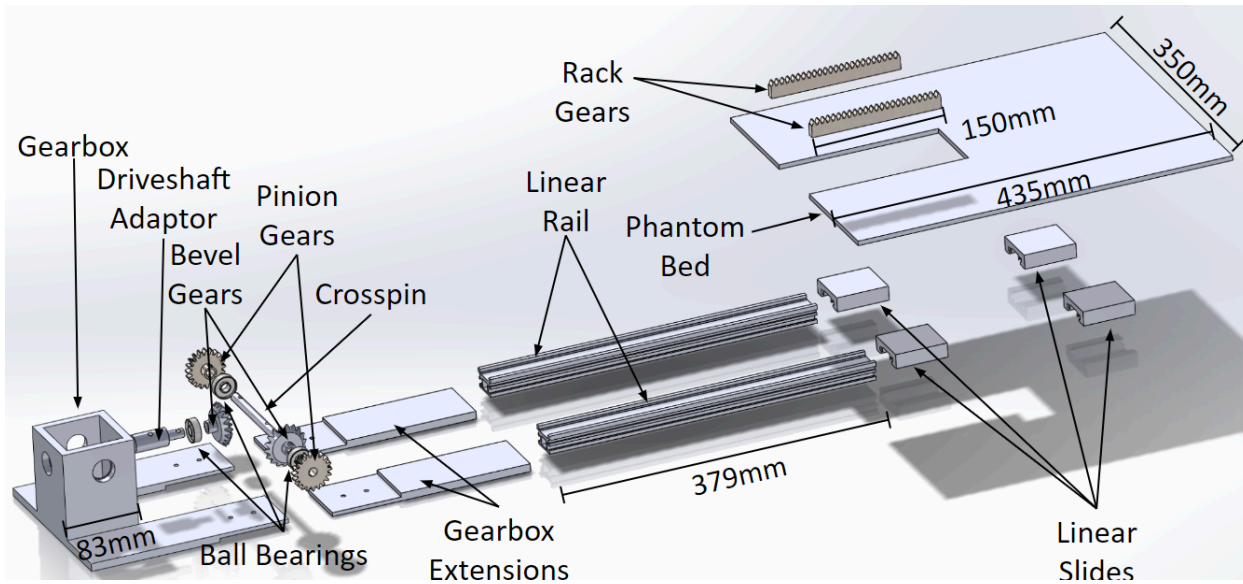
Brief status update

The team was unable to have a weekly advisor meeting due to the Tong lecture taking place. The team spent more time in the TEAMLab to completely finish the assembly of the MRI gearbox. The team decided to move forward with a 1.5:1 gear ratio to allow for better precision within the encoding of the motor. The team also placed an order for electrical components to allow for the development of a lowpass gain filter for the motor microcontroller. The team contacted a representative for Tekceleo to help troubleshoot current motor programming issues.

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.

Current design



Materials and expenses

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Component 1								
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
Component 2								

Linear Rails	400 mm linear rails	igus	CWS-06-30-400	11/13/2023	2	\$167.69	\$335.38	Link
Component 3								
Linear Slides	Slides to support platform on linear slides	igus	WWPL-06-30-06	11/13/2023	2	\$18.25	\$36.50	Link
Component 4								
Driveshaft	Connection piece between motor and gearbox	Grainger	H0400075PW1000	11/16/2023	1	\$8.00	\$8.00	Link
Component 5								
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
Component 6								
Glass Ball Bearings	Glass ball bearings to allow for frictionless rotation	Grainger	MSN0459939	12/1/2023	5	\$17.07	\$85.35	N/A
Component 7								

M5 Plastic Screws	Used to assemble final prototype	Grainger	50M050080 H016	2/15/24	1	\$1.65 per package of 25	\$1.65	Link	
M4 Plastic Screws	Used to assemble final prototype	Grainger	50M040070N 035	2/15/24	2	\$5.92 per package of 25	\$11.84	Link	
Plastic Screws and Nuts	Plastic hardware from the makerspace	Makerspace	N/A	3/6/2024	1	\$1.30	\$1.30	N/A	
Component 8 - unused features due to reprints/redesigns									
Ultimaker PLA	3D printed Gearbox	Ultimaker	RAL-9005	10/26/2023	3	1	\$19.36	\$19.36	N/A
Ultimaker PLA	Motor to driveshaft adapter piece	Ultimaker	RAL-9005	12/1/2023	1	1	\$1.12	\$1.12	N/A
Ultimaker PLA	Motor to driveshaft adapter piece reprint	Ultimaker	RAL-9005	12/4	1	1	\$2.84	\$2.84	N/A
Ultimaker PLA	Motor to driveshaft adapter piece reprint	Ultimaker	RAL-9005	12/5	1	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	1	\$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
TOTAL:	\$609.72							

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
 - n/a (spring break)
- Amber
 - n/a (spring break)
- Jamie
 - n/a (spring break)
- Kendra
 - n/a (spring break)

- Caspar
 - n/a (spring break)

Timeline

Task	Jan	Feb				March					April				May	
	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10
Project R&D																
Empathize		X	X	X	X											
Background		X	X													
Prototyping			X	X	X											
Testing																
Deliverables																
Progress Reports		X	X	X	X	X	X	X								
Prelim presentation			X		X											
Final Poster																
Meetings																
Client		X					X									
Advisor	X	X	X	X	X	X										
Website																
Update	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
 - Incorporated 1.5:1, 1:1, and 2:1 gearing ratios in the gearbox
 - Finalized gearbox assembly
 - Helped test voltage divider design
 - Helped Identify negative rail component
- Amber
 - Created voltage divider & HP filter passive circuit
 - Tested new circuit and compared to previous circuit
 - Contacted Tekceleo for assistance with using the motor
- Jamie
 - Helped test voltage divider design
 - Finalized gearbox assembly
- Kendra
 - Tested voltage divider circuit
 - Contacted Tekceleo for assistance with using the motor
- Caspar
 - Helped finalized gearbox assembly
 - Finalized drive shaft

- Helped identify negative components in rail

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	4	31.5
	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	Gearbox Assembly	2		
	Amber	1/26/24	Semester planning with team		
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 presentation w/ team	1.0		
2/14/24		Started MRI certification	0.50		
2/15/24		Ran motor code test	0.50		
2/15/24		Analyzed results	0.50		
2/15/24		Updated code	0.50		
2/16/24		Team meeting to clarify sinusoidal motion	1.0		

	2/19/24	equation (Velocity & Position) Meeting with Dr. Nimuncar to discuss sinusoidal motion function	0.5		
	2/20/24	Edited sinusoidal motion function	1.0		
	2/21/24	Tested & edited sinusoidal motion function	2.0		
	2/21/24	Watched GEHC MRI safety video	1.0		
	2/22/24	Test sinusoidal motion function	1.0		
	2/22/24	Background research on Journal Article	1.0		
	2/23/24	Drafted report and printed prototype with team	1.5		
	2/24/24	HIPPA Training	0.5		
	2/25/24	Wrote Motor and Testing sections of report	0.5		
	2/25/24	Competing Design Journal Research	0.5		
	2/27/24	Circuit Design Meeting	0.5		
	2/27/24	Edit Preliminary Report	2.0		
	2/28/24	Circuit Calculations	1.0		
	2/29/24	MRI Safety Book	1.5		
	3/1/24	Checklist I Screening	1.0		
	3/5/24	Circuit Testing	2.0		
	3/8/24	Circuit Testing w/ Team	1.5		
	3/11/24	Client Meeting	0.5		
	3/11/24	Circuit Redesign	1.0		
	3/15/24	Voltage Divider Circuit assembly & testing	2.0		
	3/19/24	Conversation with Tekceleo	0.5		
Jamie	1/26/24	Semester planning with team	1.5	4.0	30.0
	1/31/24	Client meeting	0.5		
	1/31/24	Researched organ motion	0.5		
	2/2/24	Worked on Preliminary presentation	0.5		
	2/5/24	Completed budget slide	0.5		
	2/6/24	Completed timeline slide	1.0		
	2/7/24	Review and practice prelim presentation	1.0		
	2/8/24	Researched Plastic Screws	0.5		
	2/14/24	Met with team to order screws, and calculate gearing ratio	2.0		
	2/16/24	BPAG meeting	0.5		
	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		

Kendra	1/26/24	Semester planning with team	1.5	2.5	24.0
	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			
Caspar	1-26-24	Semester planning with team	1.5	3.75	26.13
	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	1.25		
		Research, Met to work on gearbox			
	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			