MRI compatible motion platform

Date: 02/23/2024 - 02/29/2024

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.

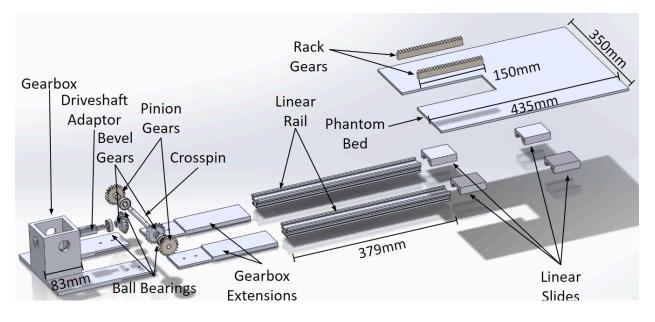
Brief status update

As for the motor control, the team met with our advisor and a UW research associate to help troubleshoot issues with the microcontroller. The team concluded that an additional step-down amplifier circuit along with a low-pass filter is necessary to get a better signal from the microcontroller to the motor control board. The team began to work on a circuit to output the desired gain and cutoff frequency.

Difficulties / advice requests

N/A

Current design



Materials and expenses

ltem	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
Component 1	I							
Ultimaker PLA (37.0 g)	3D printed gears to translate and facilitate motion	Ultimaker	RAL-9010	10/26/202 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

Component 5											
Driveshaft	Connection piece between motor and gearbox	Grainger	H0400075PW 1000	11/16/2023	1	\$8.00	\$8.00	<u>Link</u>			
Component 4	L										
Linear Slides	Slides to support platform on linear slides	igus	WWPL-06-30 -06	11/13/2023	2	\$18.25	\$36.50	<u>Link</u>			
Component 3	3										
Linear Rails	400 mm linear rails	igus	CWS-06-30-4 00	11/13/2023	2	\$167.69	\$335.38	Link			
Component 2											
Ultimaker PLA (126 g)	3D printed Motor Stand	Ultimaker	RAL-9005	12/01/202 3	1	\$10.08	\$10.08	N/A			
Ultimaker PLA (27 g)	3D printed racks	Ultimaker	RAL-9005	11/29/2023	1	\$2.16	\$2.16	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			

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 - unused features due to reprints/redesigns										
Ultimaker PLA	3D printed Gearbox	Ultimaker	RAL-9005	10/26/202 3	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		
TOTAL:	\$574.03		·							

Major team goals for the next week

- 1. Continue research for the redesign and prototype improvement
 - a. Kendra and Amber Design and build op amp circuit with LP filter. Test implementation between microcontroller and motor controller.
 - b. Max, Jamie, and Caspar Finalize algorithm to define gearbox limitations
- 2. Finish Checklist 1 to get access to research lab MRI

Next week's individual goals

- Max
 - Complete Checklist I for MRI access
 - Assembly Gearbox with 1.5:1 gear ratio
- Amber
 - Complete Checklist I for MRI access
 - Finalize circuit calculations
 - Build circuit
- Jamie
 - Complete Checklist I for MRI access
 - Begin assembling the prototype
- Kendra
 - Complete checklist 1 for MRI access
 - Build circuit with LP filter and noninverting amp
- Caspar
 - Complete Checklist for MRI access
 - Begin prototype assembly

Task	Jan		F	eb			March				April			Мау		
IdSK	26	2	9	16	23	1	8	15	22	29	5	12	19	26	3	10
Project R&D																
Empathize		Х	Х	Х	Х											
Background		Х	Х													
Prototyping			Х	Х	Х											
Testings																
Deliverables																
Progress Reports		Х	Х	Х	Х											
Prelim presentation			Х		Х											
Final Poster																
Meetings																
Client		Х														
Advisor	Х	Х	Х	Х	Х											

Timeline

Website											
Update	Х	Х	Х	Х	Х						

Filled boxes = projected timeline

X = task was worked on or completed

Previous week's goals and accomplishments

- Max
 - Watched MRI Safety Video
 - Solidworks modifications to gears with Jamie
 - Drafted report and printed prototype with team
 - Wrote 'MRI-Compatible Motion Platform' section in 'Methods' & 'Results & Discussion' for Preliminary Journal entry
 - Edit Preliminary Journal with team
 - HIPPA Training
 - Reprint Gearbox
- Amber
 - Began designing step-down amplifier circuit with low pass filter
 - Read the "ACR 2020 Manual on MRI Safety" & completed HIPPA training
 - Wrote "Characterization of Motion" and "Preliminary Sinusoidal Motion Test" sections of Results & Discussion portion of the preliminary report
 - Edited report with team
- Jamie
 - Met with Max to redesign the gears to account for different gear ratios
 - Read the "ACR 2020 Manual on MRI Safety" & completed HIPPA training
 - Wrote "Characterization of Motion" and "Preliminary Sinusoidal Motion Test" sections of Methods portion of the preliminary report
 - Edited report with team
- Kendra
 - Completed train modules for HIPPA an MRI safety
 - Met with amber to talk over the LP RC circuit with a non inverting amplifier
 - Updated PDS and organized the introduction in the preliminary deliverables
 - Edited preliminary report with team
 - Updated lab archives notebook
- Caspar
 - Wrote Conclusion and Future tests portion of preliminary report
 - Reviewed report
 - Reviewed MRI safety checklist

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Мах	1/26/24 1/31/24 2/2/24 2/2/24 2/6/24	Semester planning with team Client meeting Team meeting to review future fabrication Team presentation assignments Modeled future design in solidworks	1.5 0.5 1.0 0.5 1.5	9.5	21.5

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BME Design: 402

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	2/27/24	Edit preliminary report	2.0		
Kendra	1/26/24 1/31/24 2/1/24 2/2/24 2/5/24 2/7/24 2/26/24 2/26/24 2/26/24 2/27/24 2/27/24 2/27/24 2/27/24 2/28/24 2/29/24 2/29/24	Semester planning with team Client meeting Researched transfer function Review motor documentation Edited preliminary slides Review and practice prelim presentation HIPPA training Caught up on meetings Downloaded, read, and ran new code Wrote introduction to preliminary report Circuit design meeting Edited preliminary report Watched MRI safety video Read MRI safety manual LP non inverting amp circuit equations and circuit draft Completed design journal research	1.5 0.5 1.0 1.0 1.0 0.5 0.5 1.0 0.5 2.0 1.0 1.5 1.0 2.0	10	16
Caspar	1-26-24 1-31-24 2-2-24 2-6-24 2-7-24 2-8-24 2-14-24 2-16-24 2-16-24 2-17-24 2-25-24	Semester planning with team Client Meeting Researched organ movement in MRIs Team Meeting Worked on Presentation Slides Preliminary Presentation team meeting Researched Plastic Screws Finalizing Plastic Screw and Nut Research, Met to work on gearbox Team Meeting Journal Types Review Preliminary Report	1.5 0.5 0.75 1 1.25 1 0.75 1.25 1.0 0.33 1.0	1	10.33