

MRI compatible motion platform

Date: 03/08/2024 – 03/14/2024

Client: Jiayi Tang

Advisor: Dr. Trevathan

Team:

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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.

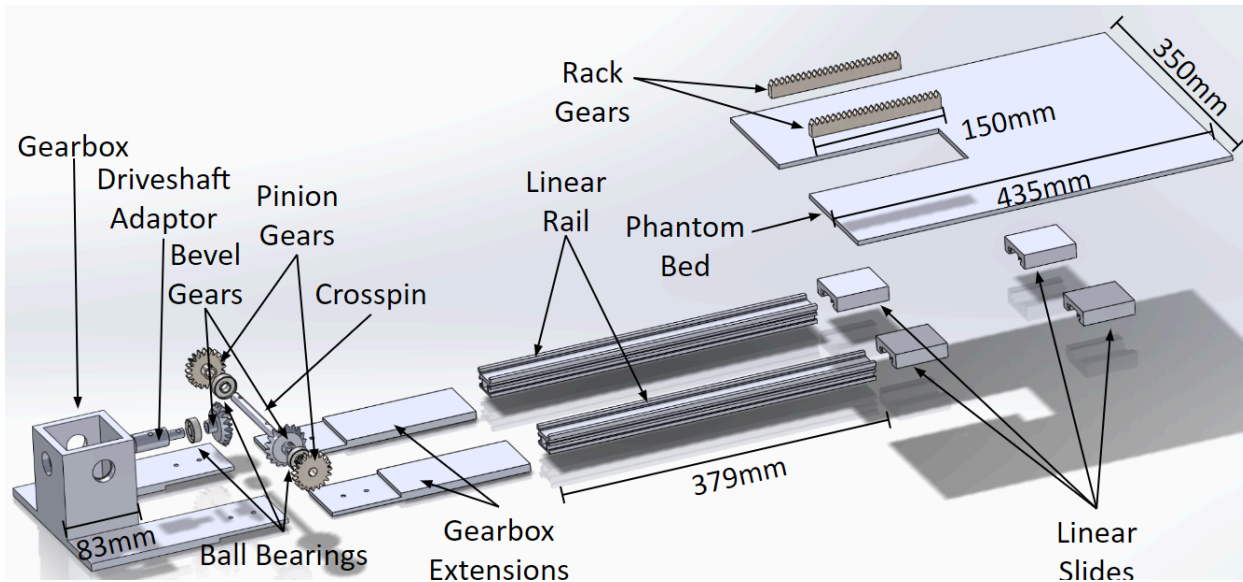
Brief status update

The team spent the week wrapping up the assembly of the MRI gearbox. The team can now shift efforts to entirely focus on the software aspects of the design. The gearbox will now be capable of producing gear ratios of 1:1, 1.5:1, and 2:1 depending on what outputs are desired. The team has also begun to look into the best way to clean the signal output from the microcontroller, the increase of gear ratio will help this aspect, but an additional lowpass filter is being developed to optimize the signal.

Difficulties / advice requests

N/A

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
 - Help team move efforts to software
 - Spend time catching up and understanding software
 - Finalize new lowpass filter
- Amber
 - Test new circuit on oscilloscope
 - Determine which circuit to use
 - Test circuit with motor

- Jamie
 - Finalize prototype
 - Begin integrating with software team
- Kendra
 - Finalize circuit design and integrate with software
 - Complete fabrication of full design and prepare for testing in MRI
- Caspar
 - Finalize prototype
 - Work with software team

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											
Testings																
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	X									
Website																
Update	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
 - Redesigned gearbox to incorporate 1:1, 1.5:1, and 2:1 gear ratios
 - Fully assembly gearbox
 - Helped redesign motor stand
 - Met with client to discuss new maximum specifications
- Amber
 - Test amplifier circuit with LP filter with team
 - Meet with client to discuss maximum specifications
 - Update circuit to a voltage divider and low pass filter
- Jamie
 - Met with client to discuss maximum specifications

- Met with Max and Caspar to deconstruct last prototype
- Redesigned motor stand
- Updated expense table
- Kendra
 - Caught up the meeting notes from last week
 - Recalculated the new prototype resistor and capacitor values
- Caspar
 - Met with Jamie and Max to deconstruct last prototype
 - Helped with newly printed gearbox assembly

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	3	27.5
	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			
Amber	1/26/24	Semester planning with team	1.5	3.0	30.5
	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 equation (Velocity & Position)	1.0		
	2/19/24	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		
Jamie	1/26/24	Semester planning with team	1.5	4.0	26.0
	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		
Kendra	1/26/24	Semester planning with team	1.5	1.5	21.5
	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		
Caspar	1-26-24	Semester planning with team	1.5	9.5	22.38
	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		