BME Design: 402

MRI compatible motion platform

Date: 03/01/2024 – 03/07/2024

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.

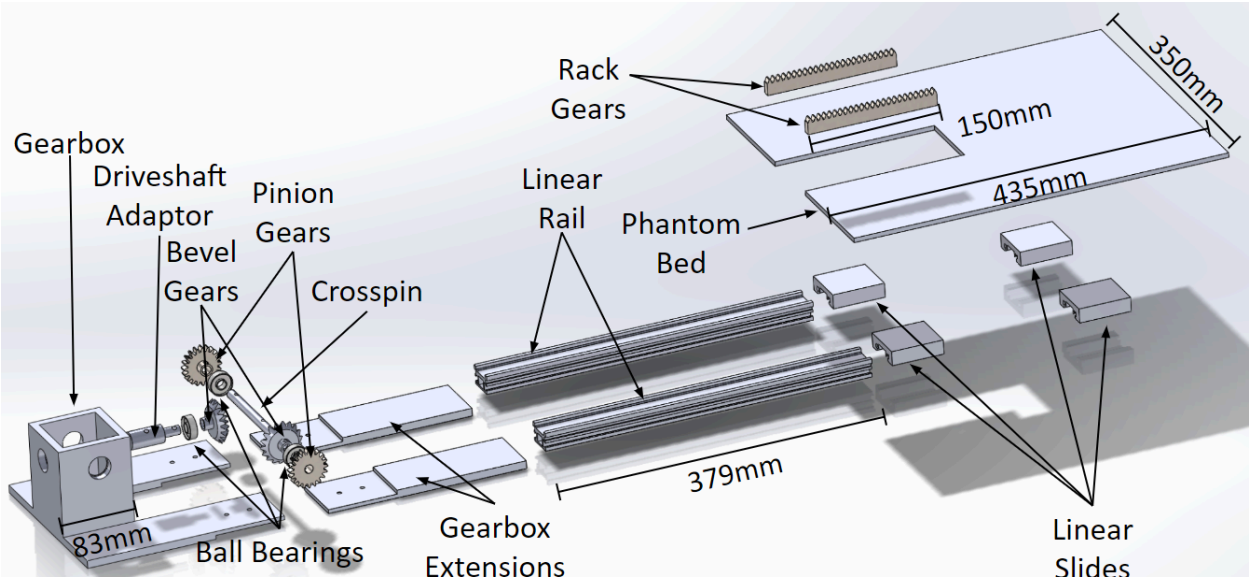
Brief status update

This week the team has spent time to start the assembly of the newly designed gearbox. The new gearbox will utilize a 1.5:1 gear ratio to improve the amount of torque delivered to the motion platform. The team has also begun the design and implementation of a low-pass filter to help deliver a clean signal to the piezoelectric motor. The incorporation of an inverting amplifier to the low-pass filter will also allow for a better utilization of output range of the microcontroller, to allow for a more accurate output.

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 (37.0 g)	3D printed gears to translate and facilitate motion	Ultimaker	RAL-9010	10/26/2023	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
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 - unused features due to reprints/redesigns								
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
TOTAL:	**$574.03**							

Major team goals for the next week

1. Continue research for the redesign and prototype improvement
    a. Kendra and Amber - built and tested circuit
    b. Max, Jamie, and Caspar - Fully assemble Gearbox and start migration towards software

Next week's individual goals

- Max
    - Finalize gearbox assembly
    - Prepare to merge teams towards software development
- Amber
    - Improve circuit
    - Adjust code based on experimental gain
    - Test with oscilloscope and motor
- Jamie
    - Finalize gearbox assembly
    - Begin to integrate with software team
- Kendra
    - Redesign circuit based on testing results
    - Test full assembly with new circuit
- Caspar
    - Finalize gearbox assembly
    - Get more plastic nuts
    - Merge teams

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									
Prelim presentation			X		X											
Final Poster																
Meetings																
Client		X														
Advisor	X	X	X	X	X											
Website																

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Update	X	X	X	X	X	X										

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

Previous week's goals and accomplishments

- Max
  - Began gearbox assembly
  - Redesigned rack design
  - 3D printed gearbox
- Amber
  - Completed Checklist I MRI certification
  - Tested circuit with oscilloscope and waveform generator
  - Adjusted circuit gain
- Jamie
  - Completed Checklist I MRI certification
  - Began assembling new gearbox
- Kendra
  - Completed checklist 1 MRI certification
  - Designed and developed circuit for LP filter and noninverting amp
  - Tested circuit with oscilloscope and waveform generator
- Caspar
  - Start assembling new gearbox
  - Complete checklist I MRI certification
  - MRI screening

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	3	24.5
	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'	1.0		

		section in ‘Methods’ & ‘Results & Discussion’ for Preliminary Journal entry			
	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		
Amber	1/26/24	Semester planning with team	1.5	3.0	27.5
	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		
Jamie	1/26/24	Semester planning with team	1.5	2.5	22.0
	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 2/22/24 2/23/24 2/26/24 2/27/24 2/27/24 2/27/24 3/1/24 3/6/24	Watched MRI Safety Video Solidworks modifications to gears Drafted report and printed prototype with team Wrote characterization of motion and sinusoidal motion test sections of report HIPPA Training MRI safety reading Edit preliminary report Checklist I Screening Meeting to start gearbox assembly	1.0 2.5 1.5 0.5 0.5 0.5 2.0 1.0		
Kendra	1/26/24 1/31/24 2/1/24 2/2/24 2/5/24 2/7/24 2/14/24 2/26/24 2/26/24 2/26/24 2/27/24 2/27/24 2/28/24 2/29/24 2/29/24 2/29/24 3/1/24 3/4/24 3/5/24	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 MRI checklist screening Gathered materials & built LP/ amp circuit Circuit Testing	1.5 0.5 0.5 1.0 1.0 1.0 0.5 0.5 0.5 1.0 0.5 2.0 1.0 1.5 1.0 2.0 1.0 1.0 2.0	4.0	20
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 2-17-24 2-25-24 2-29-24 2-29-24	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 Watched MRI Safety Video MRI Checklist Readings	1.5 0.5 0.75 1 1.25 1 0.75 1.25 1.0 0.33 1.0 1.5 1.0	2.5	12.88