

# MRI compatible motion platform

Date: 02/16/2024 – 02/22/2024

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.

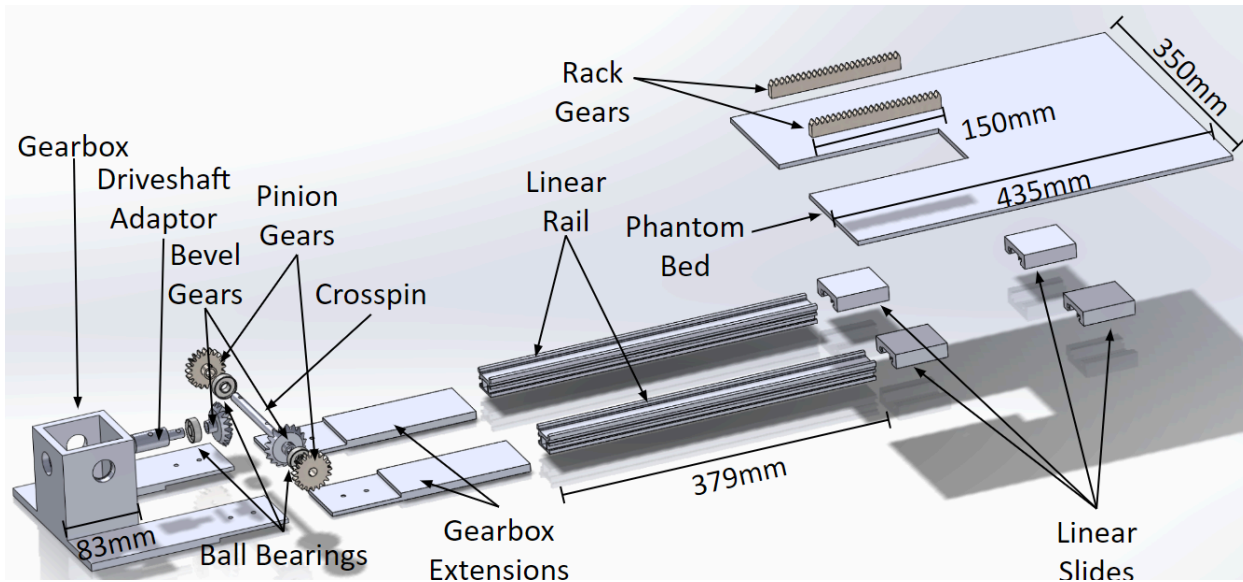
## Brief status update

The team met briefly to define limitations of the gearbox system. An algorithm to define strain placed on the motor for the required outputs was developed over the week. The motor control code was reviewed with Professor Nimunkar, who teaches the Computers in Medicine course. The sinusoidal motion function was updated and its functionality was validated with testing..

## Difficulties / advice requests

N/A

## Current design



## Materials and expenses

Item	Description	Manufacturer	Part Number	Date	QTY	Cost Each	Total	Link
<b>Component 1</b>								
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	1	\$10.08	\$10.08	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 - 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
<b>TOTAL:</b>	<b>\$574.03</b>							

## Major team goals for the next week

1. Continue research for the redesign and prototype improvement
  - a. Kendra and Amber - Test motor functionality with full prototype setup, begin implementation of PID control algorithm
  - 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
  - Finalize gear optional gear ratio for gearbox assembly
  - Finalize gearbox redesign
  - 3D print gearbox redesign prototype
  - Assemble gearbox assembly using non-metallic screws.
- Amber
  - Test sinusoidal motion function with full prototype
  - Interpret results to understand if changes were meaningful and if there is still significant error
  - Finish Checklist 1
    - Set up in-person interview
  - Begin implementation of PID control after advisor meeting
- Jamie
  - Finalize gear ratio options and redesign
  - 3D print the gearbox
  - Assemble the prototype using non-metallic screws
  - Work on journal article
- Kendra
  - Absent due to personal reasons
- Caspar
  - Assemble Gearbox with non-metallic screws
  - Work on journal article

## 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													
Background		X	X													
Prototyping			X													
Testings																
<b>Deliverables</b>																
Progress Reports		X	X													
Prelim presentation			X													

Final Poster																	
<b>Meetings</b>																	
Client		X															
Advisor	X	X	X														
<b>Website</b>																	
Update	X	X	X	X													

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

## Previous week's goals and accomplishments

- Max
  - Helped clarify torque transmission equation
  - Developed gearbox limitations algorithm
  - Helped order non-metallic screws
- Amber
  - Reviewed and explained motor code calculations to team and advisor
  - Edited and tested sinusoidal motion equation
  - Continued working on checklist 1 requirements
- Jamie
  - Worked on clarifying torque transmission equations
  - Identified and calculated range of torques and RPM for varying position functions
  - Researched potential journals for submission
- Kendra
  - Continue to research PID control and interface options
  - Edited and tested sinusoidal motion equation
- Caspar
  - Worked on finding non-metallic screw
  - Reviewed potential journal types

## Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Max	1/26/24	Semester planning with team	1.5	2	12
	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		
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	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	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	7.5	16.5
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 2/16/24  2/21/24 2/21/24	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 Team meeting to clarify torque transmission Researched potential journals Watched MRI Safety Video	1.5 0.5 0.5 0.5 0.5 1.0 1.0 0.5 2.0  0.5 1.0  1.5 1.0	4.0	12
Kendra	1/26/24 1/31/24 2/1/24 2/2/24 2/5/24 2/7/24	Semester planning with team Client meeting Researched transfer function Review motor documentation Edited preliminary slides Review and practice prelim presentation	1.5 0.5 0.5 1.0 0.5 1.0		5.0
Caspar	1-26-24 1-31-24  2-2-24 2-6-24 2-7-24 2-8-24 2-14-24	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	1.5 0.5 0.75 1 1.25 1 0.75 1.25	2.25	9.33

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	2-16-24 2-17-24	Team Meeting Journal Types Review	1.0 0.33		
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