BME Design-Fall 2022 - Mateo Silver
Complete Notebook

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Mateo Silver

on

Dec 14, 2022 @11:38 PM CST

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Team contact Information

EMILY WADZINSKI - Oct 09, 2022, 11:37 AM CDT

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Project description

EMILY WADZINSKI - Oct 12, 2022, 12:08 PM CDT

Course Number: BME 200/300

Project Name: Microscope Low-Cost Motorized Stage

Short Name: N/A

Project description/problem statement: The current inverted fluorescent microscopes have fixed stages only movable by manual knobs which is difficult to imaging and control. The new designed stage should add features such as automatic controls to lower the difficulty of using the microscope while keeping precise and low cost.

About the client: Dr. John Puccinelli

9/19/22 - Client Meeting 9/19

Mateo Silver - Sep 21, 2022, 11:21 AM CDT

Title: Client Meeting 9/19

Date: 9/19/2022

Content by: Mateo Silver

Present: Mateo, Shreya, Darshigaa

Goals: Talk to Dr. P about our questions on the project.

Content:

Before today's meeting we came up with questions for our client. The questions (bold) and answers from our client are listed below.

- **Goals for project - what have other groups not done that he'd like to see**
    - Make electronics smaller and enclosed
    - Joystick (first priority) Computer interface (second priority)
- **What is the state of the project following the last team**
    - No team has made a functional microscope stage yet
- **What is the budget for this project?**
    - $100
    - Motors can be fairly expensive
    - Can use things in 201 cabinet and previous team components
- **Scalability of project, how many microscopes does he hope to use this on**
    - Make it universal, but mostly just the two in the teaching lab.
- **What are the microscopes going to be used for?**
    - Experiments for teaching lab classes
- **What is the power source? Is the microscope stage going to be powered by an outlet or batteries?**
    - Can use either. Wall power is fine
- **Where are/how can we access a microscope to test on**
    - In the 1002 ECB room
    - Must request access using the website
    - Should make sure to cover up the microscope after use
- **Any preference on materials? Any concerns on the safety, use guidelines?**
    - 3d printing
    - Laser cutting for the clear plastic
    - Makerspace
- **Software that the microscope uses:**
    - Nikon elements, micromanger (open source)
- **Size**
    - as small as we can make it

- Don't get in the way of microscope operation

**Drifting of the stage to account for (not for nikon microscope)

Conclusions/action items:

We can move forward with the preliminary PDS now that we have more client questions answered.

9/16/2022 - Advisor Meeting 9/16

Sam TAN - Oct 12, 2022, 12:39 PM CDT

Title: Advisor Meeting 9/16

Date: 9/16/2022

Content by: Mateo Silver

Present: Mateo, Shreya, Darshigaa, Sam, Emily

Goals: Looking ahead to upcoming due dates, how course runs

Content:

Meeting notes:

- Take team picture this week (make sure we stand in order of bme website order)

- Client meeting on Monday at 11am, ECB

- Look into previous work on project, ask Dr. P and advisors for questions

- Look at rubrics ahead of time, line up presentations/deliverables to rubric

- notebook grading a bit more lenient, as long as we're focused on making a functional notebook

- new: notebook participation grade

- PDS Draft due next week (thursday)

    - As quantitative as possible, testing info, etc.

- Design matrix due following week

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

10/28/22 - Advisor meeting

SHREYA GODISHALA - Oct 28, 2022, 1:34 PM CDT

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

- problems are that the gear is not tall enough therefore we CAD the design so the gear is upside down

Gear Mechanism:

- how are gears interfacing with motor

- keep mass of system as close to the slide system that is currently in use to prevent future problems with

- increase number of shells and the thickness is going to make a stronger part.

Conclusions/action items:

Review the design with the group and then start 3-D printing the designs for the gears and the gear box model. Rebuilding the circuit and adding the joystick and then tweaking the code. Next week we have the show and tell so group is going to prepared for that.

Show and Tell Notes

EMILY WADZINSKI - Dec 14, 2022, 3:10 PM CST

Title: Show and Tell

Date: 11/4/2022

Content by: Emily

Present: Emily, Mateo, Darshigaa, Shreya, Nikhil, Sam

Goals: Consider suggestions for our project

Content:

During the show and tell, groups that came by gave us a couple suggestions that they could think of after we presented our current project and difficulities. These were some of the suggestions:

- more smaller gears

- use a drive chain/belt

- decrease gear thread size

- clean up wires by putting them in a box

- instead of a joystick, enter the exact distances when testing using a different tool

Conclusions/action items:

Discuss these ideas next group/advisor meeting

10/12/22 Design Sketches

Sam TAN - Oct 12, 2022, 12:39 PM CDT

Title: Design Sketches

Date: 10/12/22

Content by: All

Present: All

Goals: Sketch design ideas for prototype

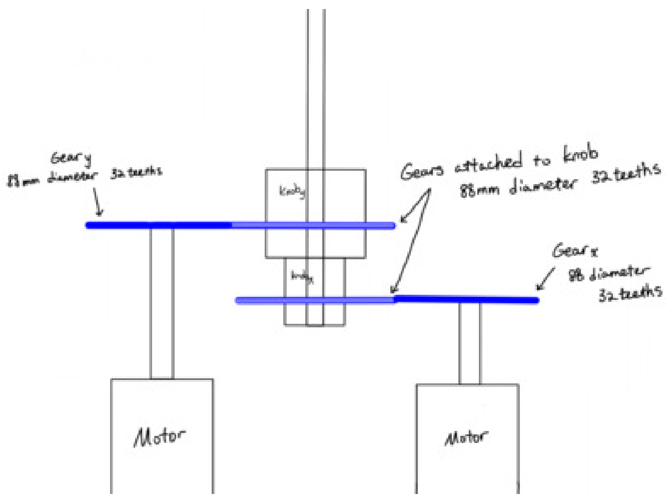
Content:

Attached

Conclusions/action items:

N/A

Sam TAN - Oct 12, 2022, 12:40 PM CDT



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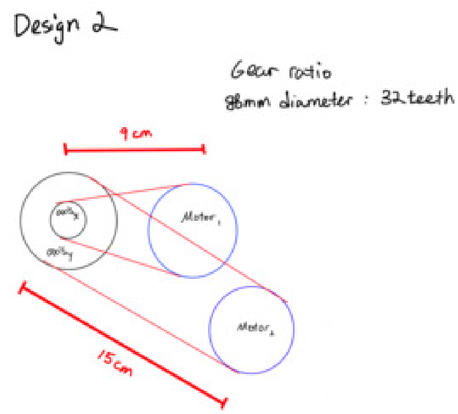
Sam TAN - Oct 12, 2022, 12:40 PM CDT



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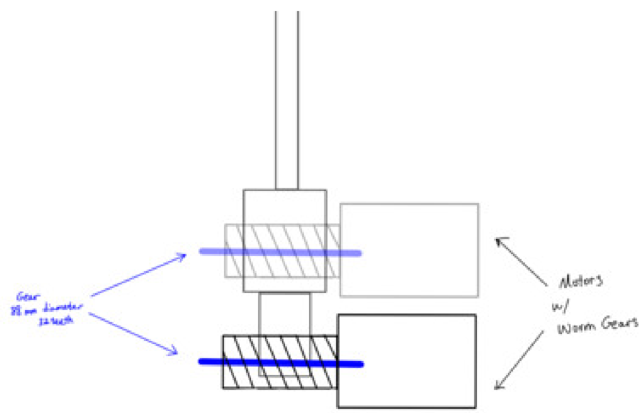
Sam TAN - Oct 12, 2022, 12:40 PM CDT



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12/5/2022 - Motor Mount Designs

EMILY WADZINSKI - Dec 14, 2022, 8:54 PM CST

Title: Motor Mount Designs

Date: 12/5/2022

Content by: Emily

Present: Emily, Nikhil, Mateo

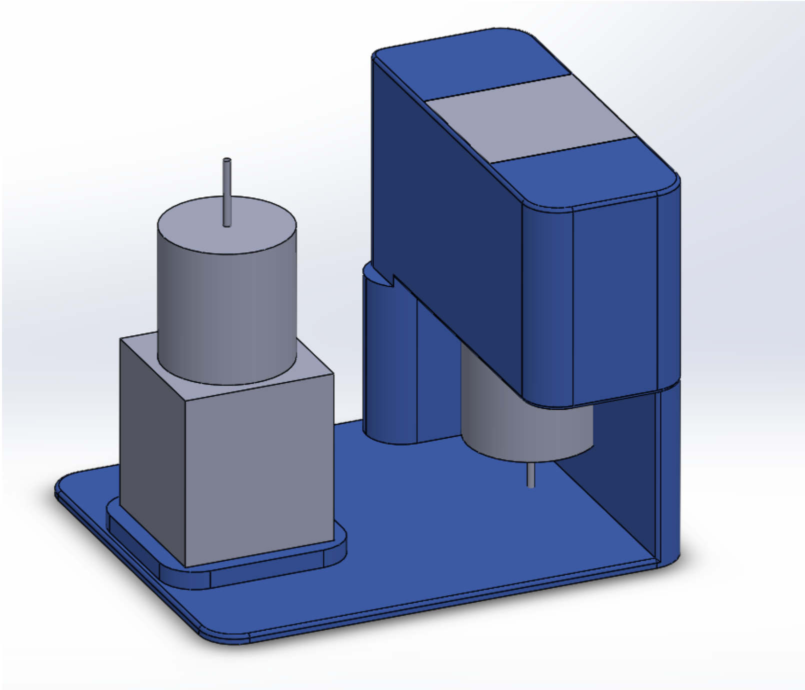
Goals: Create a final working prototype for fabrication

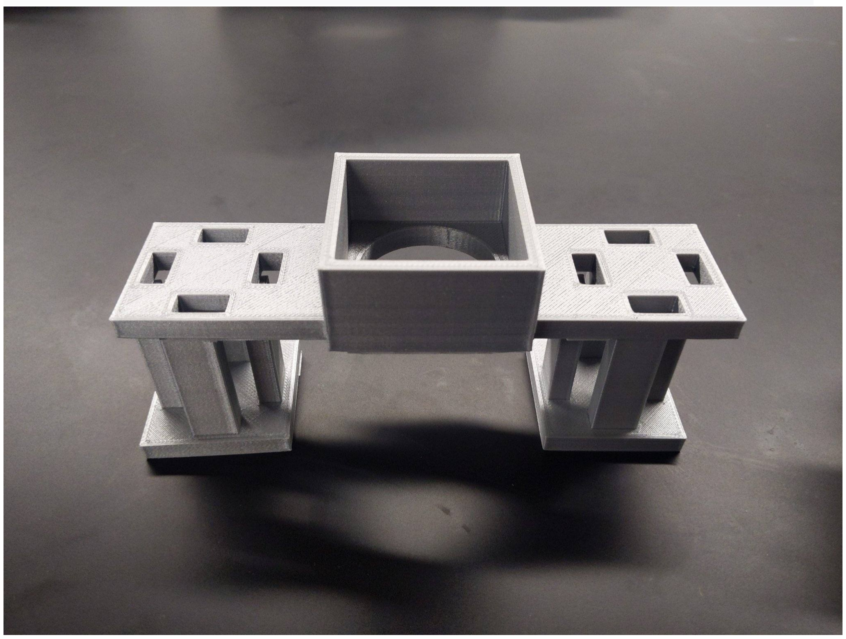
Content:

After we picked our proposed design, three different motor mounts were then created. The first was presented to the group and advisor, and then was built off of for the 2nd and 3rd. The first design introduced flipping one of the stepper motors upside down in order to reach the gears, as the motor shaft is taller than the gears are to the ground. It was then proposed that both motors must be flipped upside down in order for the gears to align, which is shown in the 2nd design. The 3rd mount was then edited from the 2nd to extend the motors' stands slightly wider in order to allow for larger gears. The 3rd design also includes another post on the bases to keep the top from falling. The second and third designs were 3D printed.

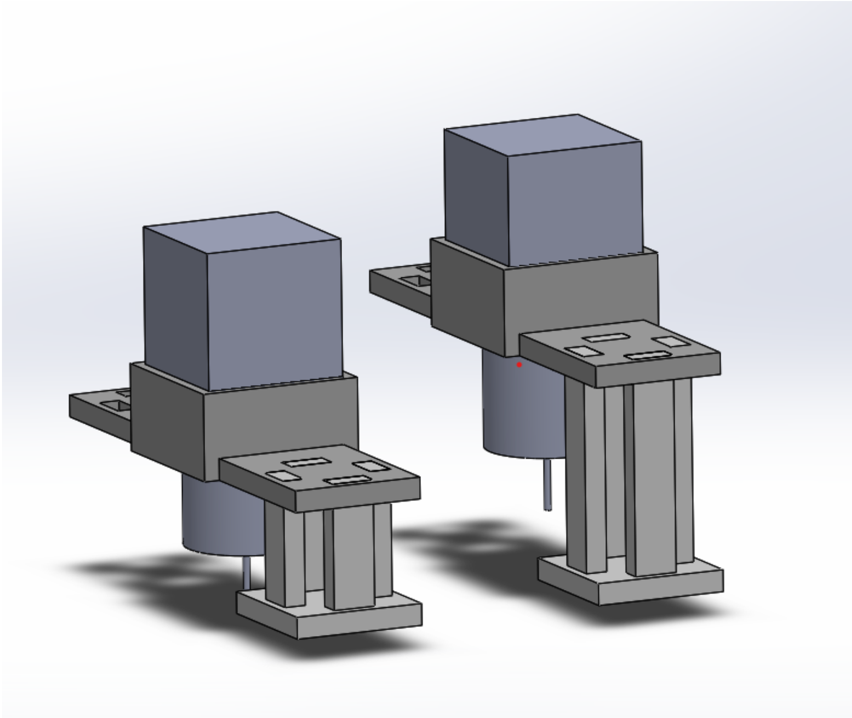
1st Mount CAD

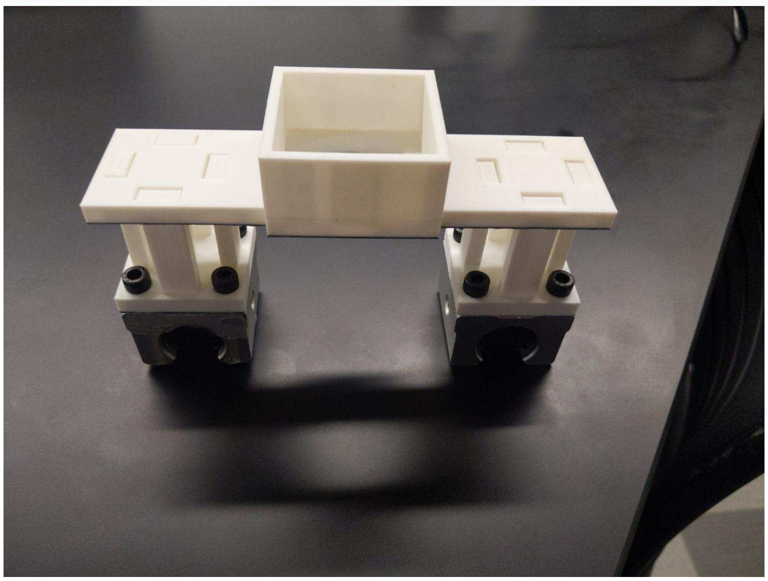
2nd Mount Print





3rd/Final Mount CAD & Print





Conclusions/action items:

Multiple designs were fabricated as we worked towards the final product

12/11/2022 - Final Design CAD

Mateo Silver - Dec 11, 2022, 5:00 PM CST

Title: Final Design

Date: 12/11/2022

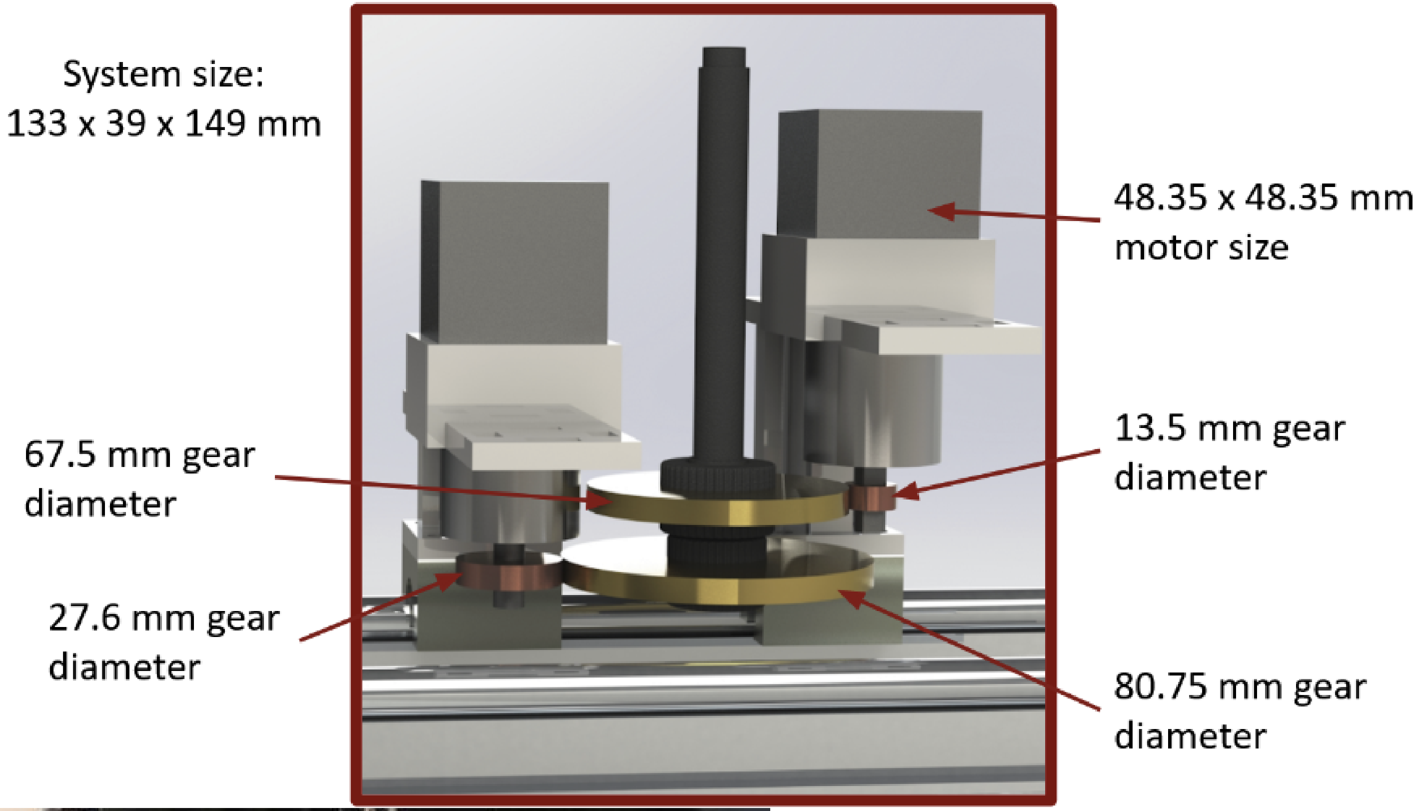
Content by: Mateo Silver

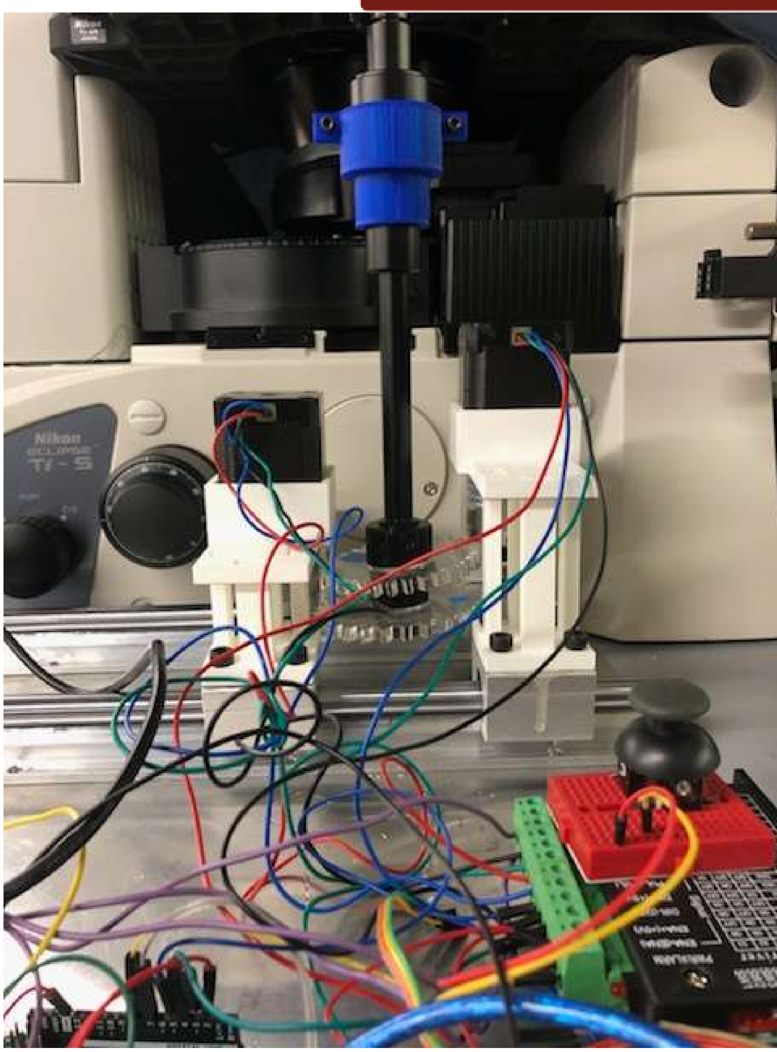
Present: n/a

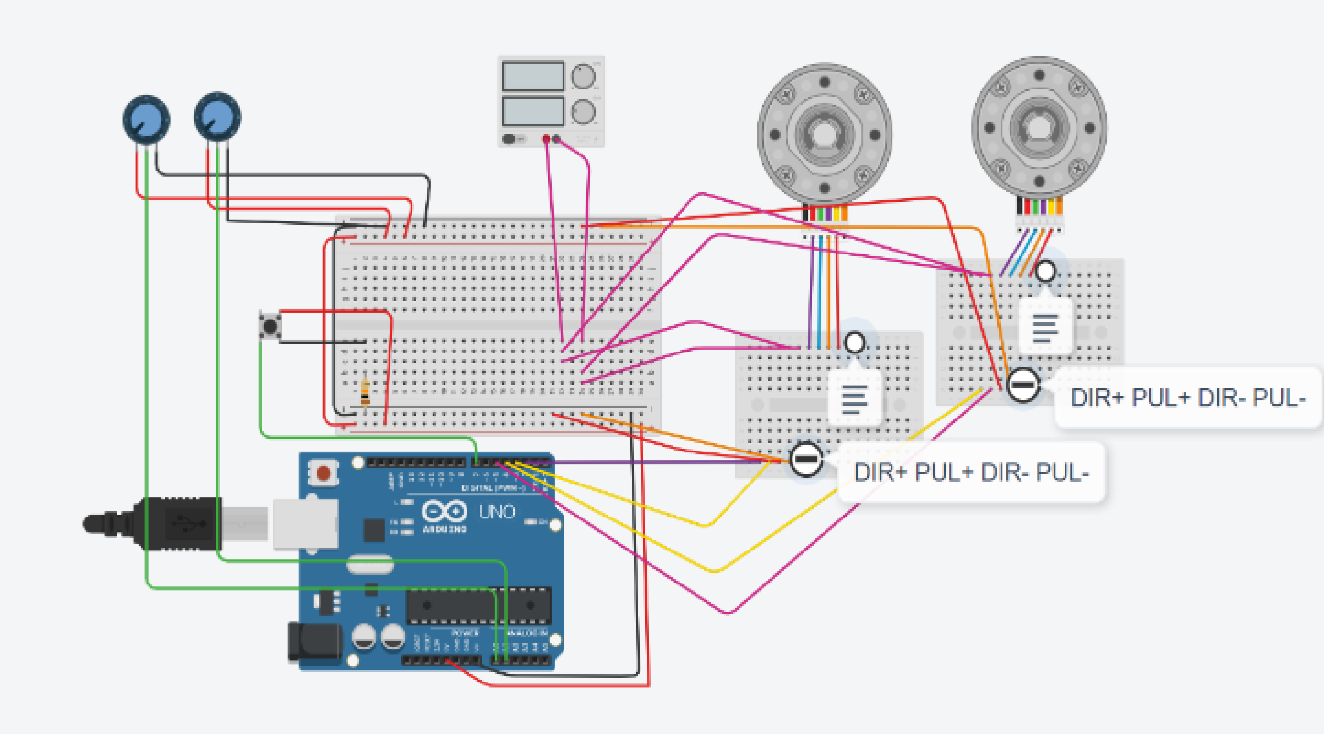
Goals: Discuss the design of the final prototype.

Content:

Our final design consisted of two stepper motors mounted onto a linear slide rail. Each motor was attached to a laser-cut acrylic gear, which meshed with a gear slotted onto the microscope wand. Below are annotated photos of the CAD render as well as the device when attached to the microscope. The final circuit design is also attached below.


System size:
133 x 39 x 149 mm
48.35 x 48.35 mm
motor size
67.5 mm gear
diameter
13.5 mm gear
diameter
27.6 mm gear
diameter
80.75 mm gear
diameter





Conclusions/action items:

Elaborate on for final report.

12/11/2022 - Final Design Pre-assessment

EMILY WADZINSKI - Dec 14, 2022, 9:31 PM CST

Title: Final Design Pre-assessment

Date: 12/11/2022

Content by: Emily

Present: Emily, Nikhil, Mateo

Goals: Illustrate the observations and assessments made before we were able to test our final design.

Content:

Right before we fabricated our final prototype, we took the parts we had to the lab to put together around the microscope.

The first observation we made was that the centers of the gears were too small to fit on the motors or the microscope wand. We had to take new measurements of the x and y control knobs' diameters along with the motor shaft's.

The 3D printed motor base meshed together nicely, and we were able to screw it into the linear rail slides. However, as we put the rail and mounts next to the microscope around the wand, the two rails could not be perfectly lined up as part of the microscope is pushed out in the back. This led to one of the rails having to be shifted an inch foward. In addition, the motor mount was slightly too wide, and could not be centered around the microscope wand. Instead, the mount was moved marginally off center to the right This led to concerns if the gears will still mesh correctly.

We brainstormed that the gears would still mesh angled diagonally, even if there were not centered. We then went foward laser cutting our final gears.

Conclusions/action item:

There was some problem solving involved before we could piece the prototype together to test.

12/11/2022 - Materials Expenses

Mateo Silver - Dec 11, 2022, 12:16 AM CST

Title: Materials Expenses

Date: 12/11/22

Content by: Mateo Silver, Emily Wadzinski

Present:

Goals: List costs from this semester's project

Content:

Below is a table of the materials used in the fabrication and development of this year's prototype. The table is divided into costs from this semester and the previous semesters. The total cost of parts purchased this year was $51.07, out of our $100 budget.

Materials	Place Purchased	Quantity	Cost
PLA Plastic for 3D Prints	Makerspace	334 g	$26.72
Four-way Joystick with Button	Makerspace	1	$4.75
18in x 24in x 0.25in Clear Acrylic Sheet	Makerspace	1	$18.00
M5 12mm Bolts	Makerspace	16	$1.60
Previous Years:		2	$62.76
Gearbox Nema 17 Stepper Motors		2	$30.74
2X SBR12 Linear Rail Guide	Makerspace	1	$10.00
Arduino Uno	Makerspace	1	$3.00
Breadboard		2	$19.96
Stepper Motor Driver Nema TB6600 boards			
Total (Out of a $100 Budget)			$177.53

Conclusions/action items:

n/a

12/13/2022 - Fabrication Protocol

EMILY WADZINSKI - Dec 14, 2022, 9:51 PM CST

Title: Fabrication Protocol

Date: 12/13/2022

Content by: Emily

Present: n/a

Goals: Establish fabrication methods.

Content:

Fabrication Steps

1. 3D print 2 motor mounts (under "Motor Mount Designs") using PLA material from makerspace

2. Screw mounts into linear rails with 16 M512mm Bolts.

3. Laser cut four gears for the two motors and x and y knobs (under "Final Design CAD"), using 18in x 24in x 0.25in clear acylic sheet

4. Slide gears onto knobs and motor, place stepper motors into mounts.

5. Create electronics circuit diagram testing with arduino. (materials under "Materials and Expenses")

Conclusions/action items:

Describe in depth in report

12/7/2022 - Testing Protocol

Mateo Silver - Dec 14, 2022, 1:56 AM CST

Title: Testing Protocol

Date: 12/7/2022

Content by: Mateo Silver

Present:

Goals: Create testing protocol for repeatable testing.

Content:

Testing Protocol for Accuracy of Motorized Stage

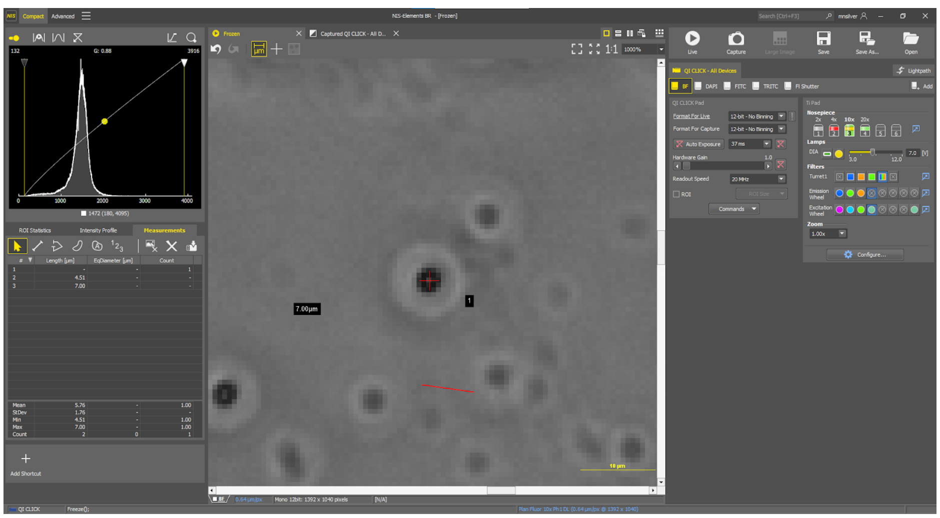
1. Turn on inverted fluorescence microscope and computer with Nikon Elements software.

2. Set microscope to bright-field imaging, and set optical path selector to "Camera" setting

3. Plate 6um beads, such as these (https://www.polysciences.com/default/fluoresbrite-yg-microspheres-600m), on a glass slide

4. Place slide on microscope stage and focus on 20x magnification setting.

5. Open Nikon Elements, and click on "Live View" button to enable the microscope camera feed. The computer screen should look like this.



6. Select a bead in frame as the starting point, and mark with crosshair tool.

7. Run Arduino testing code (under "Project Files"), which will move the stepper motor 2500 steps in one direction and then the same number in the reverse direction.

8. Measure the difference between the starting location (the crosshairs) and where the stage stopped moving.

9. Record this distance (in microns) in spreadsheet.

Conclusions/action items:

Include in appendix of final report.

12/7/2022 - Testing Results

Mateo Silver - Dec 11, 2022, 12:33 AM CST

Title: Testing Results

Date: 12/7/2022

Content by: Mateo Silver, Darshigaa Gurumoorthy, Shreya Godishala, Nikhil Chandra

Present: Mateo Silver, Darshigaa Gurumoorthy, Shreya Godishala, Nikhil Chandra

Goals: List results of testing.

Content:

Below is our raw testing results, measured in microns. Testing was conducted according to our testing protocol. Figures generated and statistical results of testing are listed in a separate entry.

Trial	Distance (microns)
1	0.54
2	1.13
3	3.28
4	0.36
5	0.86
6	-0.66
7	0.38
8	1.51
9	2.04
10	2.60
11	4.25
12	3.44

Conclusions/action items:

Complete statistical tests.

12/7/2022 - Testing Statistics

Mateo Silver - Dec 11, 2022, 12:29 AM CST

Title: Testing Statistics

Date: 12/7/2022

Content by: Mateo Silver

Present: n/a

Goals: Run statistical tests to see significance of our data.

Content:

Using vassarstats, a confidence interval test was run on the data collected. The results of the test were as follows. Our standard error of 0.43 microns and standard deviation of 1.49 microns will be important values to include on our final report and poster.

Summary Values:

N =	12
ΣX =	19.73
ΣX^2 =	56.8739
mean =	1.6442
variance =	2.2213
std. dev. =	1.4904
std. error =	0.4302
df =	11
$t_{crit(.05)}$ =	2.2
$t_{crit(.01)}$ =	3.11

Confidence Intervals for Estimated Mean of Population

For .95 CI:	1.6442±0.9464
For .99 CI:	1.6442±1.3379

Conclusions/action items:

Add statistical testing results to poster and final report.

12/7/2022 - Testing Figures

Mateo Silver - Dec 11, 2022, 12:33 AM CST

Title: Testing Figures

Date: 12/7/2022

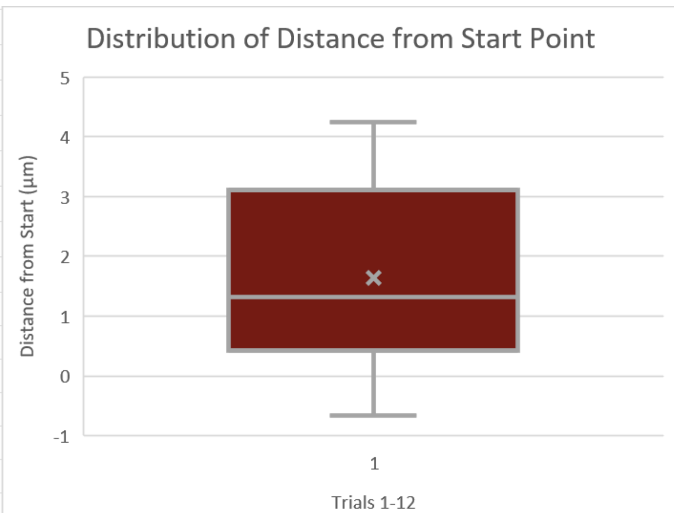
Content by: Mateo Silver

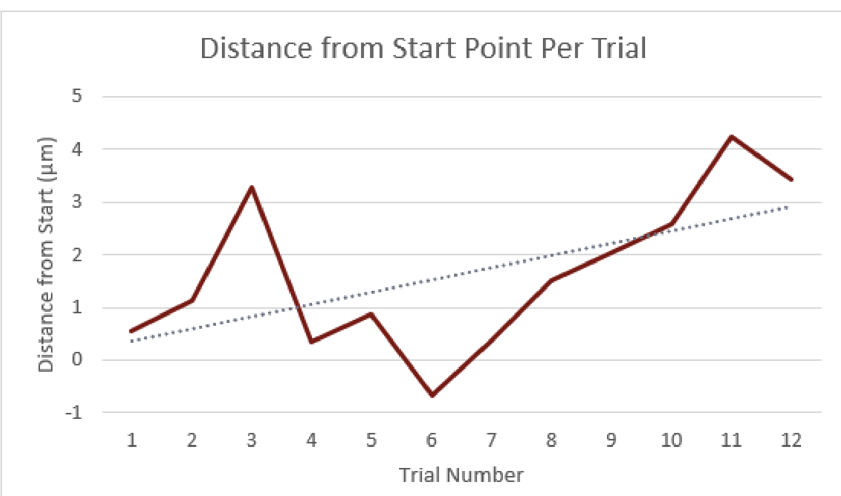
Present:

Goals: Represent testing data graphically.

Content:

Once the testing data had been collected, graphical representations of the data could be created. I chose to use a box and whisker plot to show the variation in the data as a whole, along with the mean and standard deviations. One of the important trends that we noticed in the data was the gradual increase in error over time. To show this visually, I created a line graph with a trend line. The trend line chosen was a linear fit of the data, to show the general trend present. Both the figures created are shown below.





Conclusions/action items:

Include on final report and poster.

12/7/2022 - Arduino Testing Code

Mateo Silver - Dec 11, 2022, 12:57 AM CST

Title: Arduino Testing Code

Date: 12/7/2022

Content by: Mateo Silver

Present:

Goals: Write testing code.

Content:

Attached to this entry is the code used to test the accuracy of the prototype, according to the testing protocol outlined earlier.

Conclusions/action items:

Include in appendix of final report.

Mateo Silver - Dec 12, 2022, 10:25 PM CST

Download

Arduino_Code_for_testing.ino (804 B)

12/3/2022 - Arduino Operation Code

Mateo Silver - Dec 11, 2022, 12:59 AM CST

Title: Arduino Operation Code

Date: 12/7/2022

Content by: Mateo Silver

Present:

Goals: Write code for normal use.

Content:

Attached to this entry is the code used during the normal operation of the motorized stage. It has the pins that the motor and joystick are connected to at the top, for easy assembly of the circuit.

Conclusions/action items:

Include in appendix of final report.

Mateo Silver - Dec 12, 2022, 10:22 PM CST

Download

sketch_nov28a.ino (1.67 kB)

10/5/2022 - Inverted Fluorescent Microscope Applications

Mateo Silver - Dec 11, 2022, 5:12 PM CST

Title: Inverted Fluorescent Microscope Applications

Date: 10/05/2022

Content by: Mateo Silver

Present: n/a

Goals: Discuss the applications of inverted fluorescent microscopy.

Content:

In fluorescent microscopy, specimens of interest are labeled using a chemical that emits light when it is hit by a fluorescent light. The microscope has a special filter inside which allows it to detect light at these specific wavelengths [1]. Another common usage of fluorescent microscopes is Fluorescence Lifetime Imaging Microscopy, or FLIM. This is a technique in which photoactive metabolic indicators such as NAD(P)H and FAD are excited by a wavelength of light. The length of time and intensity that the photons are emitted can be indicative of how much of these chemicals are present in the cell. The result is a representation of the metabolism of a cell, as calculated by dividing the intensity of NAD(P)H by the intensity of FAD signal.

[1] https://serc.carleton.edu/microbelife/research_methods/microscopy/fluromic.html

[2] https://pubmed.ncbi.nlm.nih.gov/34028726/

Conclusions/action items:

Elaborate on in preliminary report.

10/12/2022 - Global Impact

Mateo Silver - Dec 11, 2022, 5:19 PM CST

Title: Global Impact

Date: 10/12/2022

Content by: Mateo Silver

Present: n/a

Goals: Discuss the possible impact of the project.

Content:

A low cost motorized stage has the potential to impact a community much larger than just the students who utilize the BME teaching lab here at UW. As shown by the success of other low-cost microscope stage projects, such as OpenStage, there is a large demand for lesser funded labs to have access to these devices [1]. A motorized stage allows more advanced microscopy techniques to be taught and utilized, such as time-lapse imaging and panorama stitching. By creating a low-cost motorized stage and distributing the manufacturing instructions and parts lists, we could open the doors to other teaching labs and assist them in creating their own motorized stages.

[1] https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0088977

Conclusions/action items:

Elaborate on in introduction of preliminary report.

9/13/2022 - Competing Designs Preliminary Reserach

Mateo Silver - Sep 15, 2022, 12:57 PM CDT

Title: Preliminary Research on Competing Designs

Date: 9/13/2022

Content by: Mateo Silver

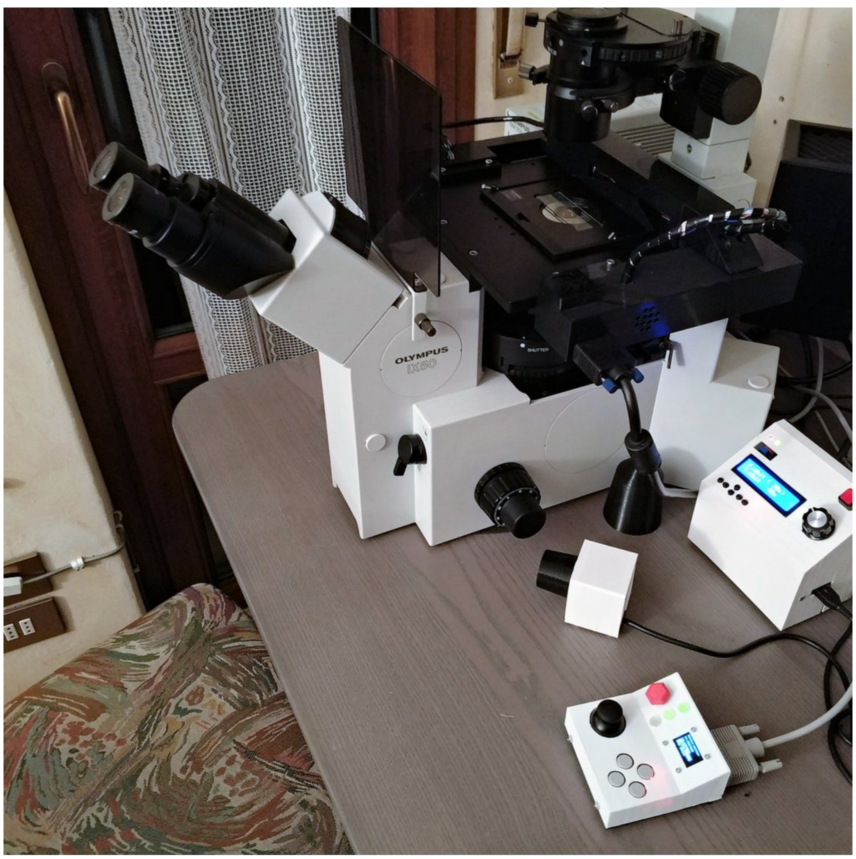
Present: N/a

Goals: Begin researching what other designs have been created.

Content:

I found a competing design online of someone who also created a low-cost motorized microscope stage. [1] Their design is compatible with the Olympus IX50 and IX70 microscopes. Utilizing stepper motors and microstepping, the creator was able to make each step of the motor equal to 27.344 nanometers. The creator also used an Arduino Due to control the stepper motors using a joystick and push buttons. They also used a MKS-LV8729-OC stepper motor driver and 12v fans for cooling.

Despite the differences between a phase contrast microscope, which this project was designed for, and a fluorescence microscope this project can give our team a good idea of what our design might look like.



[1] Fabiorinaldus and Instructables, “Motorized microscope stage for Olympus IX50,” Instructables, 12-Apr-2019. [Online]. Available: https://www.instructables.com/Motorized-Microscope-Stage-for-Olympus-IX50/. [Accessed: 13-Sep-2022].

Conclusions/action items:

This person was able to create a low-budget microscope stage controller, which is similar to what our team would like to accomplish. Their design is well documented and would be good to draw inspiration from.

9/21/2022 - Comercially Available Competing Design

Mateo Silver - Sep 21, 2022, 11:27 AM CDT

Title: Commercially available competing design

Date: 9/21/2022

Content by: Mateo Silver

Present: n/a

Goals: Doing research on competing designs which are purchasable from retailers.

Content:

The microscope we have in the BME teaching lab is the Nikon TI-U. The non-motorized version can be bought online for $15,995, compared to the motorized version, which costs $18,995. This price difference is quite significant and can be the difference between a new lab affording a motorized microscope, or using that money to invest in other lab supplies. Our motorized slide, on the other hand, should cost less than $100. Hopefully, this low-cost price point will allow lesser funded and new labs the chance to use a motorized slide, and conduct more advanced experiments.

Nikon TI-U with motorized stage.

“Nikon TI-u inverted fluorescence motorized microscope pred ti2 - AV,” Boston Industries, Inc. [Online]. Available: https://www.bostonind.com/nikon-ti-u-inverted-fluorescence-motorized-microscope-pred-ti2-av. [Accessed: 21-Sep-2022].

“Nikon Ti-U Inverted Fluorescence Microscope Pred Ti2,” Boston Industries, Inc. [Online]. Available: https://www.bostonind.com/nikon-ti-u-inverted-fluorescence-microscope-pred-ti2-2. [Accessed: 21-Sep-2022].

Conclusions/action items:

Large price difference between motorized and non-motorized microscope stages.

9/21/2022 - Testing Ideas

Mateo Silver - Sep 21, 2022, 11:53 AM CDT

Title: Testing Ideas

Date: 9/21/2022

Content by: Mateo Silver

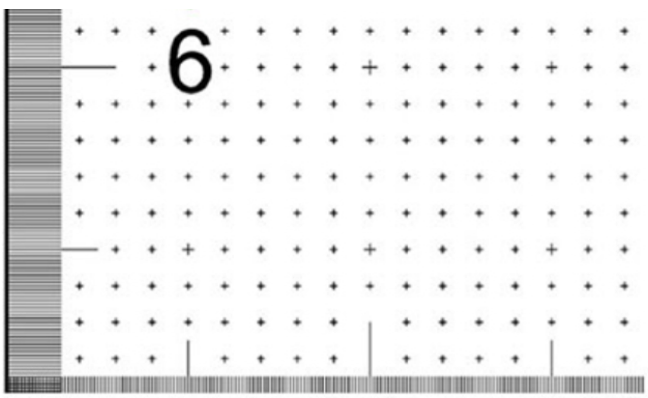
Present: n/a

Goals: Beginning to think about how we could test the device.

Content:

While completing the preliminary PDS, I found some tools that could be used to test the stage once it is operational. One was a piece of soda glass with a small 2 micron grid etched on it. We could use this to test the reliability of the positioning system of the stage. For example, by moving the microscope to a specific position and back. We would be able to see if the stage can accurately position itself without drifting away.

This tool could also be used to test the image stitching capabilities of the motorized stage. By taking photos of the entire piece of glass, we could look at the grid marks to ensure they line up.



Each small dot on the grid is 2 microns apart.

“Pelcotec™ LMS-20G Magnification Calibration Standard,” Light microscopy calibration standards. [Online]. Available: https://www.tedpella.com/calibration_html/Light-Microscopy-Calibration-Standards.aspx#_688-2.

Conclusions/action items:

Come back to this note when doing more in depth testing research.

10/5/2022 - Codes and Standard for PDS

Mateo Silver - Oct 05, 2022, 5:31 PM CDT

Title: PDS Research

Date: 10/5/2022

Content by: Mateo Silver

Present: n/a

Goals: Conduct research to complete my sections of the PDS

Content:

My assigned sections of the PDS were the: Standards and Specifications, Customer, Patient-related concerns, and competition.

The standards and specifications section required me to look into possible standards that could be applicable to our device. I found some calibration standards, such as the Pelcotec™ LMS-20G Magnification Calibration Standard. The Pelcotec standard is a piece of testing equiptment used to ensure the calibration and accuracy of a microscope. It is a piece of soda glass with a grid of 10 µm divisions. Using this tool, we could test our stage's ability to move to a specific position and back.

The client requirements of the PDS largely followed the topics discussed in our client meeting. The client emphasized the design goals of keeping the device compact and removable. Again, it should also be able to interface with the microscope software.

There were no patient-related concerns related to our device, as it will be used in a teaching lab.

The main competitive design I found was the more advanced version of one of the microscopes the design lab currently owns. The Nikon TI-U has a more complex model, with motorized stage, that costs $3000 more than the base model. Our device hopes to close the gap to motorized stages, at a budget of under $100.

[1] “Pelcotec™ LMS-20G Magnification Calibration Standard,” Light microscopy calibration standards. [Online]. Available: https://www.tedpella.com/calibration_html/Light-Microscopy-Calibration-Standards.aspx#_688-2. [Accessed: 21-Sep-2022].
[2] “Nikon TI-u inverted fluorescence motorized microscope pred ti2 - AV,” Boston Industries, Inc. [Online]. Available: https://www.bostonind.com/nikon-ti-u-inverted-fluorescence-motorized-microscope-pred-ti2-av. [Accessed: 21-Sep-2022].
[3] “Nikon Ti-U Inverted Fluorescence Microscope Pred Ti2,” Boston Industries, Inc. [Online]. Available: https://www.bostonind.com/nikon-ti-u-inverted-fluorescence-microscope-pred-ti2-2. [Accessed: 21-Sep-2022].

Conclusions/action items:

Come back and update PDS as we learn more about design constraints and goals.

9/28/2022 - Design Matrix

Mateo Silver - Oct 05, 2022, 11:29 AM CDT

Title: Design Matrix

Date: 9/28/2022

Content by: Mateo Silver

Present: n/a

Goals: Complete design matrix.

Content:

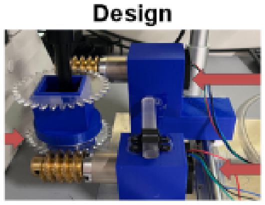
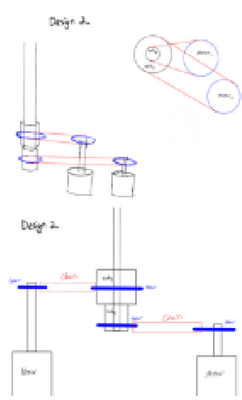
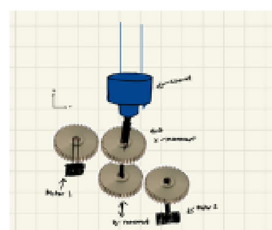
Designs:

Design 1: Our first design is a continuation of last year's worm gear design. If we went with this option, we would mainly focus on the electronics and interfacing the device with the computer. According to the testing results from the previous poster presentation, the design is functional, albeit a little less accurate than ideal. A benefit of going with design 1 is the possibility of having a functional final product by the end of the semester.

Design 2: The second design utilizes two parallel gears, driven by a chain or belt. Each set of gears would control either the x or y axis translation of the stage. This design scored lower in the matrix, because of its complexity and difficulty to fabricate.
Design 3: Design three is similar to design two, but removes the chain that connects the two gears. This makes it more compact and easier to fabricate. The size is also reduced compared to design two. Design three scored the highest in the matrix, with 85 points.

Criteria:

We evaluated the designs on six criteria: functionality, size, ease of fabrication, cost, aesthetics, and safety. Functionality was defined as how effective and accurate the design was. Size was related to how much smaller, compared to the current design, the device was. Ease of fabrication considered the difficulty of designing and assembling the parts, given our experience and tools available. Cost was the ability for the design to stay under the $100 budget. Aesthetics was a lesser consideration, but involved how clean the final design looked. Finally safety was included, as each design has the potential to cause harm to the operator.

Criteria	Design 1: Previous Design	Design 2: Chain Drive	Design 3: Gear to gear
			
Functionality (25)	4/5 * 25 = 20	3/5 * 25 = 15	4/5 * 25 = 20
Size (25)	2/5 * 25 = 10	4/5 * 25 = 20	5/5 * 25 = 25
Ease of Fabrication (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Cost (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Aesthetics (5)	4/5 * 5 = 4	5/5 * 5 = 5	3/5 * 5 = 3
Safety (5)	5/5 * 5 = 5	4/5 * 5 = 4	5/5 * 5 = 5
Total = 100	**79 / 100**	**69 / 100**	**85 / 100**

Conclusions/action items:

Present design matrix during preliminary presentation.

10/10/2022 - Previous Teams' Work

Mateo Silver - Dec 11, 2022, 1:58 AM CST

Title: Previous Teams' Work

Date: 10/10/2022

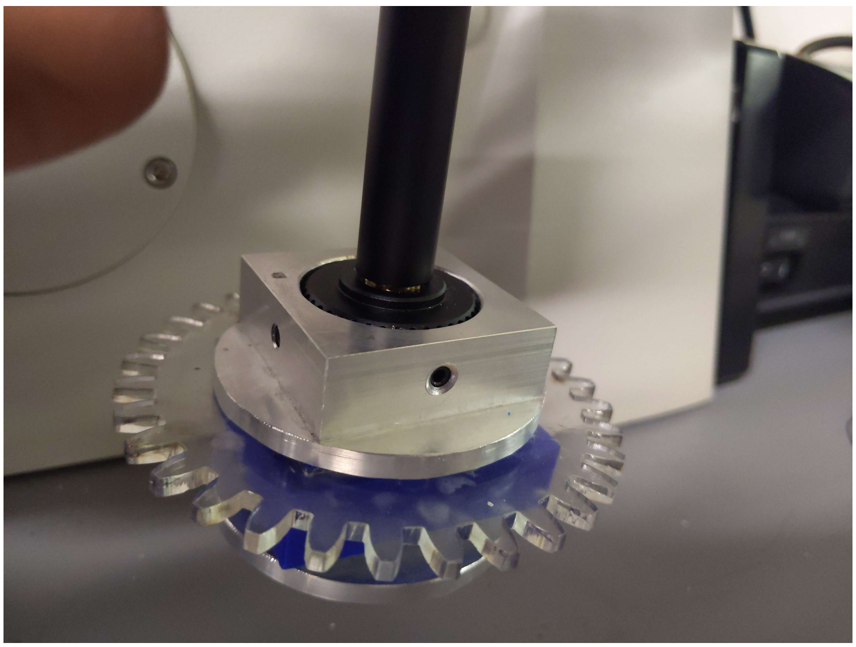
Content by: Mateo Silver

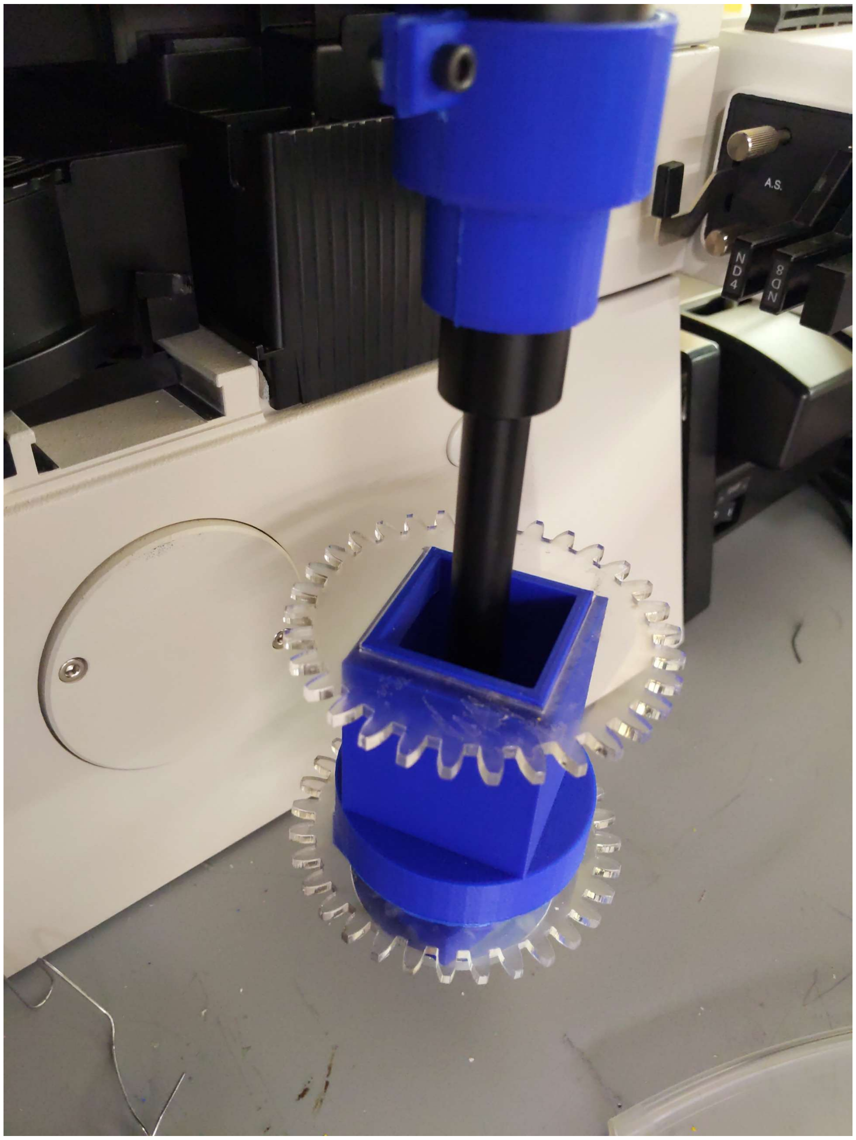
Present:

Goals: Show where the previous teams have left off.

Content:

The previous semesters of BME design have attempted to solve this problem in multiple ways, from a worm drive system to a gear on gear mechanism. Below are photos of what was left attached to the microscope at the start of the semester. A previous team had designed this mechanism to secure their custom made gears to the microscope arm. This system is particularly hard to detach from the microscope, as it requires four screws to be undone on each knob, using a very small allen wrench. Our team can improve on the method of attaching a gear to the microscope wand by attaching it in a more easily removable way.





Conclusions/action items:

Learn from past teams' missteps.

12/11/2022 - Final Electronics Used

Mateo Silver - Dec 11, 2022, 4:50 PM CST

Title: Final Electronics Used

Date: 12/11/2022

Content by: Mateo Silver

Present: n/a

Goals: List final electronics used and part numbers for future teams.

Content:

One of the initial challenges we had when beginning the design process was finding information on all the electronics that the previous teams had purchased. Below is a list of the part names and numbers of the products, for the use of future teams.

Part Name:	**Part Number:**	**Link**
Nema 17 Stepper Motor L=39mm Gear Ratio 100:1 High Precision Planetary Gearbox	17HS15-1684S-HG100	https://www.omc-stepperonline.com/nema-17-stepper-motor-l-39mm-gear-ratio-100-1-high-precision-planetary-gearbox-17hs15-1684s-hg100
SBR12-600mm Linear Bearing Rail	SBR12-600mm	https://www.amazon.com/SBR12-600mm-Linear-Bearing-Slide-Dynamic/dp/B07W89JYQ9
Four-way Joystick with Button	n/a	Purchased from Makerspace
Breadboards	m/a	Purchased from Makerspace
Arduino Uno	A000066	https://store-usa.arduino.cc/products/arduino-uno-rev3
Stepper Motor Driver Nema TB6600	TB6600	https://www.dfrobot.com/product-1547.html

Conclusions/action items:

Will be useful for future design semesters.

12/11/2022 - Final Design

Mateo Silver - Dec 11, 2022, 4:57 PM CST

Title: Final Design

Date: 12/11/2022

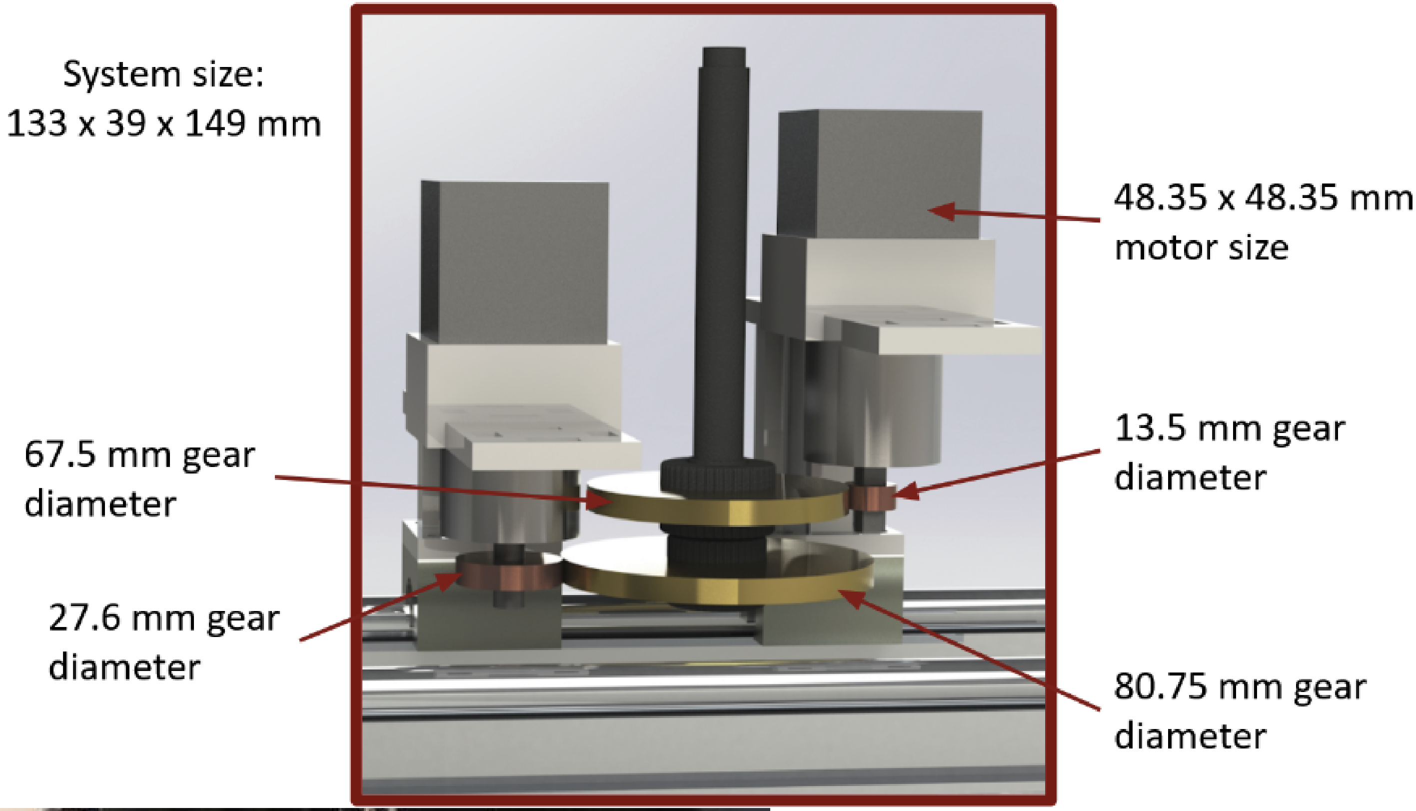
Content by: Mateo Silver

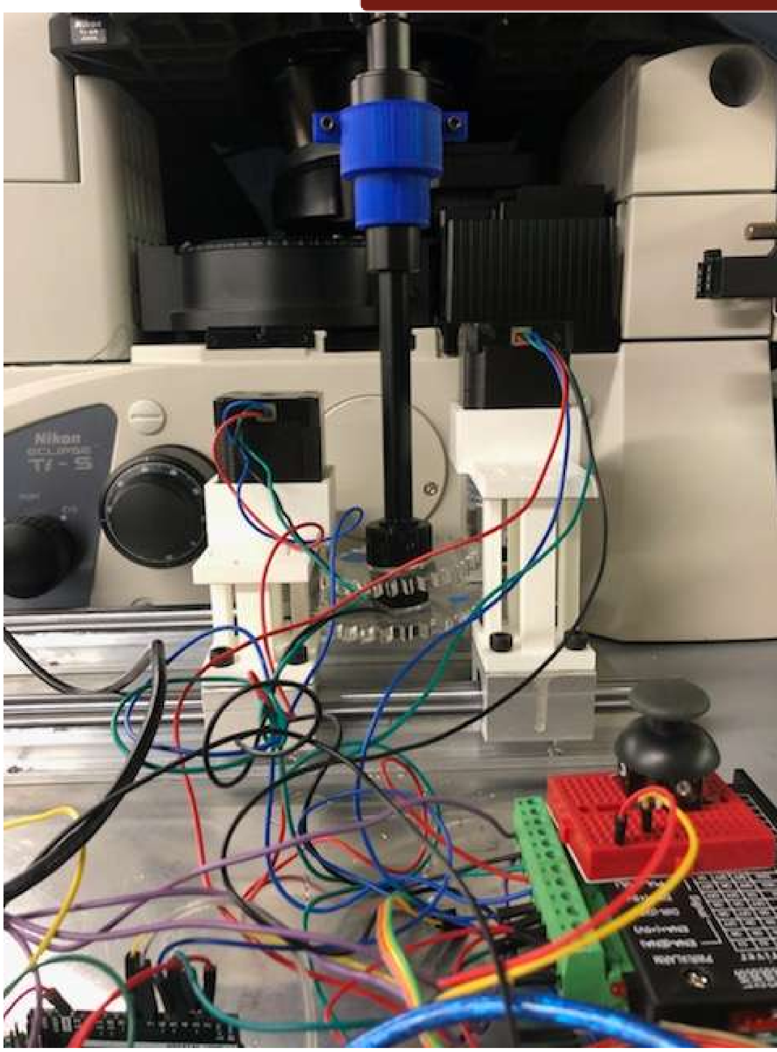
Present: n/a

Goals: Discuss the design of the final prototype.

Content:

Our final design consisted of two stepper motors mounted onto a linear slide rail. Each motor was attached to a laser-cut acrylic gear, which meshed with a gear slotted onto the microscope wand. Below are annotated photos of the CAD render as well as the device when attached to the microscope.





Conclusions/action items:

Elaborate on for final report.

11/30/2022 - Gear Design

Mateo Silver - Dec 11, 2022, 4:42 PM CST

Title: Gear Design

Date: 11/30/2022

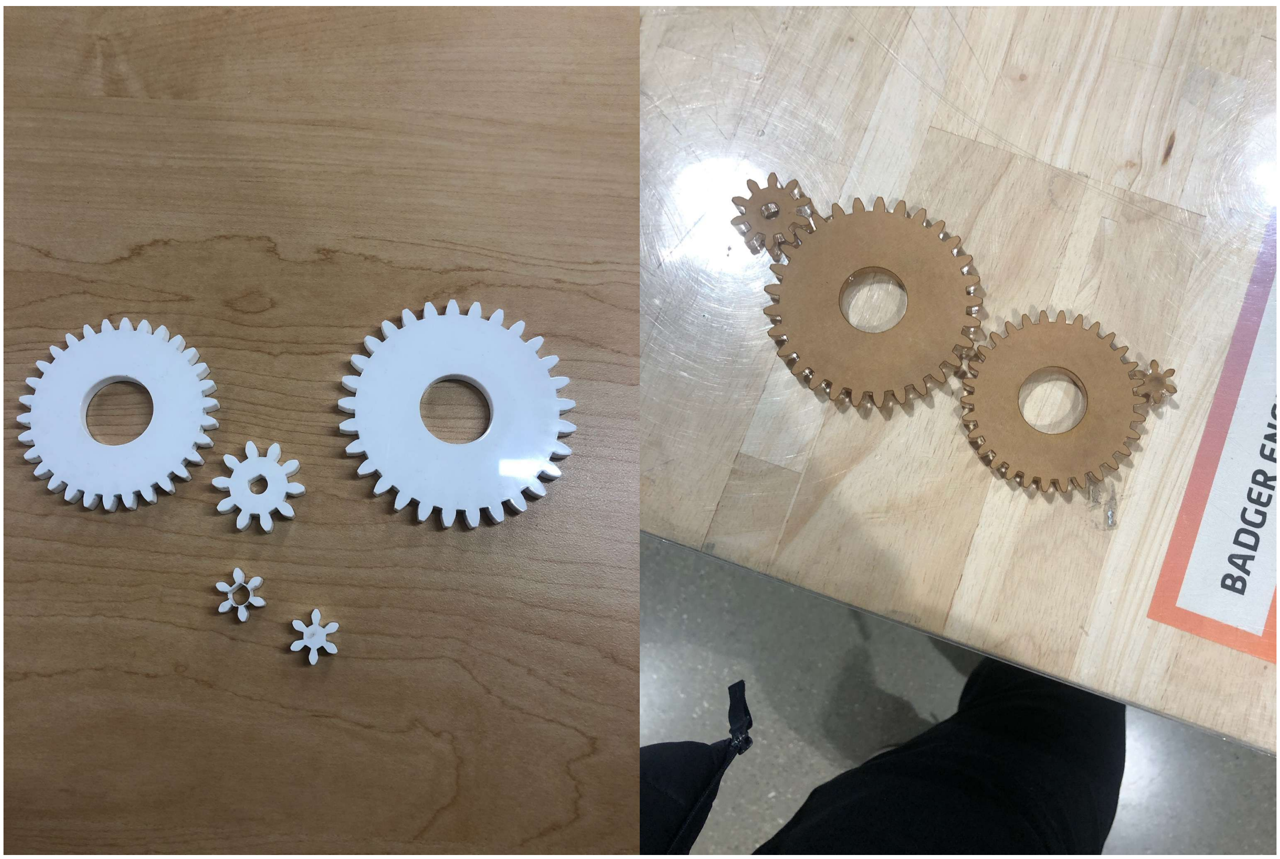
Content by: Mateo Silver, Nikhil Chandra

Present: n/a

Goals: Discuss the design of the gears.

Content:

In designing the gears for the final prototype, we iterated through models with different moduli and number of teeth. Nikhil calculated the gear ratios and dimensions of the gears, and created the models. He then laser cut the gears out of HPDE and later Acryllic. Two revisions of the design are shown below. One tool that we found very useful in designing the gears was online gear generator website. These allowed us to plug in the values we needed and generate a file which could be laser cut. A challenge we ran into when manufacturing the gears was the size of the smallest gear, which was 13.5mm in diameter. This proved to be too small to attach to the shaft of the stepper motor.



Conclusions/action items:

Include in final report.

11/29/2022 - Motor Mount Design

Mateo Silver - Dec 11, 2022, 4:31 PM CST

Title: Motor Mount Design

Date: 11/29/2022

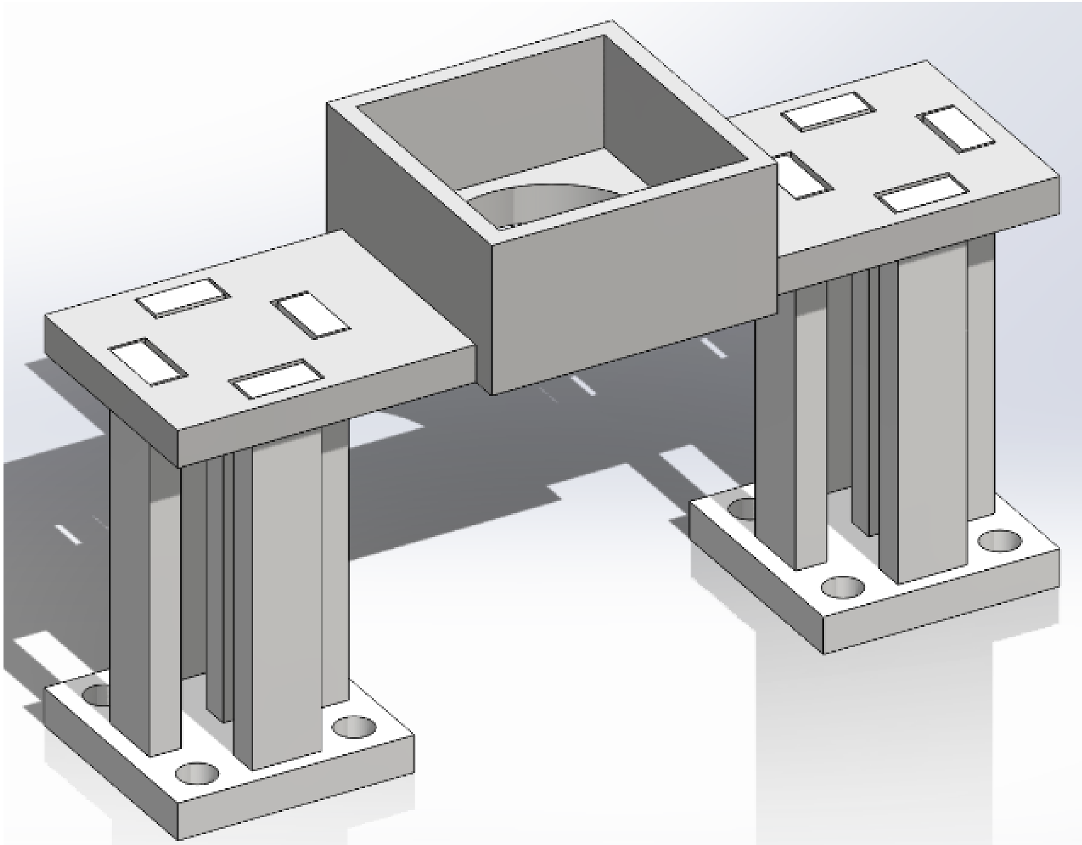
Content by: Mateo Silver

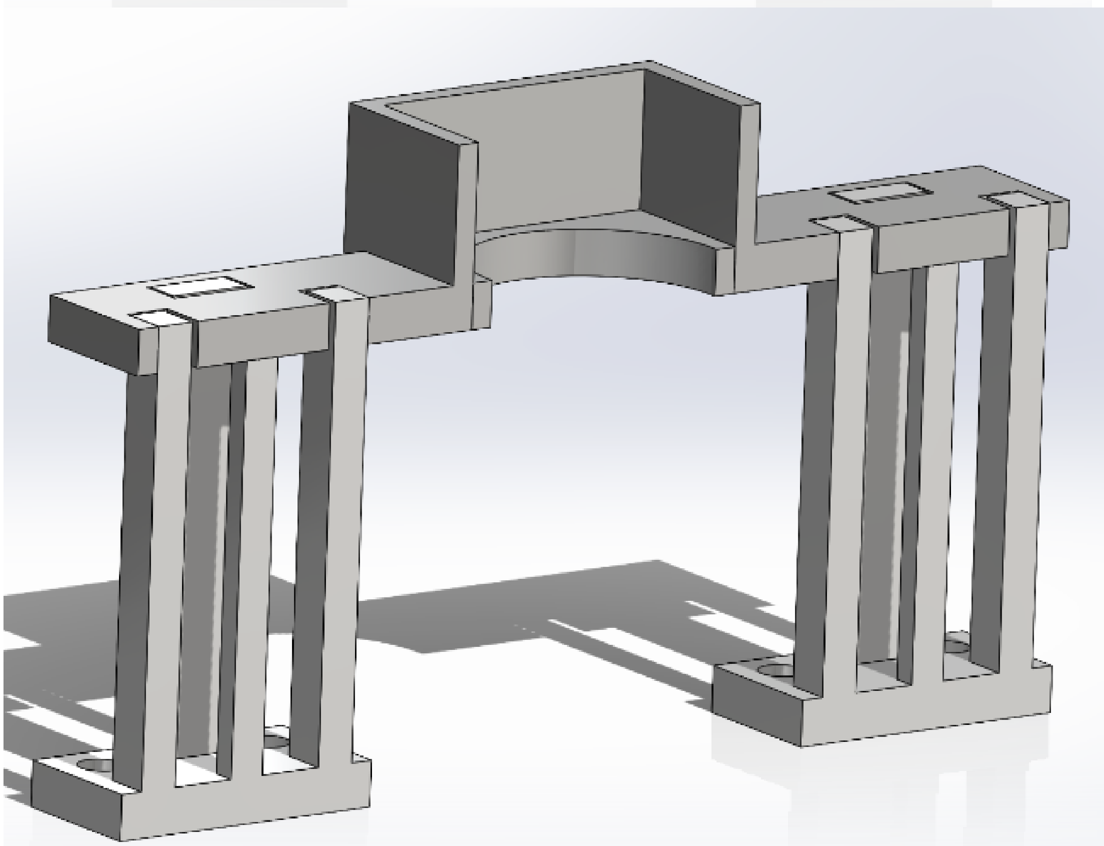
Present: n/a

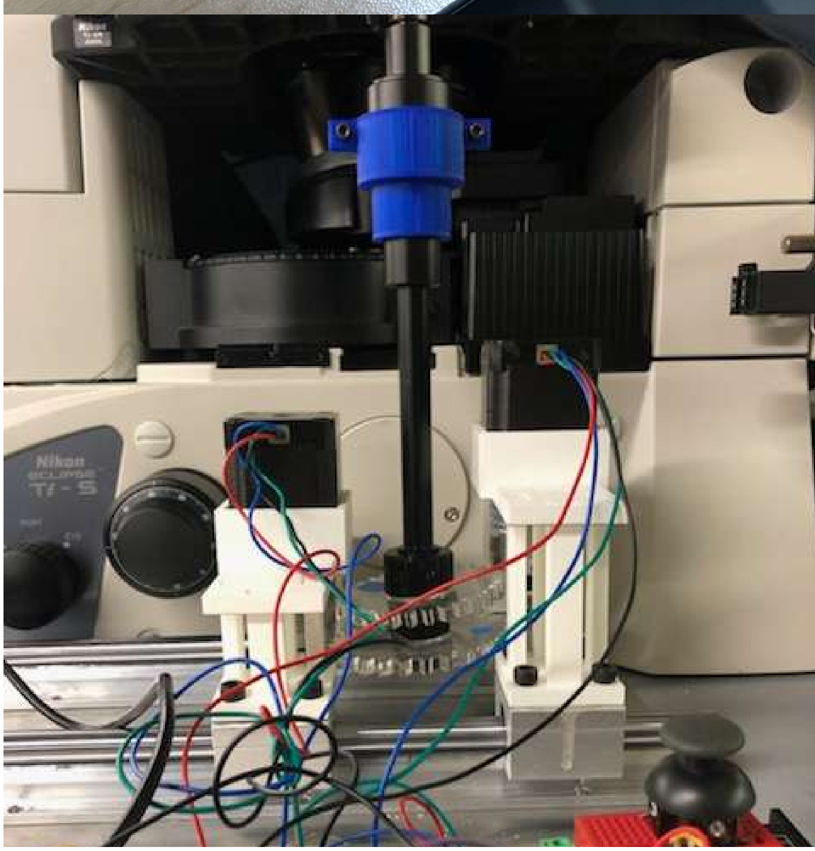
Goals: Discuss the design of the motor mount.

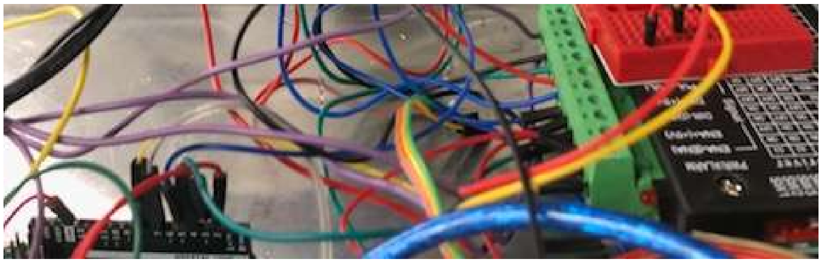
Content:

I designed the new motor mount which holds the stepper motors in place and attaches them to the linear slide. The design was split into two parts, to aid in 3d printing. The top part holds the motor in place and slots into the bottom piece. Our first version of the design did not have a support in the middle to stop the top mount from falling down. As shown in the cross-section, a center beam was added to support the top mount. Our first version also had the bottom support beams too wide to fit in the slots, so they were narrowed in the final version. Below the CAD models are photos of the assembled mounts, with and without a motor installed.






Nikon
ECLIPSE
Ti-S



Conclusions/action items:

Include in final report.

11/18/2022 - Circuit Diagram

Mateo Silver - Dec 11, 2022, 1:10 AM CST

Title: Circuit Diagram

Date: 11/18/2022

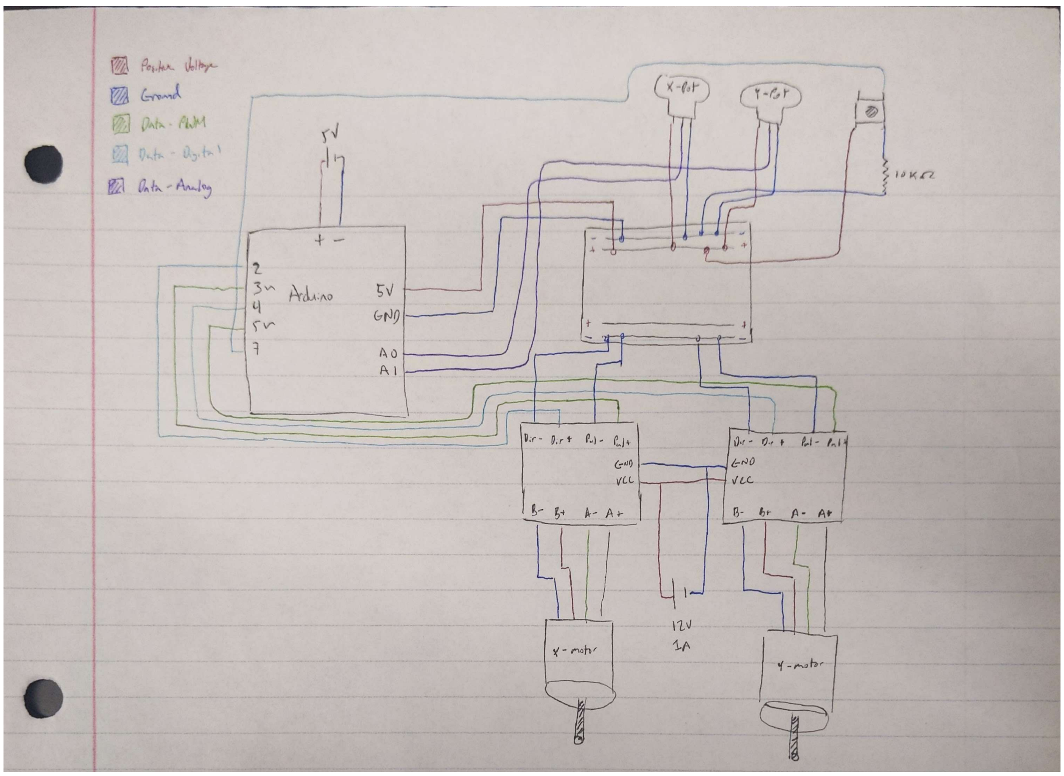
Content by: Mateo Silver

Present:

Goals: Create circuit diagram.

Content:

To aid in assembly of the circuit, I created this circuit diagram that outline all the connections made in the final circuit. The colors represent positive (5v or 12v) voltage (red), ground lines (dark blue), pulse width modulation lines (green), digital I/O lines (light blue), and analog I/O lines (purple). The final components used in the electronics were the: Arduino Uno, two Stepper Motor Drivers, Two Stepper Motors, and a two way joystick. The circuit diagram is shown below.



Conclusions/action items:

Include in appendix of final report.

10/12/2022 - Preliminary Design 1

Mateo Silver - Oct 12, 2022, 10:45 AM CDT

Title: Preliminary Design 1

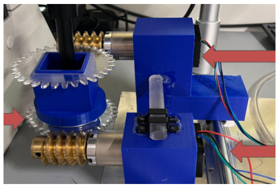
Date: 10/12/2022

Content by: Mateo Silver

Present: n/a

Goals: Discuss our first preliminary design.

Content:



Our team's first preliminary design is based on the previous design created for this project. It utilized two worm gears to spin gears attached to the knobs of the microscope wand. The entire assembly is on a sliding track to keep up with the translation of the stage in the x-axis. The main improvements we would make to this design would be software related, as the prototype is currently functional.

Conclusions/action items:

Iterate on design, evaluate in design matrix.

10/12/2022 - Preliminary Design 3

Mateo Silver - Oct 12, 2022, 10:49 AM CDT

Title: Preliminary Design 3

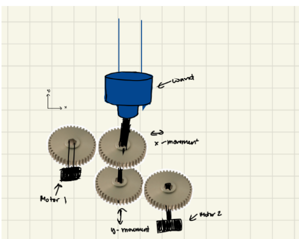
Date: 10/12/2022

Content by: Mateo Silver

Present: n/a

Goals: Discuss our third preliminary design.

Content:



Our final preliminary design is a gear to gear driven mechanism. This is similar to the chain and sprocket design, but removes the chain and has the gears meshing directly. This will make the tolerances for alignment smaller, but the prototype will be easier to manufacture. It also is considerably smaller in size than either of the other two designs.

Conclusions/action items:

Iterate on design, evaluate in design matrix.

10/12/2022 - Preliminary Design 2

Mateo Silver - Oct 12, 2022, 10:47 AM CDT

Title: Preliminary Design 2

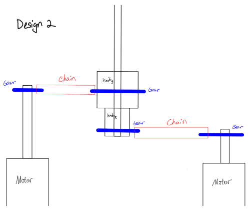
Date: 10/12/2022

Content by: Mateo Silver

Present: n/a

Goals: Discuss our second preliminary design.

Content:



Our next preliminary design is similar to the previous design, except it uses a chain and sprocket mechanism to turn the control knobs. The chain will provide more leeway for the alignment of the gears, an issue encountered in previous semesters. One potential difficulty with this design is the difficulty to manufacture a chain and gears that mesh well with it.

Conclusions/action items:

Iterate on design, evaluate in design matrix.

9/30/2022 - Green Permit

Mateo Silver - Dec 11, 2022, 4:20 PM CST

Title: Green Permit and Laser Training

Date: 9/30/2022

Content by: Mateo Silver

Present: n/a

Goals: Show proof of training.

Content:

I have completed the green permit and laser cutter trainings, as shown below. I will be able to use the TEAM lab and laser cutter when manufacturing our prototype.

You have the following permits and upgrades:

Name	Date
Green Permit	03/03/2022
Lab Orientation	09/27/2020
Red Permit	02/12/2022
Laser 1	10/06/2020

Conclusions/action items:

Use green permit and laser training in manufacturing prototype.

10/12/22 Prelim Research

SHREYA GODISHALA - Oct 12, 2022, 1:44 PM CDT

Title: Prelim Research

Date: 10/12/22

Content by: Shreya Godishala

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Fluorescent microscopes are an optical microscope that uses fluorescence that uses to study biological samples.They use high intensity light source to excite fluorescent

species. The specimen reflects back a shorter wavelength that is then measured. The fluorescent microscope uses filters to match the specific wavelength range of the specimen that is being measured. The functions of the Fluorescent microscope include measuring cell metabolism. This is done by exciting the fluorescent ROS (reactive oxygen species) NADH and FAD which fluorescent molecules. Measuring the wavelength they readout allows for researchers to measure the metabolic rates of specific samples of cells. At the teaching lab here there are 2 inverted fluorescent microscopes. The Nikon Ti- U and the Olympus IX71. The microscopes are currently controlled by manual translation control knobs. The knobs move in both the x and y directions so therefore 2 motors are required to move each individually. Affordable solution, easily attached or removed and integrated with Nikon Elements. The impact of fluorescent microscopes is crucial to the development of technology and advancement of science. Making the process of imaging and analyzing cells more accurate and time efficient would help advance the research field and make it more accessible for low funded labs to conduct important experiments.

Conclusions/action items:

This is the background research and the reasoning I have come up with behind the usages of flourescent microscopes.

9/13/2022

SHREYA GODISHALA - Sep 15, 2022, 12:48 PM CDT

Title: Competitive Designs

Date: 9/15/2022

Content by: Shreya Godishala

Present: Shreya Godishala

Goals: Find competitive Designs for an microscope with a low-cost stage

Content:

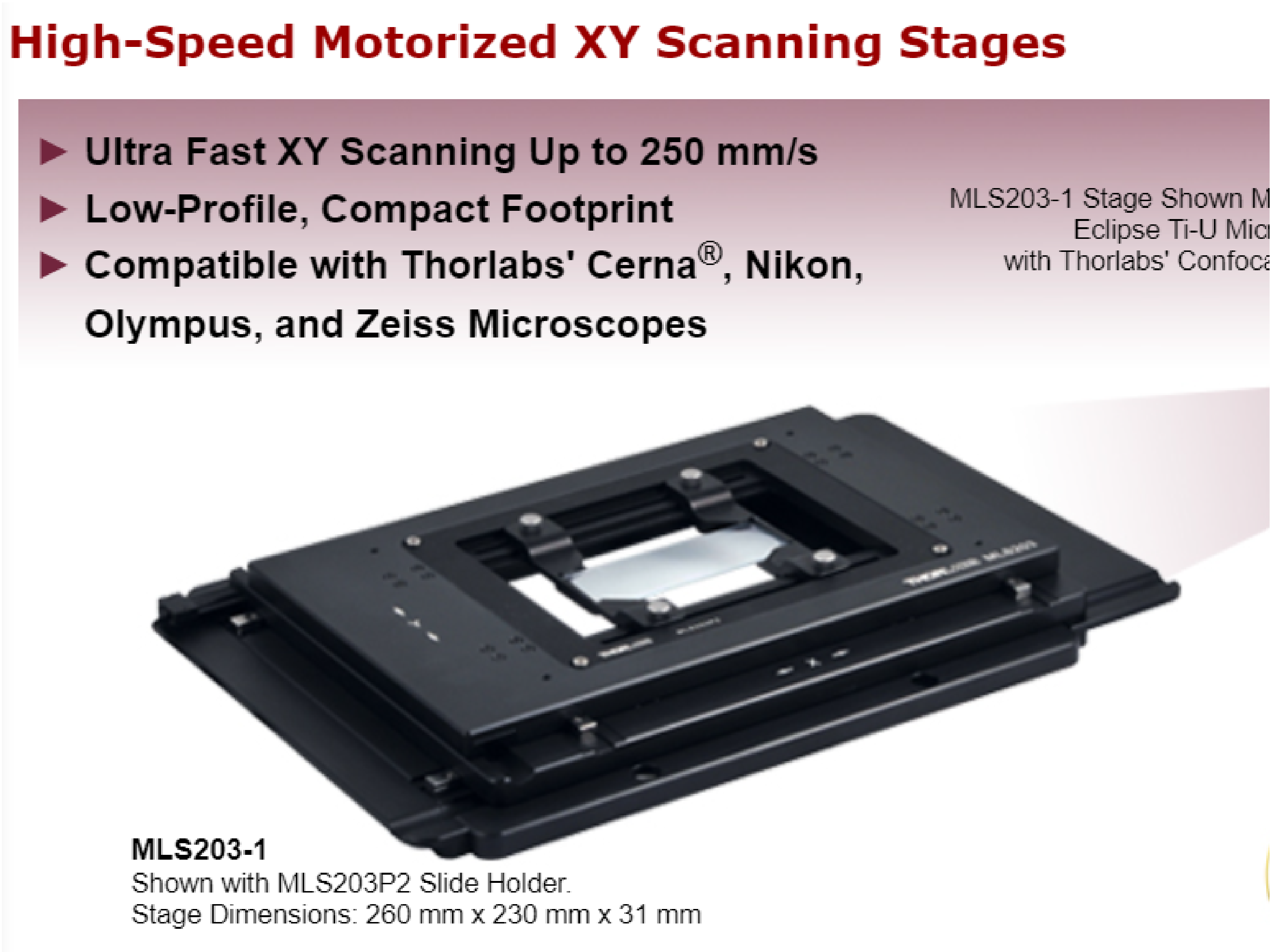
There are other motorized microscope stages on the market right now. An example is the XY motorized microscope stage M-545 from PI.

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

SHREYA GODISHALA - Sep 23, 2022, 12:31 PM CDT

This miscroscope for example from thor labs is a high- speed motorized xy scanning stage. They integreat with Nikon, have optical encoders, linear bearings, compatible with APT software. The controleler options is a DC motor controller. We offer a range of adaptors for the positioning of standard microscope slides.



10/10/22 Design Matrix

SHREYA GODISHALA - Oct 12, 2022, 1:47 PM CDT

Title: Design Matrix Reasoning

Date: 10/12/22

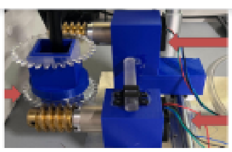
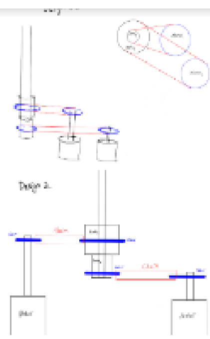
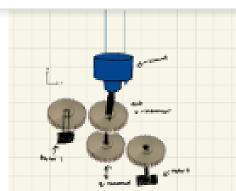
Content by: Shreya

Present: BME team

Goals: Decide which designs to go with

Content:

- Functionality
    - A measure of how effective and accurate the design is likely to be at achieving the main objective of precisely turning each knob with a 1 um resolution
- Size
    - Make sure that the size of the device does not impede operation of the microscope. The size of the design should be as small as possible while still being functional.

			
Functionality (25)	4/5 * 25 = 20	3/5 * 25 = 15	4/5 * 25 = 20
Size (25)	2/5 * 25 = 10	4/5 * 25 = 20	5/5 * 25 = 25
Ease of Fabrication (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Cost (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Aesthetics (5)	4/5 * 5 = 4	5/5 * 5 = 5	3/5 * 5 = 3
Safety (5)	5/5 * 5 = 5	4/5 * 5 = 4	5/5 * 5 = 5
Total = 100	**79 / 100**	**69 / 100**	**85 / 100**

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

11/11/22 Tong ENTREPRENEUR lecture

SHREYA GODISHALA - Nov 11, 2022, 12:36 PM CST

Title: Tong lecture

Date: 11/11/22

Content by: Bonnie J. Bachman

Present:

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Entreprenrurial Mindset (EM) is important to engineers. This mindset can be developed and changed.

There are 5 in common mindset values

1) seek new opportunities

2) enornous discipline

3) pursue only the best ideas

4) adaptive exeution to avoid exhausting themselves

5) They engage in everyone in their domain

Innovation and Entreuprenuership (I and E)

-> Entreuprenuership education along with engineering education have been student driven. Therefore there are been a initiative for students to find a gap and innovate a product and become and entrepreuner. UIF/ Stanford Epicenter is an example to empower students to innovate and introduce curriculum.

-2/3 student and 1/2 of faculty felt that entreprenuership would be helpful in students engineering education.

-> faculty point of view should look what resources they can provide for their students and how to justify education of entrprenurship at part of tenure process and education in engineering. How can curriculumn be developed to incorporate entrepreneurship.

-> student perspective are ambitious and want to perhaps work for a start up and test their entreprenuership and research in universities leads to innovation in the industrial field and could potentially start a company later in their career

-> university traditional is teaching and scientific research but there is a push for entreprenuer education

-> teaching, research and extracurricular: these come together as the operational approach

-> Internal and External support system: community, social events, mentors, speakers, industry and opportunities, infrastructure and coworking spaces

-> TEO (Technology Entrepreneur Office) is a resource for pushing for more education and also help with start ups

-> UW Madison is now part of the NSF Hub where is training faculty and and this is one of the best ways to come up with a start- up

Conclusions/action items:

The conclusion that I have come to after listening to the leture that Mrs. Bachman has given us is that there need to be a push for entreprenuer education in the engineering education that I'm pursuing. This could be beneficial to me and my education as I may want to pursue an entreprenuership role as my career progresses and also as I am now in the stage of my college career that I want to potentially join a start- up

10/9/22 Designing Software Elements

SHREYA GODISHALA - Oct 09, 2022, 11:24 AM CDT

Title: Designing Software Elements

Date: 10/9/22

Content by: Shreya Godishala

Present: Shreya Godishala

Goals: Figure out what Design elements we need to porgram for the software elements

Content:

- 2021 software

- arduino (circuit design)

- joystick

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

SHREYA GODISHALA - Oct 12, 2022, 1:48 PM CDT

The Nikon Ti- U and the Olympus IX71. The microscopes are currently controlled by manual translation control knobs. The knobs move in both the x and y directions so therefore 2 motors are required to move each individually. Affordable solution, easily attached or removed and integrated with Nikon Elements. The impact of fluorescent microscopes is crucial to the development of technology and advancement of science. Making the process of imaging and analyzing cells more accurate and time efficient would help advance the research field and make it more accessible for low funded labs to conduct important experiments.

10/12/22 Design 1

SHREYA GODISHALA - Oct 12, 2022, 1:51 PM CDT

Title: Design 1

Date: 10/12/22

Content by: Shreya

Present: n/a

Goals: advantages to having design 1

Content:

This idea builds off of last years' final design. The design stays as is, however, we will be interfacing it with the microscope's software where the previous group did not get to. In addition, the design can be made less bulky with smaller gears and 3D printed stabilizers while keeping the same idea.

Conclusions/action items:

This is the idea I was leaning towards although this is not what the design matrix ended up pushing out.

10/12/22 Design 2

SHREYA GODISHALA - Oct 12, 2022, 1:52 PM CDT

Title: Design 2

Date: 10/12/22

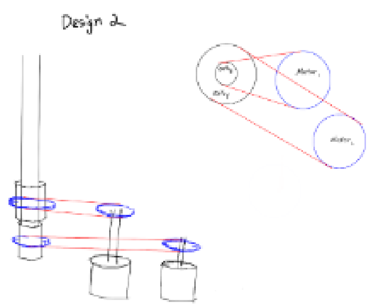
Content by: Shreya

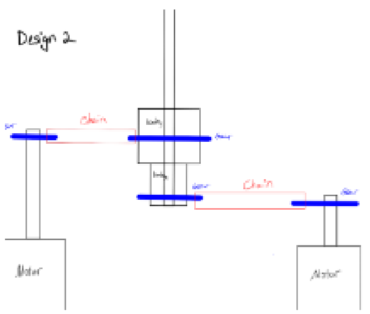
Present: n/a

Goals: advantages to having design 2

Content:

This design implements two chains to move gears connected to the x and y knobs, which are then connected to two motors on a rail.





Conclusions/action items:

This scored the lowest on the design matrix.

10/12/22 Design 3

SHREYA GODISHALA - Oct 12, 2022, 1:57 PM CDT

Title: Design 3

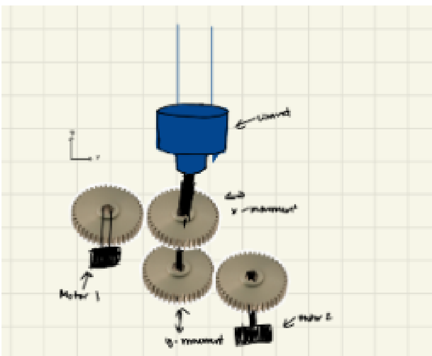
Date: 10/12/22

Content by: Shreya Godishala

Present:

Goals: Understand why Design 3 won in the Design matrix and how we should go about designing it

Content:



I drew the sketch for this one.

The third design has 4 gears. One gear on the x knob is interlocked with another gear connected to a motor. Similarly, there is a gear on the y knob connected to another gear and motor respectively.

Conclusions/action items:

Understaning how Design 3 won and the next step to be discussed with the team.

10/28/2022 Electronics Arduino Curcuit Design

SHREYA GODISHALA - Oct 28, 2022, 12:02 PM CDT

Title: Electronic Arduino Circuit Design ideas

Date: 10/28/22

Content by: Shreya Godishala

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Figure out the electronics component and the arduino code

Content:

Here is the arduino code from last semeter that we are hoping to develop. We are also looking at cicruit designs.

```
// Define pins


int driverY_PUL = 7;    // PUL- pin
int driverY_DIR = 6;    // DIR- pin
int driverX_PUL = 5;    // PUL- pin
int driverX_DIR = 4;    // DIR- pin


void setup() {


  // Set all digital pins to output
  pinMode(driverY_PUL, OUTPUT);
  pinMode(driverY_DIR, OUTPUT);
  pinMode(driverX_PUL, OUTPUT);
  pinMode(driverX_DIR, OUTPUT);
}


void loop() {

  digitalWrite(driverY_DIR, HIGH); // Controls the direction on the motor being used


  // 2273 iterations at .0011 sec/iteration = 2.5 sec
  for (int i = 0; i < 2273; i++){
    digitalWrite(driverY_PUL, HIGH);
    delayMicroseconds(550);
    digitalWrite(driverY_PUL, LOW);
    delayMicroseconds(550);
  }
```



```
  delay(2000); // delay to take picture and see how far it traveled
}
```

Conclusions/action items:

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

12/10/22 Stepper Motors vs DC motors

SHREYA GODISHALA - Dec 10, 2022, 4:35 PM CST

Title: Stepper Motor vs DC Motors

Date: 12/10/22

Content by: Shreya Godishala

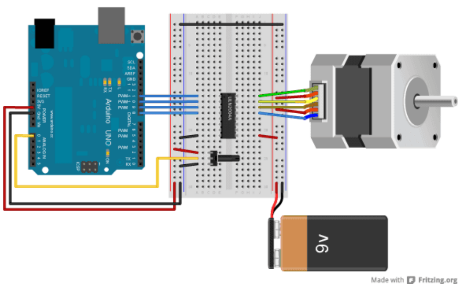
Present: Shreya Godishala

Goals: Why use the Stepper motors over a DC motor and the drivers

Content:

Electronics:

Stepper motors:
https://docs.arduino.cc/learn/electronics/stepper-motors

- arduino and stepper motor configurations
    - learn how to control a variety of stepper motor using
- The stepper motor with the driver is controlled by digital pins
- 

- We took pieces of this design into our own circuit design. The Arduino and stepper motor with the driver and instead of 9V we had 12V
- Why we decided to keep stepper motor vs a normal DC motor
    - Stepper motor converts a pulsing electrical current, controlled by a stepper motor driver, into precise one- step movement of this gear- like component
    - In the stepper motor can push harder from the rest, DC motors tend to push harder while DC motors tend to have more sustained outputs
    - Another reason why we use Stepper motors is because they are used for more incremental motion and why DC motors provide continuous motion. Both are fairly low in cost and used in a wide range of application

Conclusions/action items:

This is a reason why a circuit design with a stepper motor and a driver is a better choice than a normal DC motor. The next steps would be to integrate the stepper motor in the circuit design and figure out the wiring with the driver and the circuit board and the Arduino.

12/10/22 joystick

SHREYA GODISHALA - Dec 10, 2022, 4:39 PM CST

Title: Joystick

Date: 12/10/22

Content by: Shreya Godishala

Present: Shreya Godishala

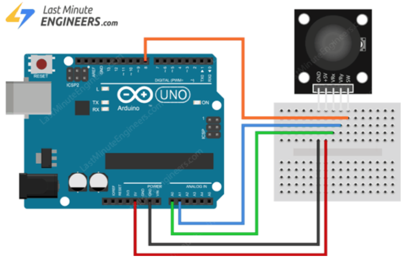
Goals: Figure out the components and the wiring to the joystick

Content:

https://create.arduino.cc/projecthub/MisterBotBreak/how-to-use-a-joystick-with-serial-monitor-1f04f0

- A joystick is essentially the sticks position on 2 axises
    - x - axis (left to right)
    - y - axis (up and down)
    - Intro an electrical signal that a microcontroller can process
- The way this is done is through 2 potentiometers
    - This is the reason why in our tinkercad final circuit design out joystick is represented with 2 potentiometers
- There is also a momentary pushbutton switch
    - This momentary pushbutton switch is is when you push down there is a click there is a lever that is on the switch's head
    - We had plans to code this as if we push down on the button that the lever pressing down would do with the switch's head
    - 

- This is the wiring for the joystick
    - There is an attachment to the ground and the VCC and there is also an attachment to the x and y and the voltage components of the joystick
    - Vrx -> the horizontal output voltage. Moving the joystick from left to right causes the output voltage from 0 to VCC
    - Vry -> the vertical output voltage. Moving the joystick up and down causes the output voltage to change from 0 to VCC
    - SW is the output from the pushbutton switch



Conclusions/action items:

The next steps are to integrate the joystick as we bought one from the makerspace. We need to find a breadboard for the joystick and use the code they used to program is once the motors have been fixed. Then we can use this to figure out speed and the direction of the testing for the motors.

12/10/22 Integrating Nikon software system

SHREYA GODISHALA - Dec 10, 2022, 4:52 PM CST

Title: Integrating Nikon system

Date: 12/10/22

Content by: Shreya Godishala

Present:

Our team wanted to address integrating the Nikon system with arduino

Goals:

-> we did some background research about how to integrate the 2 system but we had a hard time coming up with a solutions for how to integrate these 2 system

There is another project that I looked at that controlled a Nikon D40x using an infrared LED. Used the same pulse time as the infrared remote control for Nikon.

Attached below is an example code of how the Nikon was controlled using the Arduino

http://www.tauntek.com/irmimic-learning-ir-remote-control-transmitter.htm

*/**

**copied from http://www.bigmike.it/ircontrol/download.html*

WaveForm data:

Infrared period = 26us (~38.4kHz)

Strart pulse: 2000us 2ms

pause: 27830us 27.83ms

1st pulse: 390us 0.39ms

pause: 1580us 1.58ms

2nd pulse: 410us 0.41ms

pause: 3580us 3.58ms

3rd pulse: 400us 0.4ms

longpause: 63200us 63.2ms

REPEAT ONE TIME

**/*

```
int ledPin = 13;

void setup()

{ pinMode(ledPin, OUTPUT);}

void loop()

{  digitalWrite(ledPin, HIGH);

  delay(2);

 digitalWrite(ledPin, LOW);

  delay(27.83);
```

```
  digitalWrite(ledPin, HIGH);

  delay(0.39);

  digitalWrite(ledPin, LOW);

  delay(1.58);

  digitalWrite(ledPin, HIGH);

  delay(0.41);

  digitalWrite(ledPin, LOW);

  delay(3.58);

  digitalWrite(ledPin, HIGH);

  delay(0.4);

  digitalWrite(ledPin, LOW);

  delay(63.2);

}
```

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2022/10/22 - Impact of Project

DARSHIGAA GURUMOORTHY - Dec 14, 2022, 7:02 PM CST

Title: Impact of the Project

Date: 2022/10/21

Content by: Darshigaa

Present: N/A

Goals: Evaluate the global impacts of the project

Content:

- Need: Current microscopes cost more than the 10's of thousands of dollars - not feasible for use in a teaching

- Can be used to help learners devote more energy to learning new laboratory techniques as opposed to them spending hours

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

09/15/22 - Thor Labs - Existing Design

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 1:30 PM CDT

Title: Existing Design 1

Date: 09/15/22

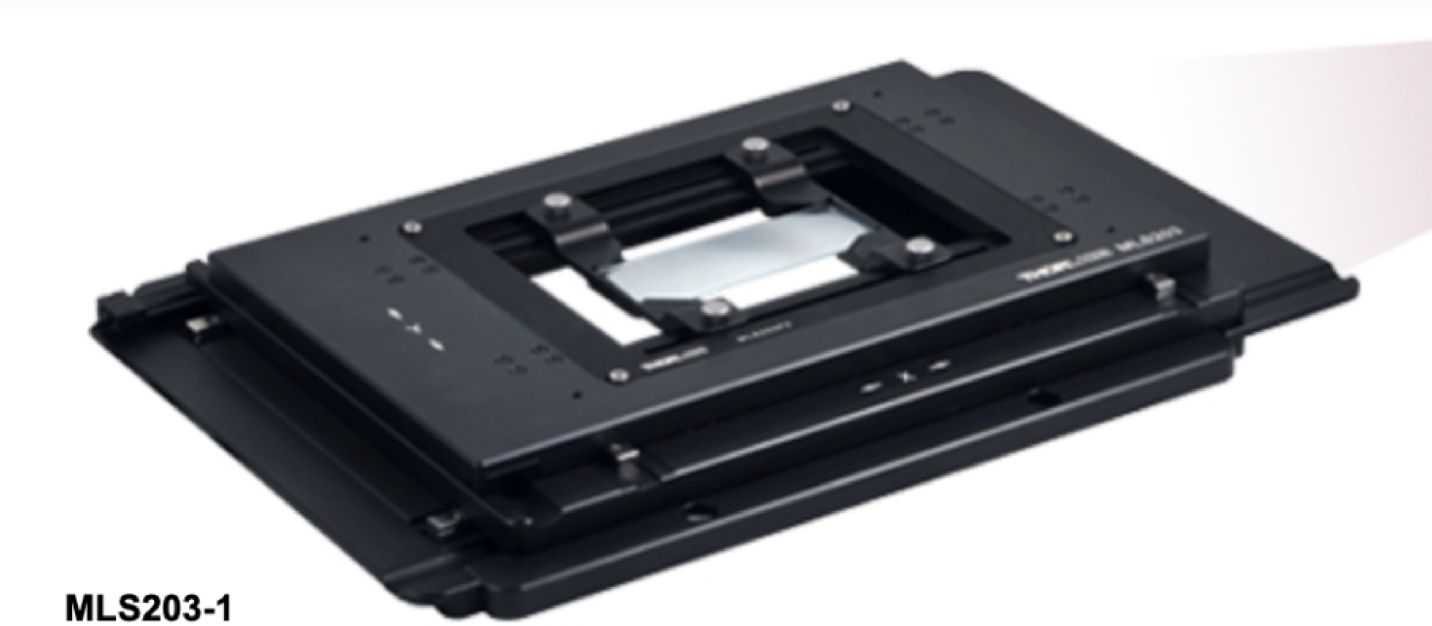
Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: To read about/gauge competition for motorized stages in the market

Content:

https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=5360



Features:

- Integrates with Nikon, Olympus, Zeiss, and Thorlabs' Cerna® Upright and Inverted Microscopes (Major microscope brands)
- Integrated Brushless DC Linear Servo Motor Actuators
- High-Quality, Precision-Engineered Linear Bearings - Bearing mechanism - Hard to replicate
- High Repeatability (0.25 µm) and Position Accuracy (<3 µm) - Good, w/in criteria of client
- Compatible with Thorlabs' Kinesis® and APT™ Software (Custom Software)

Components:

- Stage

-Controller

-Mounting Brackets

-Unclear optional accessories

**Mounting brackets - bolted to the actual optical table or breadboard

Conclusions/action items:

This design is a promising inspiration for the actual design however, the patent cannot be found. It is therefore necessary to analyze the design further in own time.

09/16/22 - Previous Work on Project

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 1:43 PM CDT

Title: Previous Work

Date: 09/16/22

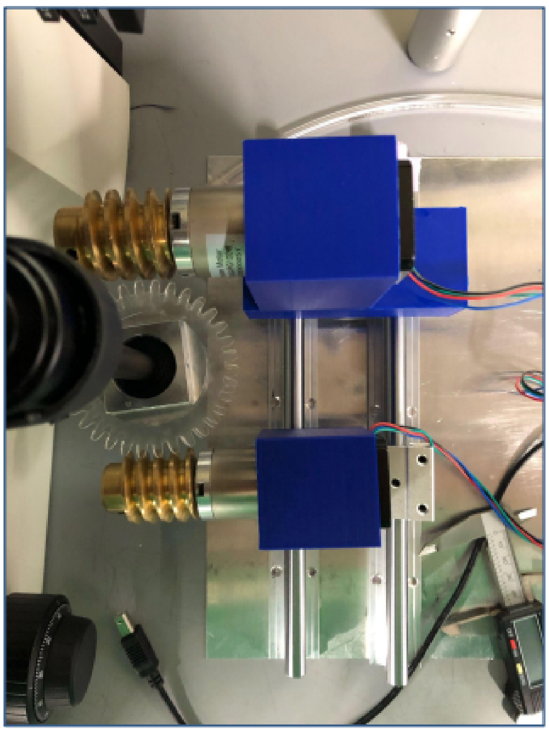
Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: Analyze previous groups' work on the project

Content:

Most Recent Design:



Use of Arduino

Resolution: 1um

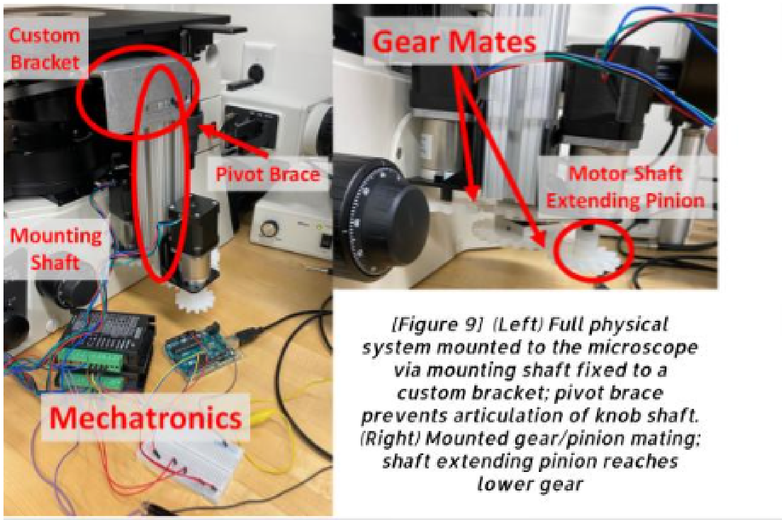
- Bulky

-Need further work to integrate it with software

- Unstable, need better housing

**Worm Gears for translation of motion.

- Functional but needs improvement



[Figure 9] (Left) Full physical system mounted to the microscope via mounting shaft fixed to a custom bracket; pivot brace prevents articulation of knob shaft. (Right) Mounted gear/pinion mating; shaft extending pinion reaches lower gear

- Design for free floating motorized stage system

- Two gears mated together - Highly risky design because it can fall apart anytime + rack and pinion design

- Not fully functional

-Weigh stage down, therefore issues with losing of focus on the sample.

Conclusions/action items:

-Although the above two designs were great designs, there is a need to come up with a fully compatible and functional design that is also not too bulky and expensive to manufacture.

09/13/22 - Preliminary Research on Fluroscent Microscopes + Microscopes available in Lab

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 1:59 PM CDT

Title: Preliminary Research + Microscopes available in Teaching Lab

Date: 09/13/22

Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: Understand working of inverted fluroscent microscopes and read up about the microscopes in the teaching lab

Content:

Microscopes in Lab:

Nikon Ti-U

- TI-SR Rectangular Mechanical Stage

- Controlled by two manual knobs on the left of the stage

- Joystick also available for free-form movement

Olympus IX71

- Mechanical Stage

-Joystick controlled

Working of a fluroscent Microscope

https://science.howstuffworks.com/light-microscope4.htm#:~:text=A%20fluorescence%20microscope%20uses%20a,light%20up%20to%20the%20specimen.

- Mercury or Xenon Lamp - produces UV light - hits dichroic mirror - light reflected above specimen

-UV light excite fluroscence w/in molecule. Objective lens collects fluoroscent light - barrier eliminates noise - eyepiece of microscope.

Fluoresence can be natural or introduced. Samples can either be stained with dyes like calcein/AM or propidium iodide or the cell can produce moles like GFP which fluoresce naturally.

Conclusions/action items: More preliminary research needs to be done on competing designs.

09/13/22 - Codes and Standards

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 2:06 PM CDT

Title: Codes and Standards

Date: 09/3/22

Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: To research codes and standards necessary for the project

Content:

https://argolight.com/blog/new-standards-about-confocal-microscopes-optical-data-whats-in-the-iso-210732019/

ISO 2103:2019

Definitions to know

- **resolution** and strength of optical sectioning,
- **uniformity** of field and centering accuracy,
- **co-registration accuracy**,
- stability of illumination power,
- field number of the confocal scan optic,
- scanning frequency,
- theoretical resolution.

the equipment will be placed in a BSI lab, therefore, it has to be compatible with that standard.

Conclusions/action items:

These need to be kept in mind while designing the prototype.

9/22/22 - PDS

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 3:00 PM CDT

Title: Project Design Specifications

Date: 9/22/22

Content by: Darshigaa Gurumoorthy

Present: Shreya, Mateo, Nikhil, Sam, Emily

Goals: Describe and come up with the PDS

Content:

The group met together and decided on the PDS (preliminary)

Conclusions/action items:

Review and submit to client.

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 3:01 PM CDT

Microscope Low-Cost Motorized Stage - BME 200/300 Section 304

Product Design Specifications

September 22nd, 2022

Client: Dr. John Puccinelli

Advisors: Dr. Kip Ludwig
Dr. James Trevathan

Team:	Mateo Silver	msilver@wisc.edu	Team Leader
	Shreya Godishala	sgodishala@wisc.edu	Communicator
	Darshigaa Gurumoorthy	gurumoorthy@wisc.edu	BSAC
	Emily Wadzinski	ewadzinski@wisc.edu	Co-BWIG
	Nikhil Chandra	nchandra5@wisc.edu	Co-BWIG
	Sam Tan	stan66@wisc.edu	BPAG

Function:

Contemporary inverted fluorescent microscopes are equipped with manual control knobs that enable a researcher to translate the microscope stage freely in the x and y directions. This manual control system presents a series of challenges to a user in recording and stitching sample images and in relocating or refocusing on specific sample areas. A manual knob is also generally more prone to error and tedious to operate when translating within the sample. A new motorized stage control system is needed that can automate the translation of a sample. The motorized stage with the options of a joystick or computer interface would enable a user to seamlessly and precisely move between areas of the sample. Programmed translations would also allow for the recording and stitching of numerous images. Fundamental specifications for the design include that it be low in cost (<$100) and have a high precision and accuracy in translations (1 μm resolution). As a whole, current inverted fluorescence microscopes necessitate a low cost motorized system for stage translations that would allow for the automated recording and stitching of images and seamless precise translations.

Client Requirements:

- Cost of the product to be within $100.
- Use 3D printing and laser cutting.
- Capable with Nikon Elements imaging software.
- Resolution of the movement is around 1 μm.

Download

Preliminary_PDS_-_Microscope_Stage.pdf (110 kB)

10/5/22 - Design Descriptions

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 3:06 PM CDT

Title: Design 1

Date: 10/5/22

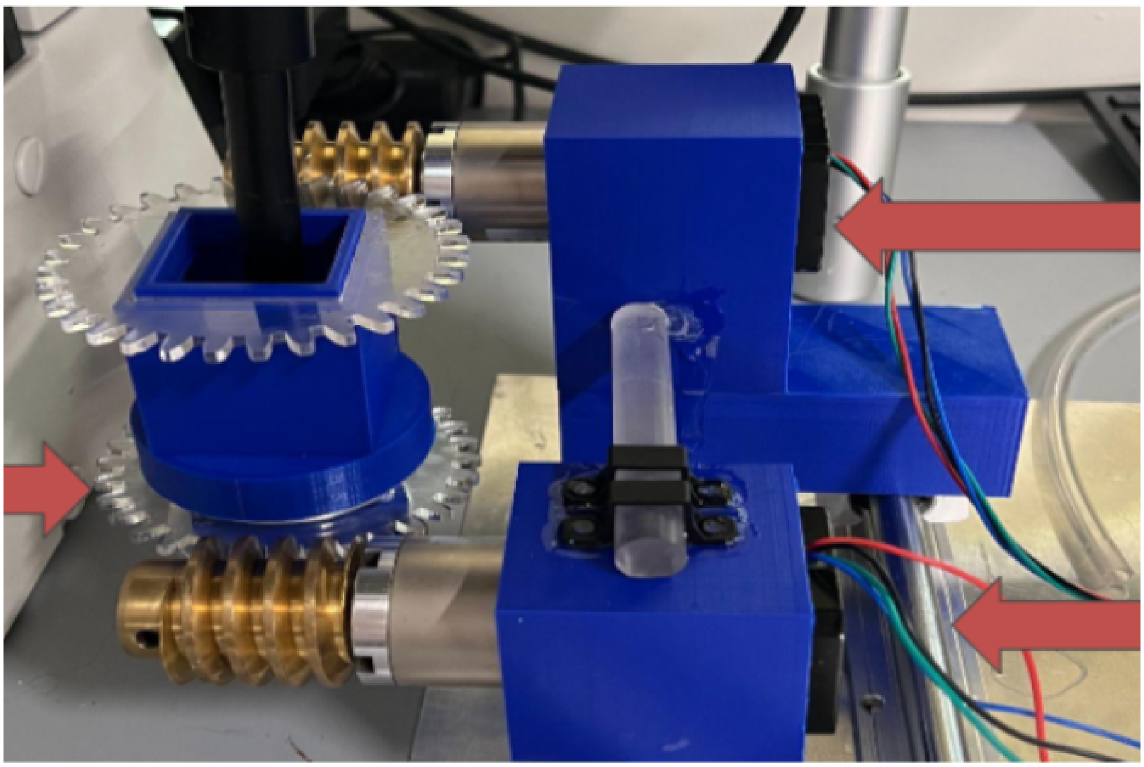
Content by: Darshigaa

Present: Mateo, Shreya, Sam, Nikhil, Emily

Goals: Describe Design 1, 2 and 3

Content:

****In collaboration with other teammates**

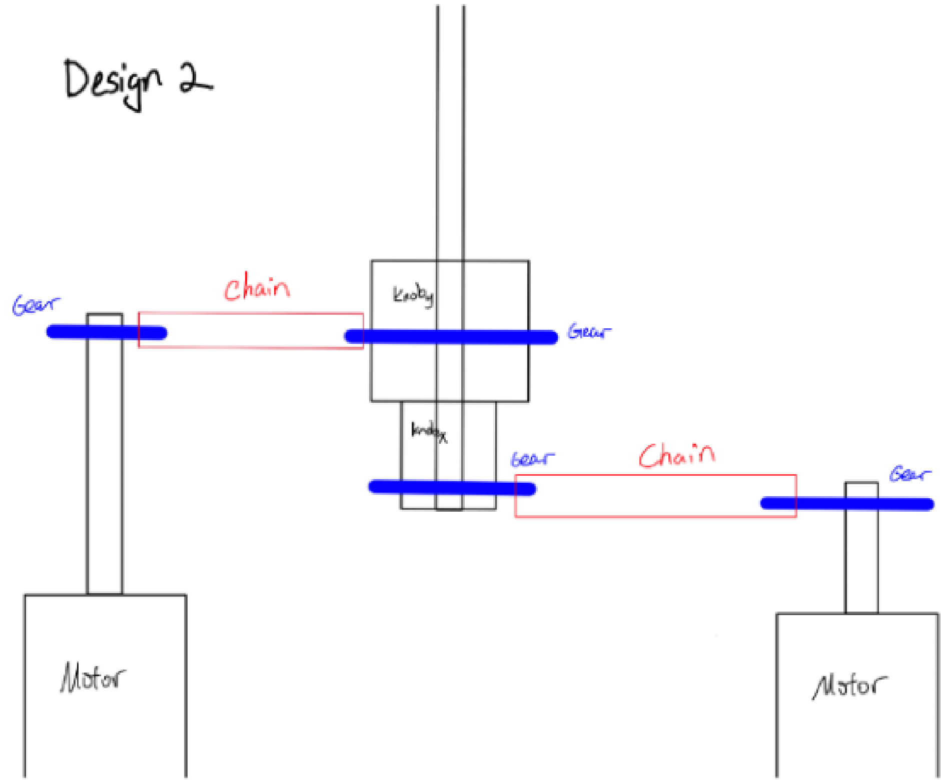


- Build off of Actual Design

-Encompasses two worm drive gears connected to two spur gears that are attached directly onto the knobs that translate the stage. Two steppers motors are used to individually turn each worm drive gear, which rotates the spur gear, thereby turning the knob and moving the stage.

-The system sits on a linear sliding rack, since as the x-axis knob turns, the wand itself with the knobs moves as well, and thus the prototype must move with it.

-Needs to be integrated with the microscope software

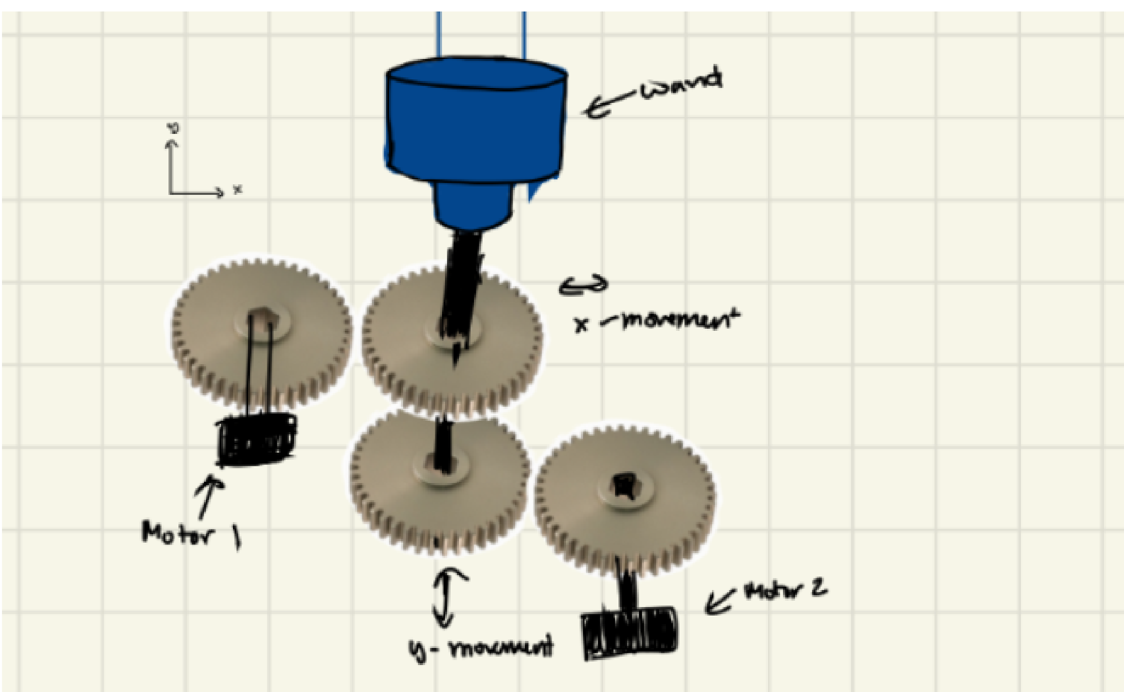


-Replaced the worm drive gear with a spur gear that is connected to the knob's gear through a chain. Notably, in this design the spur gears would not be directly in contact with one another. As the motor is activated, a spur gear will turn thereby rotating the chain which is tension and allowing the knob gear to also rotate and translate the stage.

-The primary advantage of this design is in the stability of the system where the teeth of the gear fall in place into the holes of the chain making misalignment more difficult between the gears as the system slides on the linear rack.

**Removing the worm drive gears and positioning the motors vertically also decrease the bulkiness of the design.

-Potential weakness - chain itself would be tedious to fabricate and the faulty fabrication of the chain would only increase the likelihood that the system jams and fails.



-Eliminates the need for a chain by placing the gears in direct contact with one another.

**Each motor is directly connected to a spur gear where as it rotates, it's horizontal alignment and connection with a knob spur gear would allow the knob to turn thereby moving the stage.

-The principal advantage of this design is that it eliminates the bulkiness associated with the use of worm drive gears and a chain, and by fine tuning the gear ratios between the spur gears, it could be possible to improve the resolution and accuracy of the system.

-The main drawback of this design is in the potential for misalignment between gears. As the x knob rotates, the stage is translated horizontally, and the system itself will move on a rack.

-However now the fluidity of this movement must be considered to prevent sudden breaks that cause the gears to fall out of place which was not a major issue with the chain and sprocket system.

-Will then further need to be integrated with the software.

Conclusions/action items:

Designs have to be evaluated

10/6/22 - Design Matrix

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 2:16 PM CDT

Title: Design Matrix

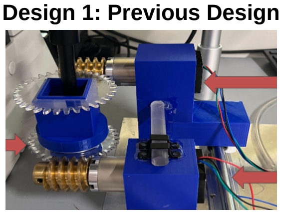
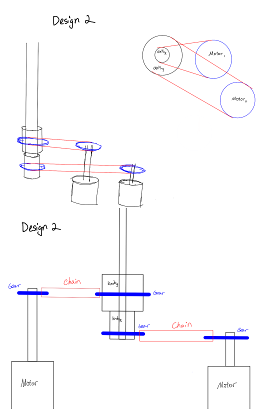
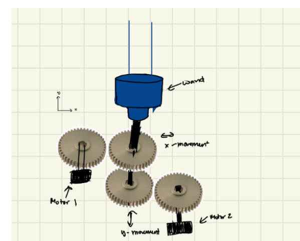
Date: 9/5/2016

Content by: Darshigaa Gurumoorthy

Present: Mateo, Shreya, Emily, Nikhil, Sam

Goals: Evaluate Designs to come up with the design matrix

Content:

	Design 1: Previous Design	Design 2: Chain Drive	Design 3: Gear to gear
			
ality (25)	4/5 * 25 = 20	3/5 * 25 = 15	4/5 * 25 = 20
	2/5 * 25 = 10	4/5 * 25 = 20	5/5 * 25 = 25
abrication	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
s (5)	4/5 * 5 = 4	5/5 * 5 = 5	3/5 * 5 = 3
)	5/5 * 5 = 5	4/5 * 5 = 4	5/5 * 5 = 5
00	**79 / 100**	**69 / 100**	**85 / 100**

Design Matrix Criteria:

- Functionality
  - A measure of how effective and accurate the design is likely to be at achieving the main objective of precisely turning each knob with a 1 um resolution
- Size

- Make sure that the size of the device does not impede operation of the microscope. The size of the design should be as small as possible while still being functional.

- Ease of fabrication
    - The general complexity of the design including moving parts, software, electrical components, and how difficult it may be to tie each of these in together to develop a prototype that accurately represents the design
- Cost
    - The cost of the automated microscope must stay within the $100 budget. Materials purchased in prior semesters do not count towards this cost.
- Aesthetics
    - A measure of how clean-cut and pleasing to the eye the finished prototype is
- Safety
    - The parts of the design when in use should not cause harm to the user.

Design 1: Previous Design

- This idea builds off of last years' final design. The design stays as is, however, we will be interfacing it with the microscope's software where the previous group did not get to. In addition, the design can be made less bulky with smaller gears and 3D printed stabilizers while keeping the same idea.

Design 2: Chain Drive

- This design implements two chains to move gears connected to the x and y knobs, which are then connected to two motors on a rail.

Design 3: Gear to gear

- The third design has 4 gears. One gear on the x knob is interlocked with another gear connected to a motor. Similarly, there is a gear on the y knob connected to another gear and motor respectively.

Conclusions/action items:

10/12/22 - Green Permit

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 2:53 PM CDT

Title: Green Permit

Date: 10/12/22

Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: Provide Green Permit

Content:

Permit Attached

Conclusions/action items:

Permit attached

DARSHIGAA GURUMOORTHY - Oct 12, 2022, 2:53 PM CDT

Welcome, Darshigaa Gurumoorthy
You are logged in to the
EMU Reservation System

TEAM Lab | Reserve a Machine | My Reservations | My Status

Materials Fee is paid through 2022-06-30. See Receipt

You may apply for the following upgrades:

Name
Welding 1
CNC Mill 1
Woodworking 1
CNC Lathe Haas 1

You have the following permits and upgrades:

Name	Date
Green Permit	03/09/2022
Lab Orientation	09/21/2020
Laser 1	10/08/2020

View Upcoming Seminars

You have used the following:

Type	Machine	Hours
Lathe	Lathe 2	3.5
Lathe Total		**3.5**

Download

EMU_Account_Status_-_EMU_-_UW-Madison.pdf (119 kB)

10/29/22 - Electronics Prelim Research

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 1:09 AM CST

Title: Electrical Components and Requirements

Date: 10/29/2022

Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: To understand the electrical components to accomplish the goals of the project

Content:

Stepper Motors:

https://docs.arduino.cc/learn/electronics/stepper-motors

Use: Move shaft forward or backward, allowing the entire system to move forward or backward.

Advantage: Can be controlled with a high degree of accuracy without any feedback mechanisms. Two tyoes - Unipolar and Bipolar - have different purposes

Working:

Shaft of motor mounted with a series of magnets that are controlled by a series of electromagnetic coils charged positively or negatively in a sequence.

Sample Code for bipolar motor to move one revolution in one direction and one in the other direction:

```
 #include <Stepper.h>


const int stepsPerRevolution = 200;  // change this to fit the number of steps per revolution
// for your motor

// initialize the stepper library on pins 8 through 11:
Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11);

void setup() {
  // set the speed at 60 rpm:
  myStepper.setSpeed(60);
  // initialize the serial port:
  Serial.begin(9600);
}

void loop() {
  // step one revolution  in one direction:
  Serial.println("clockwise");
  myStepper.step(stepsPerRevolution);
  delay(500);

  // step one revolution in the other direction:
  Serial.println("counterclockwise");
  myStepper.step(-stepsPerRevolution);
  delay(500);
}
```

Hardware Required:

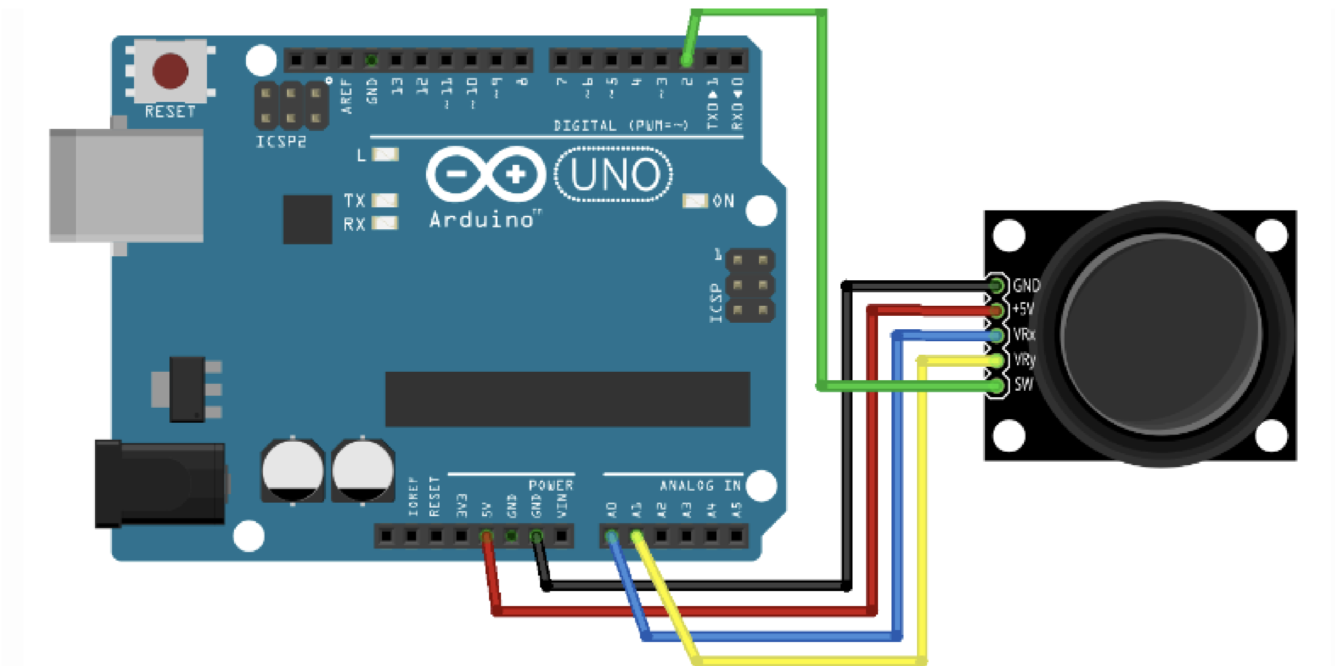
- Arduino Board
- stepper motor
- U2004 Darlington Array (if using a unipolar stepper)
- SN754410ne H-Bridge (if using a bipolar stepper)
- power supply appropriate for your particular stepper
- hook-up wires
- breadboard

<u>Joystick (Analog):</u>

https://exploreembedded.com/wiki/Analog_JoyStick_with_Arduino

- Similar to two potentiometers connected with each other - one for horizontal movement and the other for vertical movement. Also includes select switch.

Connections



Sample Code:

Raw Sketch

```
#define joyX A0
#define joyY A1

void setup() {
Serial.begin(9600);
}

void loop() {
// put your main code here, to run repeatedly:
xValue = analogRead(joyX);
yValue = analogRead(joyY);

//print the values with to plot or view
Serial.print(xValue);
Serial.print("\t");
Serial.println(yValue);
}
```

Mapping

```
#include "LedControl.h"
```

```
#define joyX A0
#define joyY A1

int xMap, yMap, xValue, yValue;
LedControl lc=LedControl(12,11,10,1);

void setup() {
Serial.begin(115200);

lc.shutdown(0,false);
/* Set the brightness to a medium values */
lc.setIntensity(0,8);
/* and clear the display */
lc.clearDisplay(0);
}

void loop() {
// put your main code here, to run repeatedly:
xValue = analogRead(joyX);
yValue = analogRead(joyY);
xMap = map(xValue, 0,1023, 0, 7);
yMap = map(yValue,0,1023,7,0);
lc.setLed(0,xMap,yMap,true);
lc.clearDisplay(0);

}
```

Conclusions/action items:

A stepper motor and the joystick are important components for the project, therefore it is important to understand these components along with their action and coding required to make them work.

10/3/2022 - Gear Ratios - Calculation and Math

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 12:26 PM CST

Title: Mechanical Fabrication - Gear Ratios and Mathematics

Date: 10/3/2020

Content by: Darshigaa Gurumoorthy

Present: N/A

Goals: Figure out equations for the calculations of gear ratios

Content:

Online Calculator:

https://zalophusdokdo.github.io/StepperMotorsCalculator/en/index.html

$$\text{First Gear Diameter} = \frac{\text{Total Gear Diameter}}{[1 - (\text{Motor Step Angle} / 1\ \mu\text{m Knob Angle})]^2}$$

Second Gear Diameter = Total Gear Diameter - First Gear Diameter

Above formula should provide a step size that allows a1 uM accuracy

Conclusions/action items:

Use above formula to calculate gear ratios.

11/25/2022 - Arduino Code and Diagram

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 1:13 PM CST

Title: Arduino code and Diagram

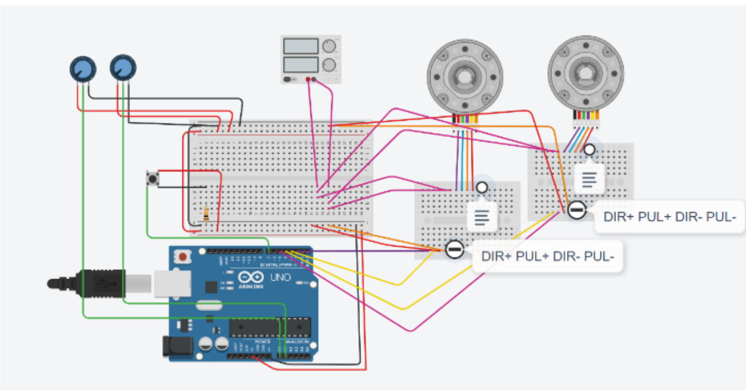
Date: 11/25/2022

Content by: Darshigaa

Present: Shreya, Sam, Darshigaa

Goals: Edit code and connections for the Arduino and Stepper Motors

Content:



circuit diagram for arduino

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

12/5/2022 - Nikon Imaging Elements Software

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 10:56 AM CST

Title: Nikon Imaging Elements Software

Date: 12/5/22

Content by: Darshigaa

Present: N/A

Goals: Prelim research into Nikon Elements imaging software to integrate into the software.

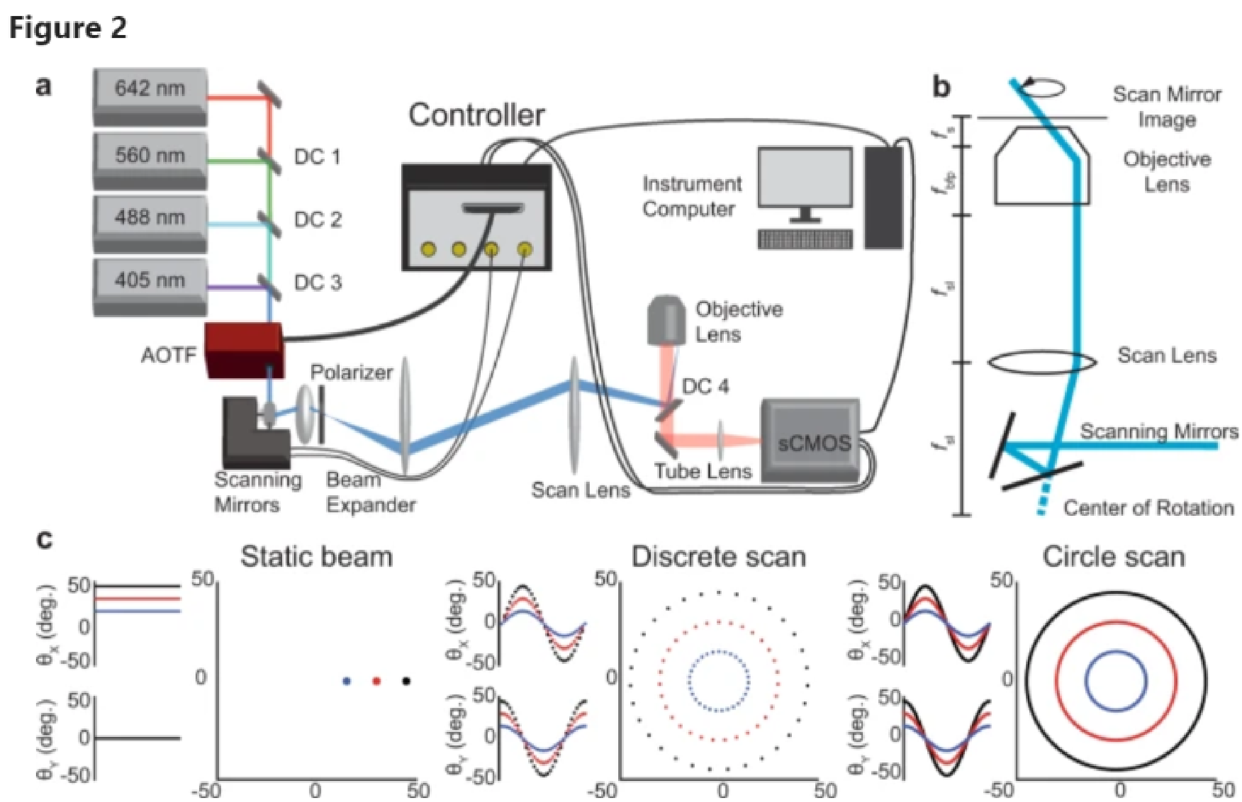
Content:

Purpose: Control Nikon Microscopes and 3rd Party elements

Has visualization tools, data acquisition tools and data sharing.

Currently, not many online resources to help us with the integration of an arduino with the software.

source: https://www.nature.com/articles/s41598-019-48455-z



schematic for arduino-software control.

Conclusions/action items:

-In conclusion, we will have to read through more of the documentation of the software to ensure that we integrate the components effectively.

10/7/2022 - Mechanical Testing

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 12:58 PM CST

Title: Testing of the Mechanical components of the project

Date: 10/7/22

Content by: Darshigaa Gurumoorthy

Present: Mateo, Nikhil, Shreya, Darshigaa

Goals: Test and provide results of the mechanical components of the project

Content:

Qualitative:

Current prototype - Occupies < 2x the space of the original prototype

Mechanical Components mesh well together

Solid works testing of design implies model is sturdy enough to withstand normal levels of wear and tear experienced in a general teaching laboratory.

Conclusions/action items:

Final design works well and meshes well. Electronics testing still required.

10/7/22 - Electrical Testing

DARSHIGAA GURUMOORTHY - Dec 13, 2022, 1:09 PM CST

Title: Testing of the electrical components of the final design

Date: 10/7/22

Content by: Darshigaa

Present: Mateo, Nikhil, Shreya, Darshigaa

Goals: Test the electrical components of the project

Content:

Testing Protocol:

1. Set the fixed 6uM polymer beads on the microscope stage.

2. Open Nikon Elements Imaging software, switch microscope to brightfield microscopy, change the objective to computer

3. Setup the stepper motors, arduino, rail system etc. to connect with the wand of the microscope stage so that it may move.

4. Mark a point in the field view of the microscope.

5. Upload code and allow it to run

6. After each movement of 250 steps back and forth, check for the error in distance between starting point and end point

7. Record error

8.Analyze data obtained

Testing Results:

Observed: Error increased exponentially as time went on, however initially accuracy rates were about 0.5 uM accuracy.

95% CI = 1.6442 +/- 0.9464 uM

p-value of t-test = 2.2 (not significant)

SE = 0.4302 uM

variance = 2.2213 uM

Conclusions/action items:

Although the electrical components work as expected, the desired error rates were still not obtained. This is probably due to faulty wire connections or backlash from the gears.

9/15/2022 - Prelim Research

EMILY WADZINSKI - Sep 16, 2022, 11:17 AM CDT

Title: Background Research

Date: 9/15/22

Content by: Emily

Goals: Develop a basic understanding of the project and find background research

Content:

Inverted microscope - lens are above stage, light sources are below

automated stitching - combining multiple images with overlapping fields of view

Previous BME 200 designs:

Fall 2021 report includes a joystick to control the stages. Worm drives spun the x and y gears on a rail system to move the stage with the help of an adapter to connect the two.

In the Spring 2022 report they secured the motors from tipping over with a clamp system of two 3D device holders. They also included a manual control knob stabilizer to hold the ball and socket in a straight position, and added a second rail instead of just one.

Conclusions/action items:

Should look into the other projects more as a group to see what we can build off of.

9/15/2022 - Competing Design

EMILY WADZINSKI - Oct 12, 2022, 1:43 AM CDT

Title: Competitive design

Date: 9/15/2022

Content by: Emily

Present: NA

Goals: Examine similar designs

Content:

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0088977

This design created in 2014 includes a hand held control pad that can control a variety of speeds, move quickly locationally, and is along 3-axes. (Their control pad is a PlayStation controller)

An X/Y drive system translates the stage, with the z-stage suspended over it.

Conclusions/action items:

The cost of their materials are under $1000, not $100. Not ethical for students or users to purchase without sufficient funding.

9/27/2022 - Preliminary PDS

EMILY WADZINSKI - Oct 12, 2022, 2:18 AM CDT

Title: PDS Research

Date: 9/27/2022

Content by: Emily

Present: NA

Goals: Research information to complete assigned sections.

Content:

Received Size, Weight, Materials, and Aesthetics, Appearance and Finish to complete upon group agreement.

For size, I considered one of client's biggest goals, to have the product small and less bulky.

Weight wise, the product had to be easy to attach and for students or professors to lift.

Upon talking to my teammates and client, we decided 3D printing was necessary. I researched makerspace at UW and the possible plastics we would use. Looking on the website, the FDM/FFF printing methods seemed the best fit for our project. The client also expressed we would need a laser cutter. The laser cutter at UW is the Universal ILS9.150D model. Materials need to cost under a hundred dollars total. With a joystick also needed, cheap options are reusing the Fall 2021 semester's select button and breakout board. Purchasing a new one would only be under $6 as well. (Sold on this website: https://www.adafruit.com/product/512 as well as other sellers.)

Lastly, the appearance of the design was decided that it should simple for classmates to use and learn on. The new design should be more compact than last year's design (Spring 2022) while still looking compatible with the entire microscope.

[1] “3D Printing at the Makerspace.” *UW Makerspace*, https://making.engr.wisc.edu/3d-printing-the-makerspace/.

[2] “Ils9.150D Platform.” ULS, https://www.ulsinc.com/products/platforms/ils9150d.

Conclusions/action items:

Can now update PDS with research.

9/28/2022 - Design Matrix

EMILY WADZINSKI - Oct 12, 2022, 2:55 PM CDT

Title: Design Matrix

Date: 9/28/2022

Content by: Emily

Present: Emily, Nikhil, Sam, Mateo, Shreya, Darshigaa

Goals: Grade our designs as a group

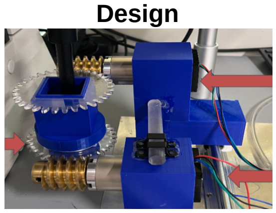
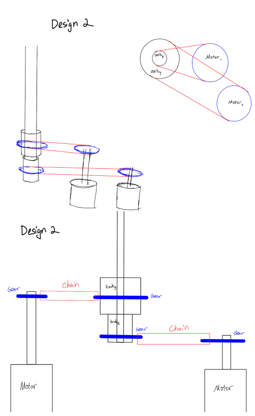
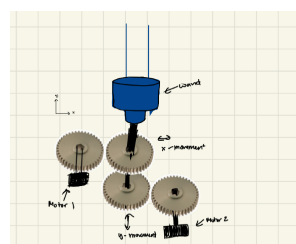
Content:

Design 1: Previous Design
This idea builds off of last years' final design. The design stays as is, however, we will be interfacing it with the microscope's software where the previous group did not get to. In addition, the design can be made less bulky with smaller gears and 3D printed stabilizers while keeping the same idea.

Design 2: Chain Drive
This design implements two chains to move gears connected to the x and y knobs, which are then connected to two motors on a rail.

Design 3: Gear to gear
The third design has 4 gears. One gear on the x knob is interlocked with another gear connected to a motor. Similarly, there is a gear on the y knob connected to another gear and motor respectively.

Matrix:

Criteria	**Design 1: Previous Design** 	**Design 2: Chain Drive** 	**Design 3: Gear to gear** 
Functionality (25)	4/5 * 25 = 20	3/5 * 25 = 15	4/5 * 25 = 20
Size (25)	2/5 * 25 = 10	4/5 * 25 = 20	5/5 * 25 = 25
Ease of Fabrication (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Cost (20)	5/5 * 20 = 20	3/5 * 20 = 12	4/5 * 20 = 16
Aesthetics (5)	4/5 * 5 = 4	5/5 * 5 = 5	3/5 * 5 = 3
Safety (5)	5/5 * 5 = 5	4/5 * 5 = 4	5/5 * 5 = 5
Total = 100	**79 / 100**	**69 / 100**	**85 / 100**

Conclusions/action items:

Designs were effectively evaluated and compared. Ready to turn in matrix.

9/25/2022 - Lab Safety Required Training

EMILY WADZINSKI - Oct 12, 2022, 1:39 AM CDT

Title: Lab Safety Required Training

Date: 9/25/2022

Content by: Emily

Present: NA

Goals: Complete safety modules to enter BME lab

Content:

Chemical Safety: The OSHA Lab Standard;

Chemical Safety Training > Assignments > Final Quiz >

Ongoing

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Course Summary

Submission Details

Final Quiz

EMILY WADZINSKI (She/her) submitted Sep 25 at 7:02pm

Due No due date **Points** 20 **Questions** 20 **Time Limit** None
Allowed Attempts Unlimited

Instructions

This is the final quiz. You must earn at least 80% (16/20) to pass, but may take the quiz as many times as you need to. If you need a record showing that you successfully completed this course, print the page showing your quiz score or email Nils Gibson at nils.gibson@wisc.edu to receive a certificate.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	less than 1 minute	19 out of 20

Biosafety Required Training:

Submission Details

Biosafety Required Training Quiz 2022

EMILY WADZINSKI (She/her) submitted Sep 25 at 6:09pm

This course quiz version has been updated for 2022.

- *Annual quiz updates are needed for OBS record-keeping purposes.*
- *If you already completed this training & the previous quiz version within the last 4 years, you do not need to complete the quiz now. Wait until you are due for your 5 year renewal and complete the quiz for that year.*
- *Complete this quiz if you are renewing your training at 5 years or if you are new to this training.*

You must complete the quiz with a passing score of 18 out of 25 questions correct (70%)

You may take the quiz more than once in order to achieve a passing score.

After you submit the quiz and have a passing score, click here to finish the course.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
LATEST	Attempt 1	2 minutes	24 out of 25

Conclusions/action items:

Completed items.

11/29/2022 - Red Permit

EMILY WADZINSKI - Dec 14, 2022, 4:32 PM CST

Title: Red Permit

Date: 11/30/2022

Content by: Emily

Present: Emily

Goals: Obtain permit for BME

Content:

Materials Fee is paid through 2022-12-31. See Receipt

Pay Fee Through 2023-06-30

You may apply for the following upgrades:

Name
Welding 1
Woodworking 1
Laser 1

You have the following permits and upgrades:

Name	Date
Lab Orientation	10/19/2022
Red Permit	11/30/2022

Apply for a new/additional permit

View Upcoming Seminars

11/29/2022 - Gear Design #2

EMILY WADZINSKI - Dec 14, 2022, 5:14 PM CST

Title: Gear Trial Designs

Date: 11/29/2022

Content by: Emily

Present: n/a

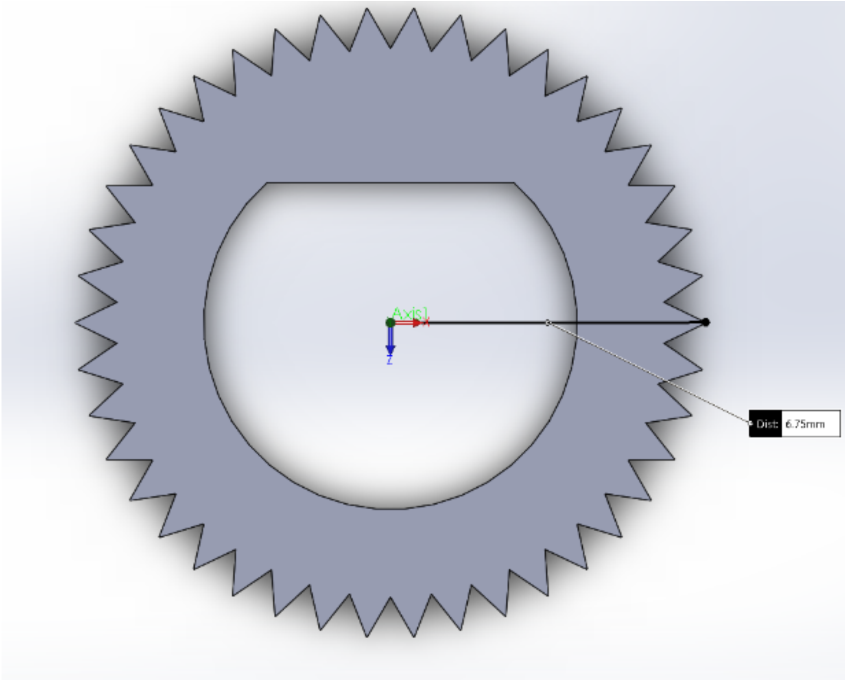
Goals: Create working gear design in order to fabricate.

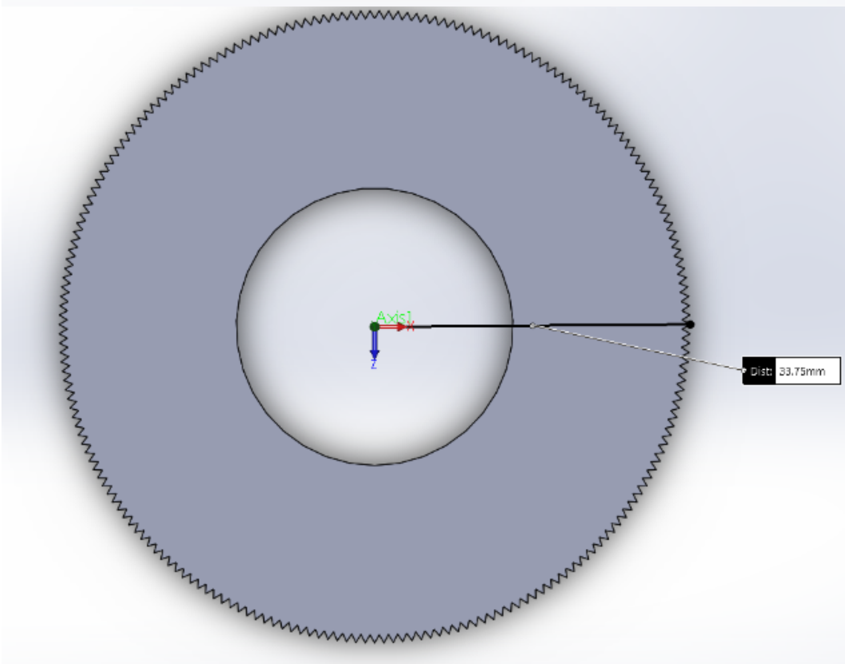
Content:

During the design process, three different gear designs were made. First, Nikhil calculated the four gears' diameters based off our first cad design. However, our motor mount design changed and new gear sizes were calculated. The second round of gears needed teeth added, so I went in and made those additions on solidworks. These gears below were laser cut into wood as the first test, but failed as a design as the teeth came out too small.

y motor gear

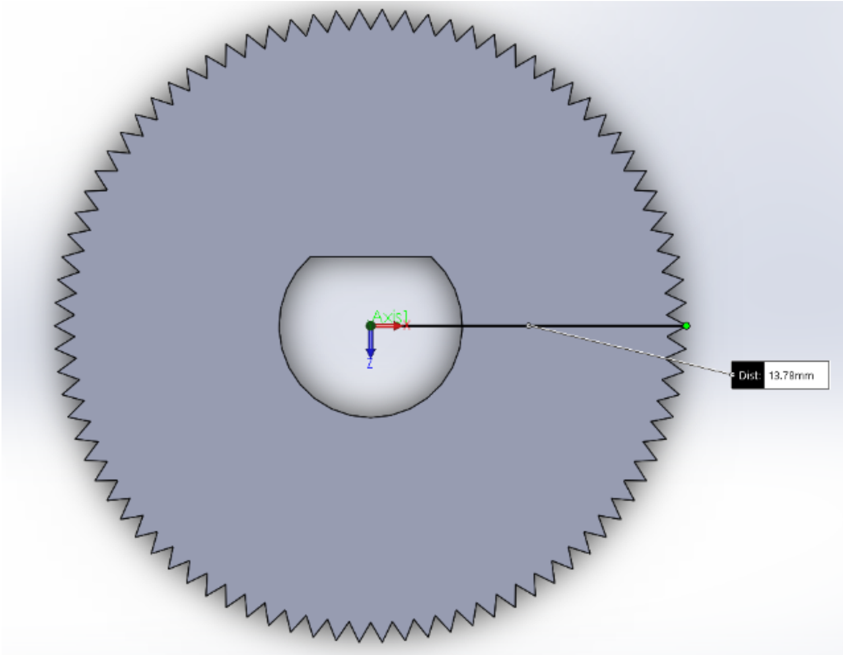
y knob gear

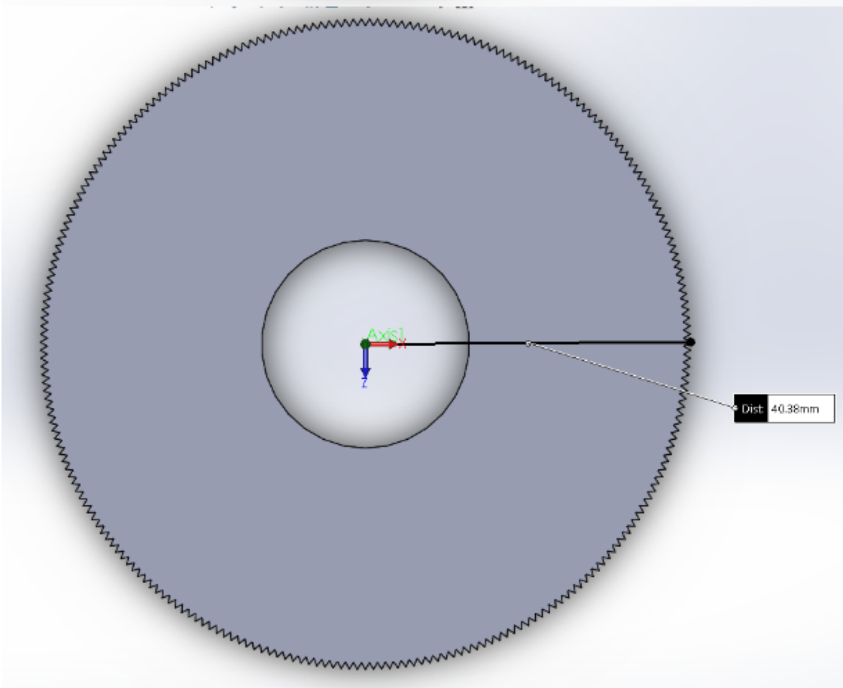




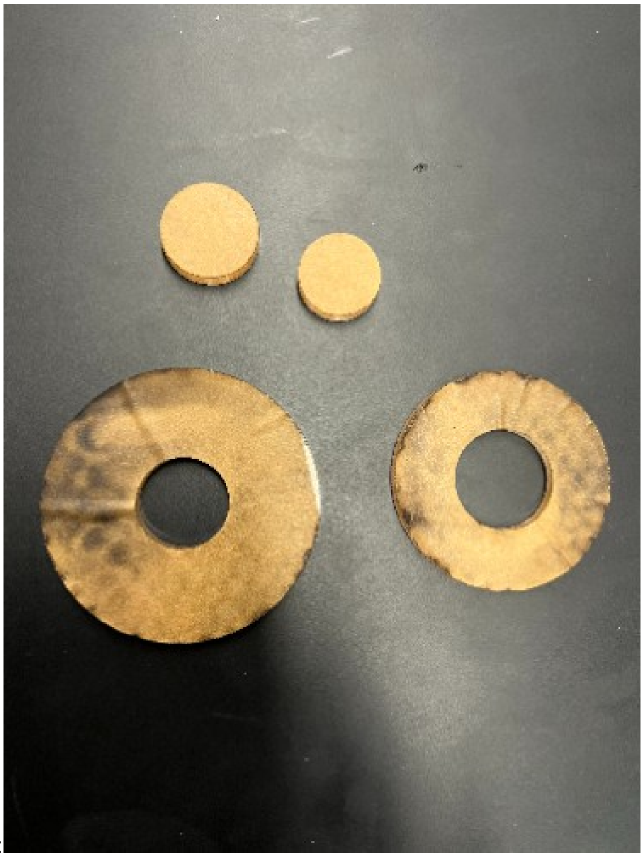
x motor gear

x knob gear





Laser Cut

:

Conclusions/action items:

Must redesign better gear teeth ratios

12/5/2022 - 3D Prints

EMILY WADZINSKI - Dec 14, 2022, 8:32 PM CST

Title: 3D prints

Date: 12/5/2022

Content by: Emily

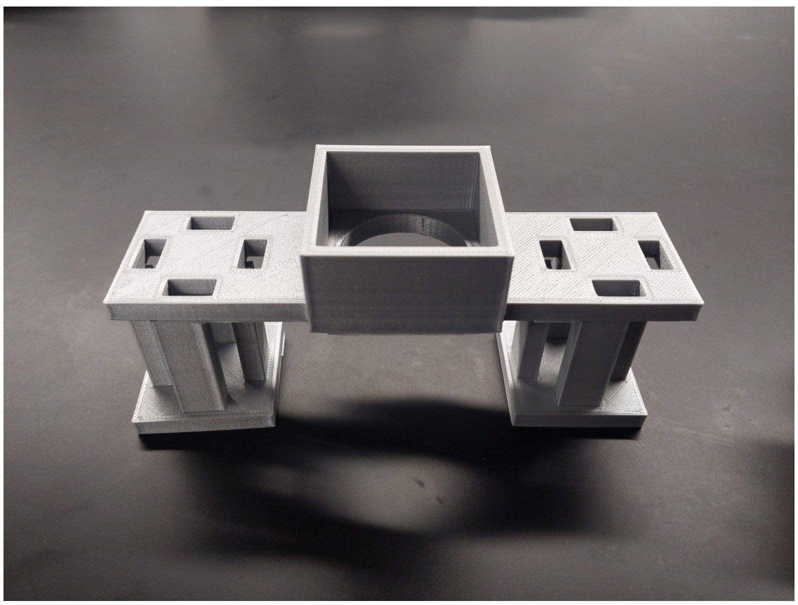
Present: n/a

Goals: Fabricate designs

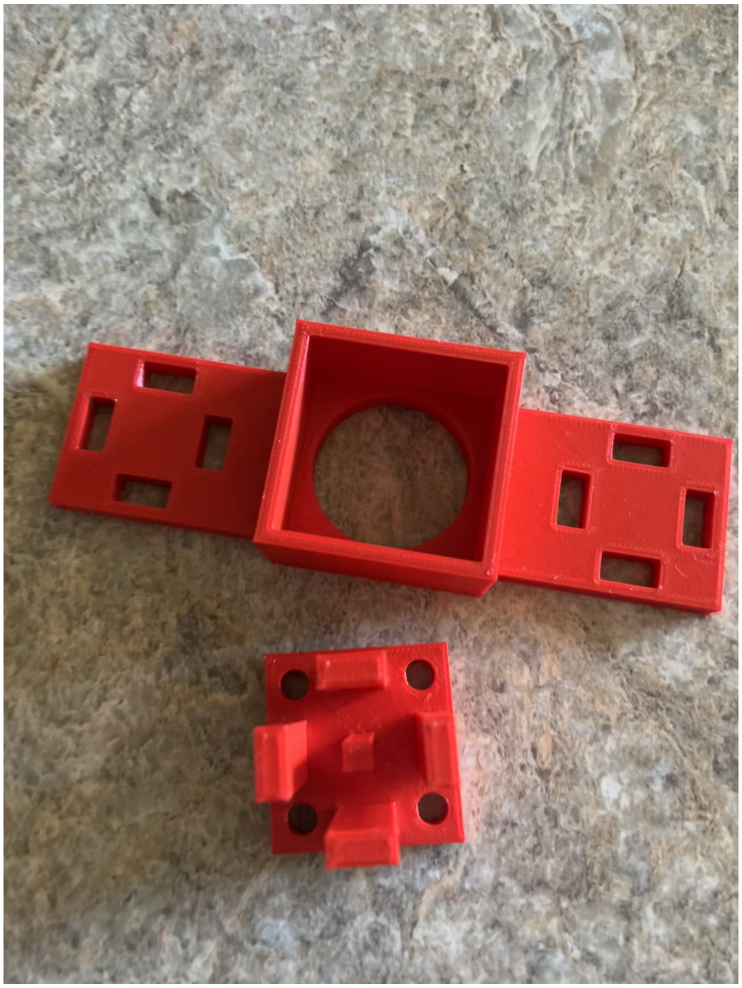
Content:

Three different prints were made during the fabrication process. All prints were done in makerspace with PLA material.

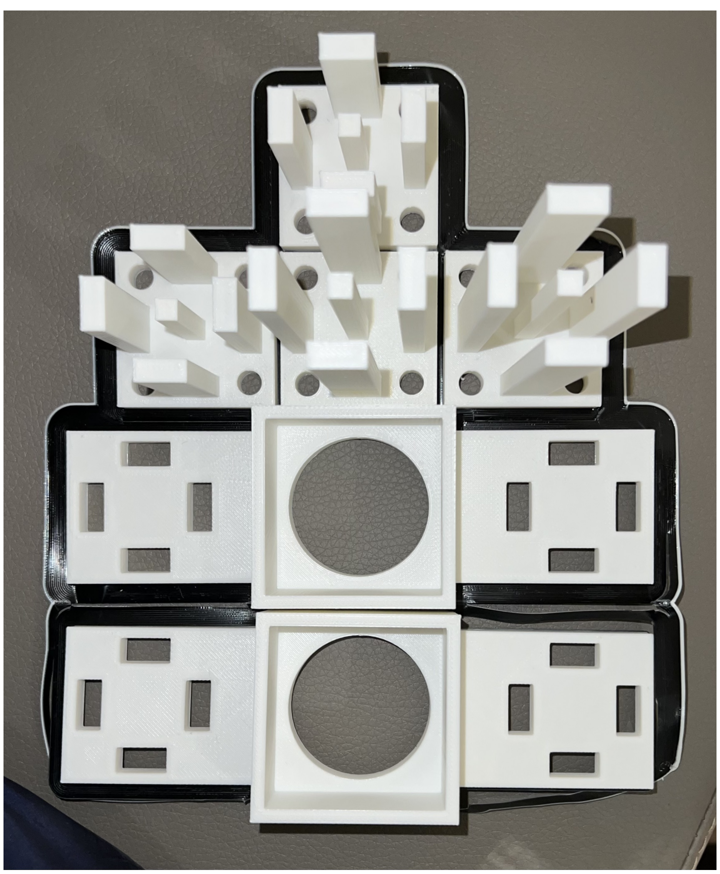
The first print was of the 2nd motor mount design. Instead of a 20% fill, 15% was done as it was the first prototype and did not have to be the strongest. It also saved material and money, as our project has a small budget. The print costed $10.32, and was 129 grams.



The 2nd print was only a portion of the final motor mount design. We wanted to print just one base mount and top in order to see if the CAD measurements worked and everything fit together snuggly. This print costed $3.60, was 45 grams, and of 20% fill.



After the 2nd print's success, I printed the entire design in order to use as our final prototype. This last print was of 20% fill, costed $12.80, and was 160 grams.



Conclusions/action items:

With many parts were recycled from last years design, the 3D printing was the most cost worthy of the items we bought this year.

9/22 - Research on Competing Designs

NIKHIL CHANDRA - Oct 12, 2022, 12:55 PM CDT

NIKHIL CHANDRA - Oct 12, 2022, 3:21 PM CDT

Title: Research on Competing Designs for Motorized Stages for Inverted Fluorescent Microscopes

Date: 9/22/22

Content by: Nikhil Chandra

Present: NA

Goals: Gain an understand of existing designs on the market and in research for automating the translation of an inverted fluorescent microscope stage.

Content:

https://www.bestscope.net/bs-2095fma-motorized-inverted-fluorescent-microscope/

- Inverted fluorescent microscope with a motorized stage built in directly to the stage, and a bluetooth joystick can control the translation of the stage

- Although accurate with a high resolution, the device is exceedingly more costly than inverted fluorescent microscopes with manual translation knobs

- One of the major designs on market, and shows the importance of developing a low cost motorized stage that can be purchased seperately from the microscope, which would be optimal for teaching labs that may not have a high budget to buy an automated inverted fluorescent microscope

Conclusion/Action Item:

Moving forward, begin personal brainstorming on developing an attachable device that can interface with the wand of a manual inverted fluorescence microscope, while maintaining a budget of under a $100 in contrast to current automated inverted fluorescent microscopes which can cost almost $10000 more.

9/20/22 General Research on the Problem

NIKHIL CHANDRA - Oct 12, 2022, 12:15 PM CDT

Title: General Research on Understanding the Problem

Date: 9/20/22

Content by: Nikhil Chandra

Present: NA

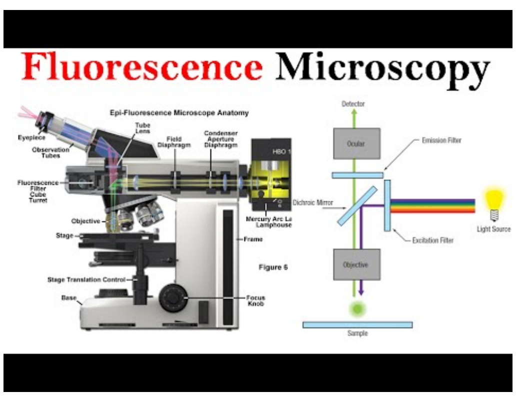
Goals: Generally understand more about the purpose of inverted fluorescent microscopes and how a motorized stage would be useful or necessary.

Content:

- A diagram of an inverted fluorescent microscope is shown. An inverted fluorescent microscope employs a halogen lamp to light up the specimen on the stage, where UV light specifically is reflected off a dichroic mirror through the specimen thereby activating fluorescence in the sample for a researcher to analyze which can be useful for a range of reasons including analyzing the presence or abundance of living cells.

- The notable parts of the diagram relative to our diagram include the wand directly connected to the stage, and how there are two knobs on the wand. The knob closer to the stage has a larger diameter than the knob farthest, which would be important when designing a motorized stage.

- Contemporary inverted fluorescent microscopes are equipped with manual control knobs that enable a user to translate the microscope stage freely in the x and y direction. This manual control knob presents a series of challenges to a researcher in recording and stitching sample images, and when relocating or refocusing on specific areas of the sample.



https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DgxekhnnFg2I&psig=AOvVaw1YmAFByJ-vKPunCnAC97tz&ust=1665680329843000&source=images&cd=vfe&ved=0CA0QjhxqFwoTCMCiuvmU2_oCFQAAAAAdAAAAABAI

Conclusions/action items:

Moving forward now that we generally understand the need for a low cost motorized stage and how inverted fluorescence microscopes work and are applied in research, we can now move forward with researching competing designs then brainstorming.

9/25 - Individual Brainstorming of Design Ideas

NIKHIL CHANDRA - Oct 12, 2022, 12:35 PM CDT

Title: Individual Brainstorming on Designs for a Low Cost Motorized Stage

Date: 9/25/22

Content by: Nikhil Chandra

Present: NA

Goals: To brainstorm as many design ideas for a low cost motorized stage on an inverted fluorescent micrscope, where specifically we can apply stepper motors to turn each of the two knobs individually to translate the stage in the x and y direction

Content:

- A chain and sprocket system where we have two spur gears on the knobs connected individually to two spur gears, and a chain wraps around each set of gears for stability. Two motors positioned vertically can rotated each of the non knob spur gears.

- A clamp system where we have a singular motor that has a clamp attached two it that can squeeze the knob similar to the way our fingers would squeeze a knob to turn it. And it would extend to either position itself on the x or y axis knob depending on how the stage should move

- A cylindrical design similar to the clamp where there is a cylinder that wraps around the knob and is connected to the motor. As the motor turns, the cylinder rotates thereby turning the knob. We can have two motors where one larger cylinder connects to the upper knob and encases a smaller cylinder connected to the lower knob

- A bevel gear system, where two bevel gears sit on each of the knobs individually, and and another two bevel gears are directly in contact with the knob gears and connected to two individual motors that are positioned horizontally. As one bevel gear turns, it moves the knob gear thereby translating the stage

- An elastic tension system where a string is wrapped around the motor tip like a pulley, and as the motor turns it applies tension to the string thereby turning the knob to which it is connected to. As the tension is released, somehow we can get the knob to turn back to its original position, and this idea definitely needs to be refined by overall we could potentially use tension as a way to turn the gear and the level of tension can determine the current rotation of the knob.

Conclusion and action items:

Moving forward now that I have thought of a few individual ideas, I hope to bring these to the group during our team brainstorming session, receive feeback, and overall develop more ideas that either improve upon these or are potentially completely different.

10/12 - 1 Micron Knob Angle Testing and Calculations

NIKHIL CHANDRA - Dec 14, 2022, 1:00 PM CST

Title: 1 Micron Knob Angle Testing and Calculations

Date: 10/12/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The goal is to determine the angle in degrees the x and y axis knob control angles must move to translate the stage exactly 1 micron.

Content:

The strategy in testing is to turn the knob 360 degrees using a tape marker and visual observations to ensure the knob has rotated the full 360 degrees and the tape is back to its starting point each time. Then using a metric ruler, I can observe how much the stage has moved. I will do this 3 times for each knob to ensure there have been repeatable results, then take the sample average distance the stage moved in cm. At the end the ratio of 360 degrees to the average distance moved in cm will be found, then this ratio will be converted to degrees per unit micron, to find the angle the knob must turn to move the stage 1 micron.

The testing results are below:

Y knob(top knob):
Trial 1:

0.7 cm starting
3.9 cm ending

Trial 2:
0.8 cm starting
4 cm ending

Trial 3:
0.7 cm starting
3.9 cm ending

Average difference: 3.2 cm
Ratio: 3.2 cm / 360 degrees rotation
To turn 1 micron:
360/(3.2*(10^4))
0.01125 degrees/micron

X knob(bottom knob):

Trial 1:
31.9 cm starting
30.1 cm ending

Trial 2:

32 cm starting
30.1 cm ending

Trial 3:
32 cm starting
30.15 cm ending

Trial 4(simply because some variation was noticed, and another trial was of interest):
30.15 cm starting
28.2 cm ending

Average difference: 1.875 cm
Ratio: 360 degrees / 1.875 cm
To turn 1 micron: 0.0192 degrees/micron

Conclusion and action items:

The angle to turn the y knob and x knob for a 1 micron translation precision was experimentally found to be 0.01125 degrees and 0.0192 degrees respectively. Given these measurements, we can now move forward in calculating the exact gear ratios necessary such that the smallest step angle of each of the motors can translate into turning each of the control knobs exactly the angle above such that when the motors turn their smallest angle they can translate the stage exactly 1 micron in theory. The next entry should describe these gear calculations even further and all the scratch work associated when making these calculations.

10/13 - Gear Ratio Calculations to Achieve 1 Micron Translation Precision

NIKHIL CHANDRA - Dec 14, 2022, 8:55 PM CST

Title: Gear Ratio Calculations to Achieve 1 Micron Translation Precision

Date: 10/13/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The objective is to calculate the optimal gear ratios to translate the smallest step angle of the project motors to the knob angle required for a 1 micron translation precision.

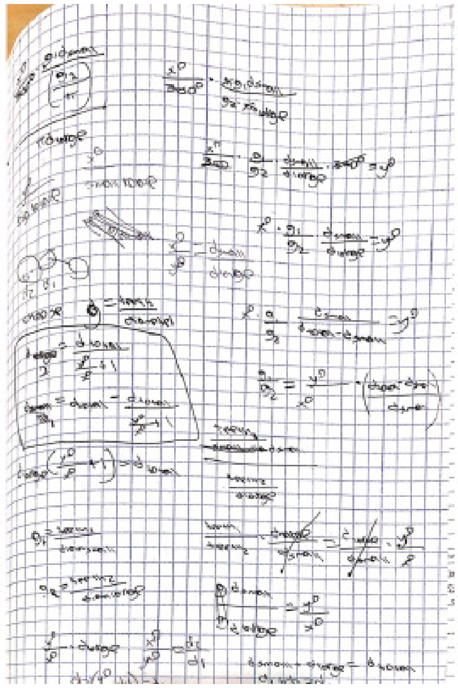
Content:

The rough calculations and derivation is shown before the final formula was reached in the attachment. The general idea behind the derivations is that given the constraints including the 1 micron knob angle, the stepper motor step angle, and the total desired diameter of the system being the addition of the pitch diameter of gear 1 and gear 2, we can then calculate the diameter of gear 1. And the total diameter minus the gear 1 diameter can then be used to calculate the diameter of gear 2. From the CAD design, given the distance available from the knob to the microscope, we chose an optimal total gear diameter to make the system both compact and ensure it fit within the available amount of space before physical conflict with the microscope. The final formula and gear diameters are boxed in the scratch paper. Look to the final CAD design to see the gears with these diameters in the context of the full assembled prototype.

Conclusion and action items:

The formula to achieve a 1 micron translation stage precision was determined involving the constraints including the step angle of the motor, the 1 micron control knob angle, and the desired total gear diameter to determine the diameter of one of the gears, which can then be used to calculate the diameter of the second gear. A desired total gear diameter was determined for each of the control knobs, and the gear diameters were calculated and checked in the context of the full assembled prototype to ensure everything fit together. Moving forward, we can now fabricate the gears by calculating the module(# of teeth/diameter) then designing the gears in solidworks or in adobe illustrator directly since the gears will have to be laser cut as a 2d vector file.

NIKHIL CHANDRA - Dec 14, 2022, 8:55 PM CST



Download

Gear_Calculations_and_Derivation.pdf (2.26 MB)

10/15 - X and Y axis Spur Gear Design First Iteration

NIKHIL CHANDRA - Dec 14, 2022, 4:30 PM CST

Title: Gear Ratio Calculations to Achieve 1 Micron Translation Precision

Date: 10/15/2022

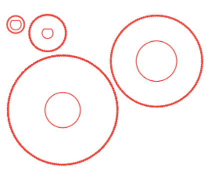
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The objective is to design the gears in solidworks then adobe illustrator such that it can be converted into a vector file to be fabricated in the laser cutter.

Content:

The pitch diameters of the first gear and second gear for the x axis control knob are 80.75 mm and 27.563 mm respectively. The pitch diameters of the first gear and second gear for the y axis control knob are 67.5 mm and 13.5 mm. Given these pitch diameters and a pressure angle of 20 degrees, the gears were designed in solidworks then converted to drawings and put in adobe illustrator. The adobe illustrator gears ready for laser cutting are shown below:



Conclusion and action items:

The gears for both control knobs and motors were designed in a 2D vector file, and are now ready for fabrication via laser cutting. By reserving time on a laser cutter, we can then fabricate the gears and analyze their meshing before proceeding with the fitting of them on the control knobs and motors. If necessary, the gears can be re-fabricated to ensure a proper fit and better meshing.

10/17 Gear Fabrication First iteration and Analysis

NIKHIL CHANDRA - Dec 14, 2022, 11:14 PM CST

Title: Gear Ratio Calculations to Achieve 1 Micron Translation Precision

Date: 10/15/2022

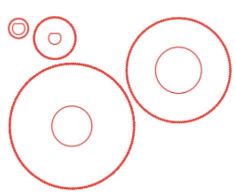
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The obejctive is to fabricate the gears for both the control knobs and motors as already designed in adobe illustrator as a 2d vector file.

Content:

The first iteration was a failure for a variety of reasons. The inverse module for the gears was too high meaning there were too many teeth per unit diameter, and thus the gears did not mesh at all. Rather each gear looks relatively circular and the teeth are barely visible because of how many there are. The smallest gear also was too small to the point that it got melted completely, and was in the shape of a melted ball coming out of the laser cutter. An image of the large gear is shown below, notice how the teeth can barely be seen. To note as well, the gears were cut out of scrap acryllic plastic and we did not have to dive into our budget just yet. I believe the smallest gear melted not only because it was small being about 1 cm, but also because of the large number of teeth causing there to be too much power from the laser cutter for too long in that region.



Conclusion and action items:

As a whole, the first iteration of the gears failed because the module(number of teeth per unit diameter) was too high, causing the gears not to mesh and the smallest gear to melt completely. To solve each of these issue, module calculations need to be redone where the inverse module should be significantly lower, which should not only solve the meshing issue, but also with less teeth, I hypothesize there will be less concentrated power for the smallest gear during laser cutting causing it to not melt as well.

10/20 Gear Redesign and New Calculations for Second Fabrication Iteration

NIKHIL CHANDRA - Dec 14, 2022, 5:31 PM CST

Title: Gear Redesign and New Calculations for Second Fabrication Iteration

Date: 10/20/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The goal is to recalculate the modules for a second design iteration of the gears, then redesign the gears with these new modules. This is to address the issue from gear fabrication iteration 1, where there were too many teeth and the gears could not mesh at all the smallest gear had melted completely.

Content:

The module calculations for a second design iteration of the gear was shown below. The calculations were done simply by estimating a number of teeth that would be reasonable for the knob gear, then given the number of teeth and diameter of the knob gear, the module was calculated which was then used with the diameter of the motor gear to calculate the number of teeth to maintain a consistent module between each of the meshed spur gear systems.

Knob gear 1:

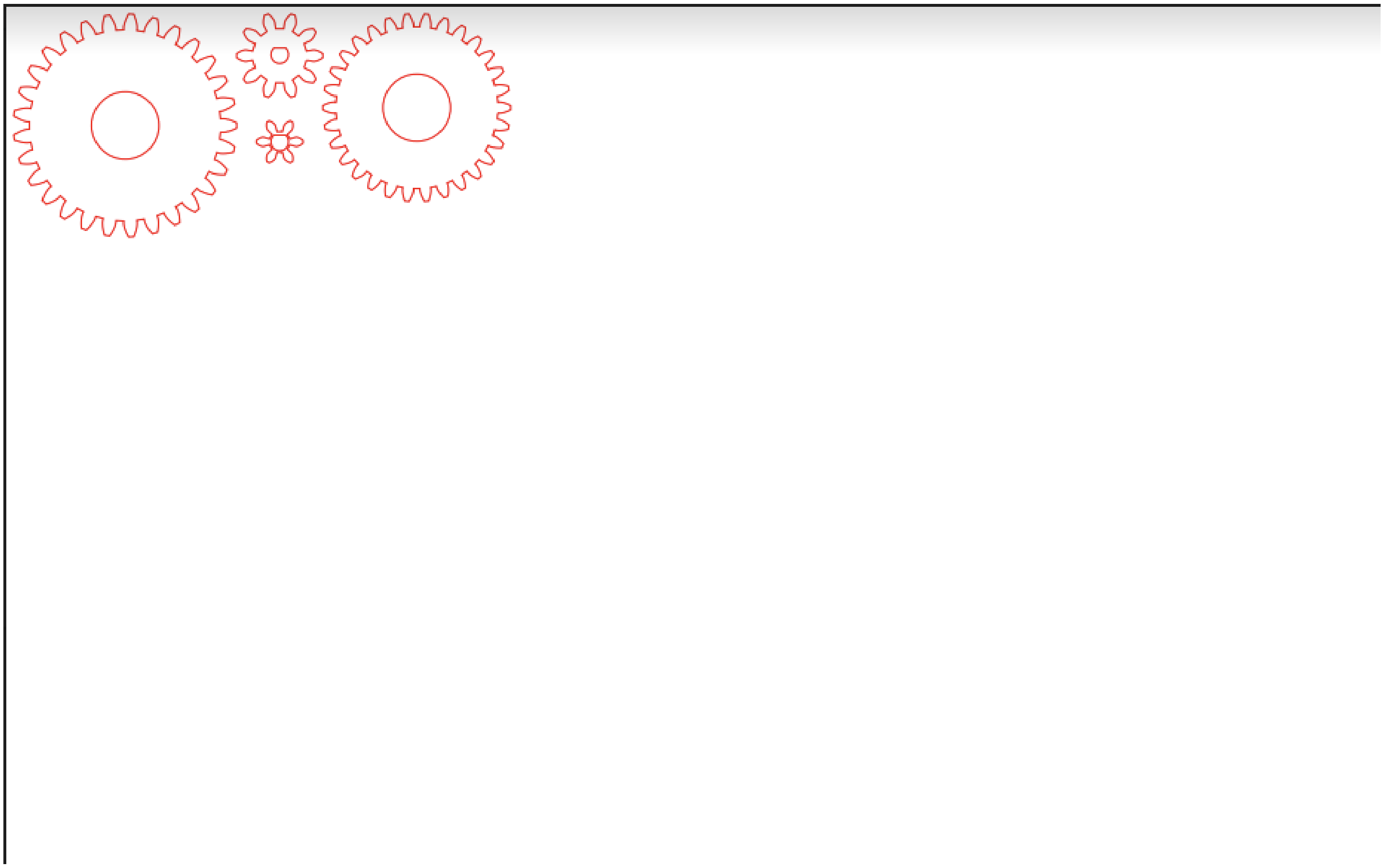
80.75 mm, 29 teeth, module 2.7563

Motor gear 1:
27.563mm, 10 teeth, module 2.7563

Knob gear 2:
67.5 mm, 30 teeth, module 2.25

Motor gear 2:
13.5 mm, 6 teeth, module 2.25

Given the modules, a pressure angle of 20 degrees, and the pitch diameters above, the new gears were redesigned. However, instead of using solidworks, an online gear generator was used instead which makes it easier to import the gear design into adobe illustrator for it to be a vector file. The website is cited below, and the final adobe illustrator design is also below:



Conclusion and action items:

The module calculations were done successfully where the number of teeth for each of the gears was significantly reduced to address the issue of gear fabrication iteration 1 where the gears did not mesh. Given the new modules, the gears were then redesigned in adobe illustrator making use of a website for generating 2d spur gears. Moving forward, given the 2d vector file containing the gears for the knobs and motors, the new set of gears can now be fabricated via the laser cutter.

References:

Edge, Engineers. “Spur Gear Calculator and Generator Download DXF, SVG or CSV Excel Format Files.” *Engineers Edge - Engineering, Design and Manufacturing Solutions*, https://www.engineersedge.com/calculators/spur_gear_calculator_and_generator_15506.htm.

10/22 Gear Fabrication Second Iteration and Analysis

NIKHIL CHANDRA - Dec 14, 2022, 7:11 PM CST

Title: Gear Fabrication Second Iteration and Analyses

Date: 10/22/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The goal is to fabricate the second iteration of the gears which have smaller modules compare to the first gear fabrication iteration. We will then determine how well the gears mesh and assess whether refabrication is necessary.

Content:

With the 2d vector file of the gears, the gears were fabricated and are shown below. The gears mesh really well as they smoothyl rotate around one another and there are only a few spots where they get stuck, which was due to the laser cutter not cutting all the way through, which can be solved simply through recutting the gears. However, one small problem is that the hole in the smallest gear is right at the edge of the gear center, which caused the gear to be unstable and in turn break. The smallest gear was cut again however without the hole such that we could still analyze how well it meshes with the knob gear. The gears were again laser cut out of acrylic plastic. Another video as well is attached to show how the gears meshed.

Conclusion and action items:

The second iteration of gear fabrication was mostly successful. Each of the gears meshed well with one another for the most part and the module calculations translated well practically. Moving forward, one small issue that needs to be addressed is how the smallest gear can fit on the motor without breaking, since currently the smallest gear with the hole would be very unstable even if we tried to recut it and got it to not break during the laser cut itself. We also need to check whether each of these gears fit on the control knob and motors well with a tight fit, otherwise we will need to re-measure and re-fabricate the gears with the same modules but different center hole sizes.

NIKHIL CHANDRA - Dec 14, 2022, 7:10 PM CST

Download

69154210644__A6F3ADBF-373D-4668-8AF3-3D41DD36A4F6.MOV.3gp (279 kB)

10/22 Gear Fabrication Second Iteration Meshing Video

NIKHIL CHANDRA - Dec 14, 2022, 7:12 PM CST

Download

69154210644__A6F3ADBF-373D-4668-8AF3-3D41DD36A4F6.MOV.3gp (279 kB) A video briefly showing how smoothly the gears meshed with one another, and the places where they got stuck because the laser cutter did not cut fully through. This is specifically for the second fabrication iteration of the gears.

11/5 Remaining Gear Fabrications and Analyses, Measurement Fine Tuning

NIKHIL CHANDRA - Dec 14, 2022, 7:48 PM CST

Title: Remaining Gear Fabrications and Analyses, Measurement Fine Tuning

Date: 11/5/2022

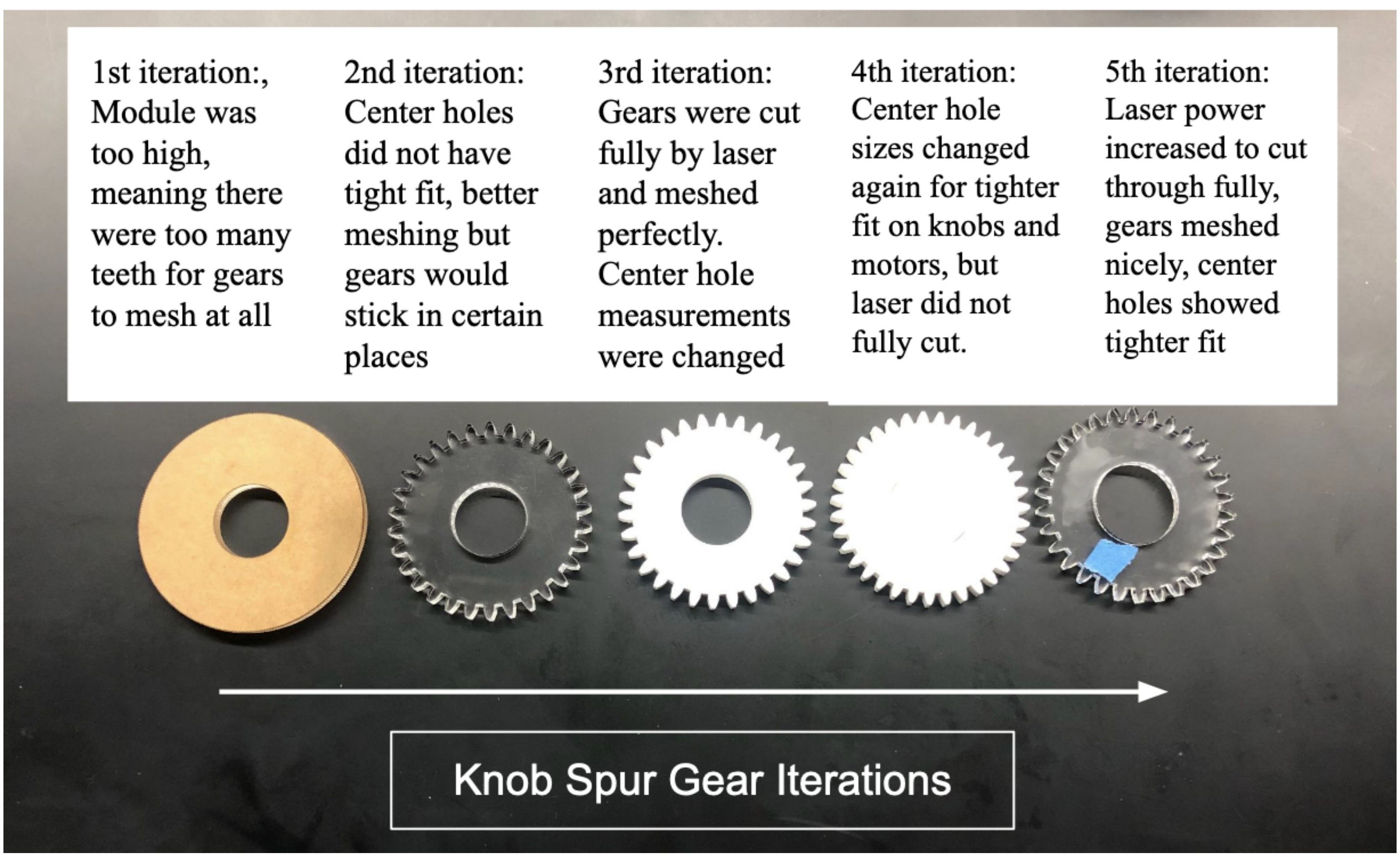
Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals: The objective is to redesign the gear specifically by altering the center hole sizes such that the gears fit tightly on the knobs and motors. The meshing of the gears has been successful and there is not a need to change the module calculations.

Content:

From the 2nd gear fabrication iteration, to solve the problem of the hole for the motor being too large causing the smallest gear to break, we decided to remove the hole and instead fasten the gear to another part with a hole that does fit on the motor then adjust the spur gear on the knob as necessary for it to mesh with the small gear, which will be seen in our final prototype. In the 2nd iteration, we noticed although the meshing was fine overall except for minor problems due to the laser cutter not cutting fully through, the gears themselves did not fit properly around the knobs or motors, and we needed to adjust the measurements slightly for a tight fit. Thus, we made minor iterations until the final fabrication of the gears where we changed the center hole sizes including the size of the hole for the spur gears that will sit on the knob and the size of the D cut for the gear that will sit on the motor. A diagram of the knob gears and how they looked through the iterations is shown below.

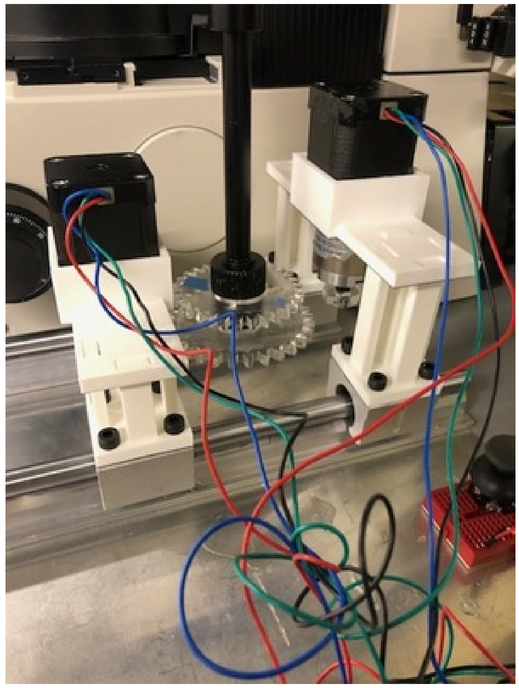


Conclusion and action items:

Overall, we were able to successfuly fabricate gears after 5 iterations overall that meshed well with one another and did not get stuck at any teeth. The gears also had a nice tight fit around the motor and knob gears. We can now move forward with assembly of the final prototype where we can then analyze the final prototype for any initial observations or concerns before then moving into testing.

11/20 Full Prototype Assembly and Observations

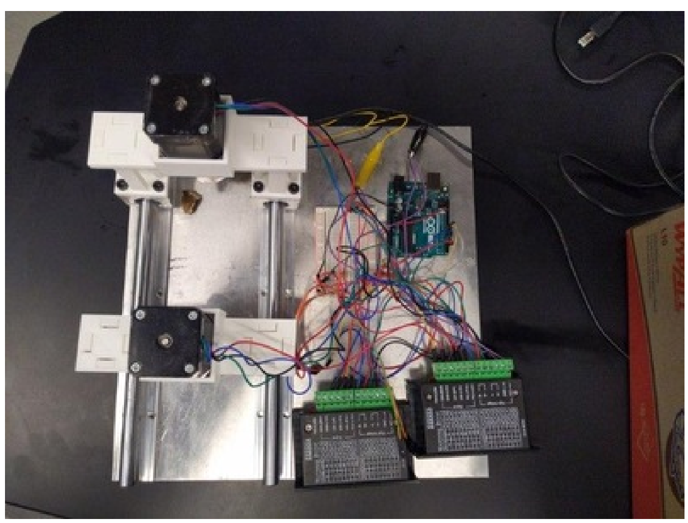
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

E5887F96-6473-487E-B4B5-B0EA715C38DC.jpeg (119 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

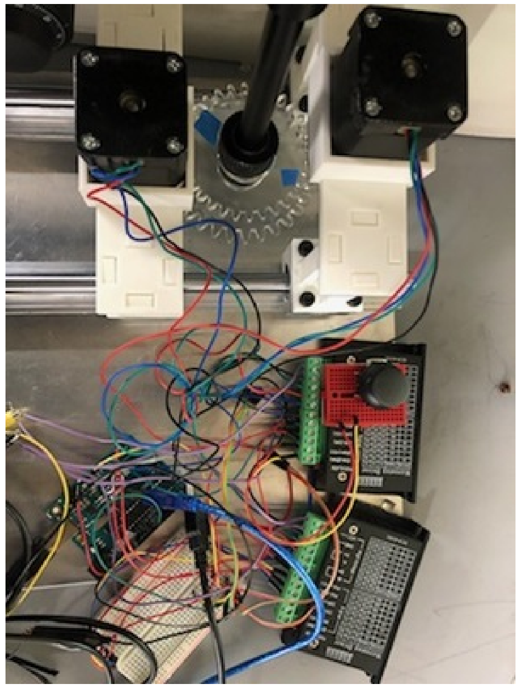
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

F292293F-D9A9-4995-9C20-52FABFE8ABF3.jpeg (102 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

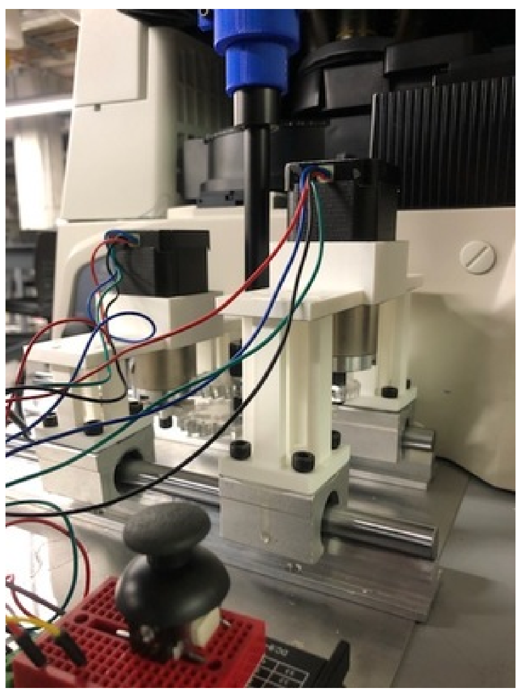
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

4B6117A1-90C7-4547-A19D-6B9BFA0048EB.jpeg (93.7 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

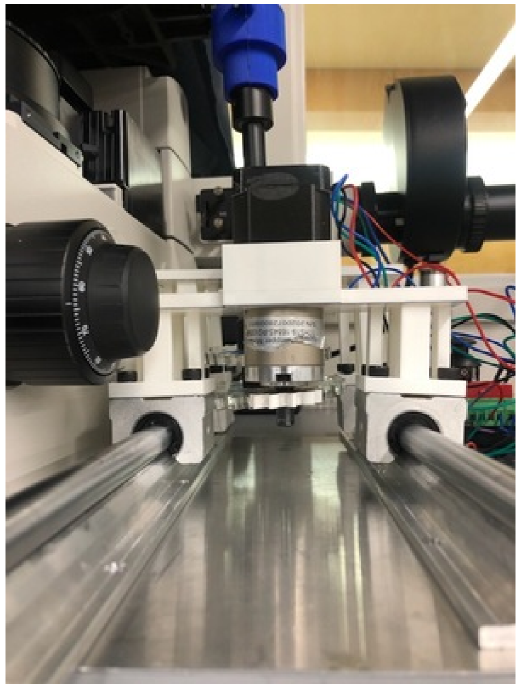
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

5D6A0C8A-BE25-4A55-B98F-8E357679A91A.jpeg (80.9 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



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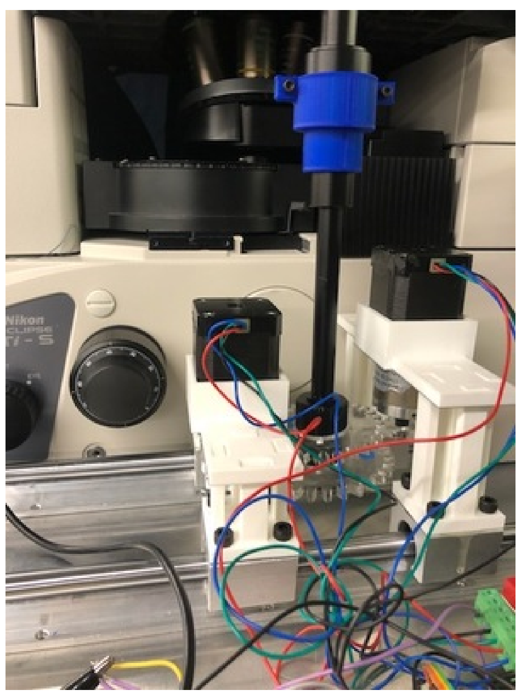
3F717E28-2418-4E16-90A6-572E4EAB082C.jpeg (101 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

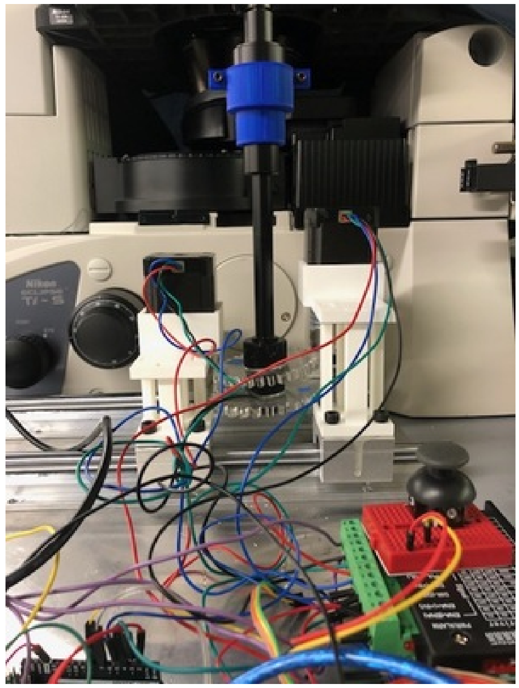
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

46026D1A-2FF0-4E63-88AA-693BDA563560.jpeg (85.2 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

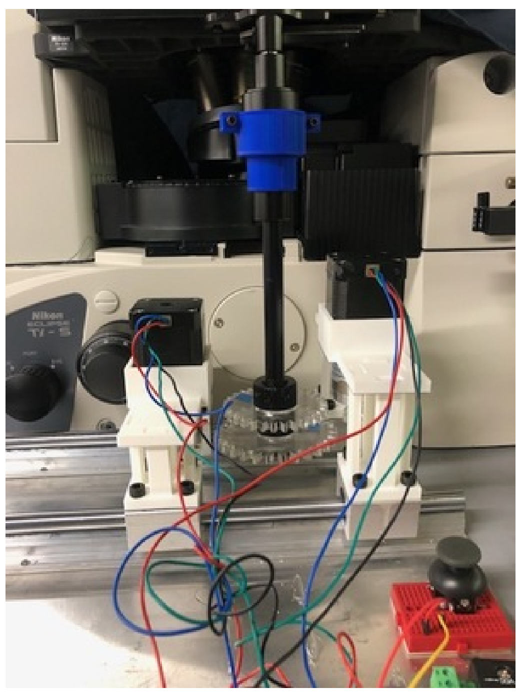
NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

1821734B-A431-41F2-9599-2139F081887D.jpeg (125 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

NIKHIL CHANDRA - Dec 14, 2022, 7:58 PM CST



Download

7AF48BC5-FEEE-41E3-B01F-DC9E05BB53D6.jpeg (110 kB) Individual photos I took of the final prototype assembled together, which we may use in the final report, final poster, ... An analysis and testing of the final prototype is in the teams section of this lab notebook

10/21 Motor Base Design 1 Iteration

NIKHIL CHANDRA - Dec 14, 2022, 8:27 PM CST

Title: Motor Base Design 1 Iteration

Date: 10/21/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals:

To design the motors and the base that will hold the motors parallel to the microscope and around the wand in solidworks with the correct dimensions.

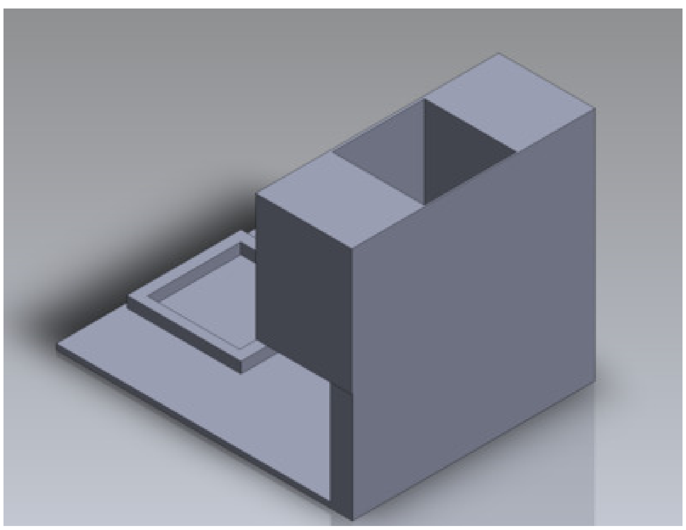
Content:

The dimensions of the microscope, the motors, the linear rack, the wand, along with other components we had available to us were measured using calipers and were made use of during design. The CAD designs are shown below. A few issues that need to be discussed with the team include whether both motors should be placed vertically upside down or if it would be better to have one vertically facing up and the other vertically facing down to save on material costs, since there will be less material needed to hang the motor upside down. The reason why one of the motors has to be upside down is simply because when the motor is vertical it is taller than the bottom knob, and the only way we can get a spur gear to mesh with a spur gear on the bottom knob is by hanging it upside down vertically.

Conclusion and action items:

Some brief notes on how we could potentially go about testing the precision and accuracy of the final prototype both with the motors turning the gears or without the motors by isolating in on the gears. We can now have a group meeting discussing how we can test the final prototype system with the microscope, and I can present some of my ideas.

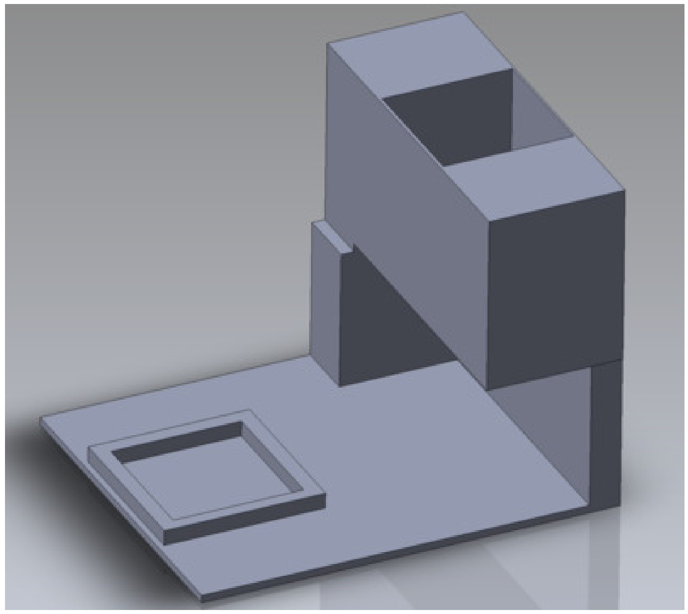
NIKHIL CHANDRA - Dec 14, 2022, 8:57 PM CST



Download

Side_View_2.png (273 kB) CAD Design of Motor Base Images

NIKHIL CHANDRA - Dec 14, 2022, 8:57 PM CST



Download

Side_View_1.png (224 kB) CAD Design of Motor Base Images

12/5 - Ideas for Testing to Bring to Team

NIKHIL CHANDRA - Dec 14, 2022, 8:20 PM CST

Title: Gear Ratio Calculations to Achieve 1 Micron Translation Precision

Date: 12/5/2022

Content by: Nikhil Chandra

Present: Nikhil Chandra

Goals:

To write some brief notes on how we could go about testing the final prototype in terms of its accuracy or precision either without the motors by isolating in on the gears or with the motors turning the gears.

Content:

Without motors:

-
- Test gear ratios, divide 360 into 6
    - Plot angle vs measurement, do linear regression
    - Do this for both
    - Make it pass through 0,0
- Subtract slope and expected slope from gear ratios, create confidence intervals

With motors:

-
- Choose n different angles, those are starting points
    - Make the motor move 1 micron, and measure the error
- Find the sample mean error, create a confidence interval
    - Maybe hypothesis test if you want to reject null being zero

Conclusion and action items:

Some brief notes on how we could potentially go about testing the precision and accuracy of the final prototype both with the motors turning the gears or without the motors by isolating in on the gears. We can now have a group meeting discussing how we can test the final prototype system with the microscope, and I can present some of my ideas.

2022/9/14-Research

Sam TAN - Sep 14, 2022, 6:47 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2018/01/16-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/14/2022

Content by: Sam

Present: Sam

Goals: Research on some of the background of the device and some of the features I think it would be important to have on the device.

Content:

https://www.instructables.com/Motorized-Microscope-Stage-for-Olympus-IX50/

1. Use electric as a source of power.

2. Have bottoms that can be use to make precise move of the stage so instead of moving the whole microscope itself, moving the stage with the sample on it would be safer for the actual microscope.

The DIY stage shown in the webpage is a pretty detailed device of what we might be looking for. It has all the feature I mentioned above and also have a detailed list of materials and parts we need to assemble. Of course we are not going to just copy the stage but instead we can use it as a guide line and reference along with our own inventions and ideas to further improve the already existing idea to meet our clients' needs.

Conclusions/action items:

This could be a very helpful reference material for our project since it already have all of the things we're looking for. However, considering the fact that this is a design class, we still need to do more research on how to further improve this device or we can come up with new designs that's even better.

2022/12/14-Fluorescent Microscope

Sam TAN - Dec 14, 2022, 10:23 PM CST

Title: Microscope Structure

Date: 12/14/2022

Content by: Sam

Present: N/A

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Fluorescent microscopy is often used to image specific features of small specimens such as microbes. It is also used to visually enhance 3-D features at small scales. This can be accomplished by attaching fluorescent tags to anti-bodies that in turn attach to targeted features, or by staining in a less specific manner. When the reflected light and background fluorescence is filtered in this type of microscopy the targeted parts of a given sample can be imaged. This gives an investigator the ability to visualize desired organelles or unique surface features of a sample of interest. Confocal fluorescent microscopy is most often used to accentuate the 3-D nature of samples. This is achieved by using powerful light sources, such as lasers, that can be focused to a pinpoint. This focusing is done repeatedly throughout one level of a specimen after another. Most often an image reconstruction program pieces the multi level image data together into a 3-D reconstruction of the targeted sample.

https://serc.carleton.edu/microbelife/research_methods/microscopy/fluromic.html

Conclusions/action items:

N/A

2022/12/14- Microstep driver with arduino

Sam TAN - Dec 14, 2022, 10:38 PM CST

Title: Arduino Research

Date: 12/14/2022

Content by: Sam

Present: N/A

Goals: Figure out how to deal with arduino and microstep driver and motors.

Content:

https://www.makerguides.com/tb6600-stepper-motor-driver-arduino-tutorial/

Conclusions/action items:

Testing

Design sketches

Sam TAN - Oct 11, 2022, 10:20 PM CDT

Title: Descriptive title (i.e. Client Meeting)

Date: 10/11/2022

Content by: Sam

Present: N/A

Goals: Sketch designs to understand the mechanics.

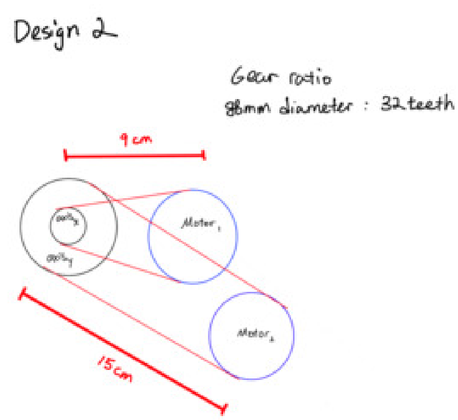
Content:

Attached

Conclusions/action items:

Precise measurements need to be conduct to better understand the length and ratio of the system.

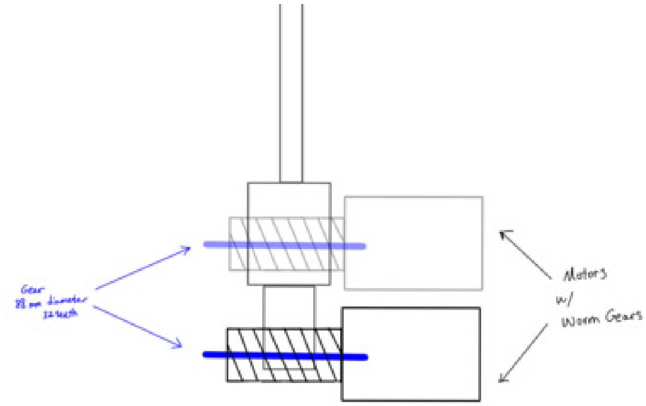
Sam TAN - Oct 11, 2022, 10:20 PM CDT



Download

Untitled_26.png (261 kB)

Sam TAN - Oct 11, 2022, 10:20 PM CDT



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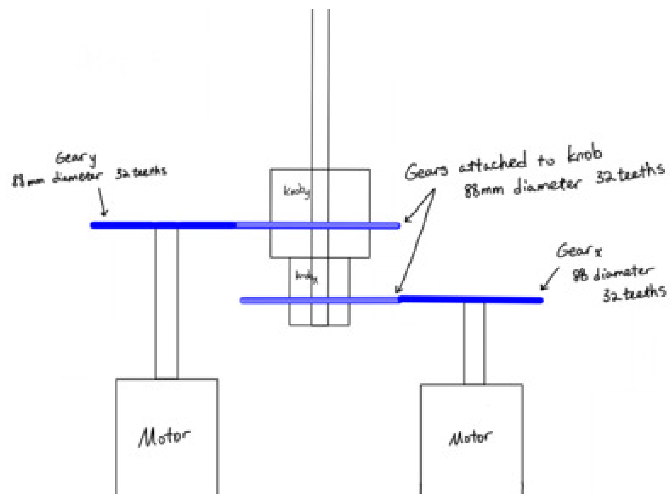
Sam TAN - Oct 11, 2022, 10:20 PM CDT



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2022/12/14 Design Sketches

Sam TAN - Dec 14, 2022, 8:21 PM CST

Title: Design Sketch

Date: 12/14/202

Content by: Sam

Present: N/A

Goals: N/A

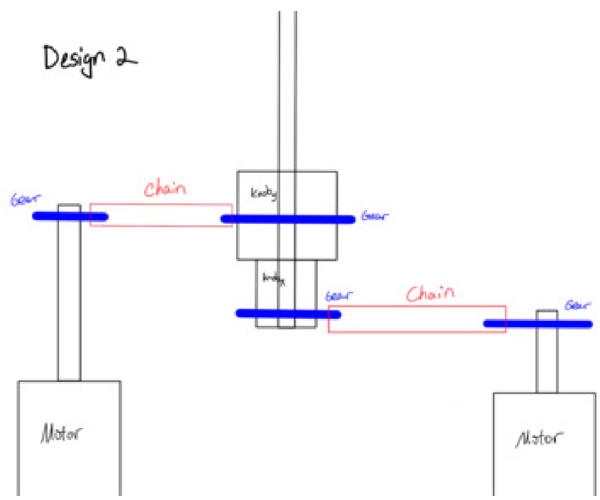
Content:

Attached

Conclusions/action items:

N/A

Sam TAN - Dec 14, 2022, 8:21 PM CST



Download

Untitled_30.png (186 kB)

2022/12/14 Design Sketches 2

Sam TAN - Dec 14, 2022, 10:24 PM CST

Title: Design Sketch

Date: 12/14/202

Content by: Sam

Present: N/A

Goals: N/A

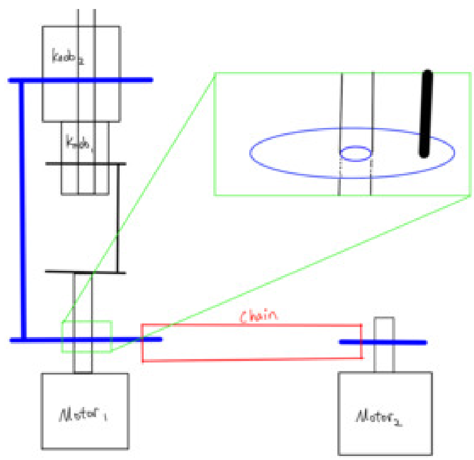
Content:

Attached

Conclusions/action items:

N/A

Sam TAN - Dec 14, 2022, 10:24 PM CST



Download

Untitled_31.png (215 kB)

2022/12/14-Lab Training

Sam TAN - Dec 14, 2022, 8:31 PM CST

Title: Chemical and bio lab training certificate

Date: 12/14/2022

Content by: Sam

Present: N/A

Goals: Get into the teaching lab

Content:

attached

Conclusions/action items:

N/A

Sam TAN - Dec 14, 2022, 8:31 PM CST

Download

Screen_Shot_2022-12-14_at_8.30.06_PM.png (32.3 kB)

Sam TAN - Dec 14, 2022, 8:31 PM CST

Download

Screen_Shot_2022-12-14_at_8.30.38_PM.png (21.3 kB)

2022/12/07- Different codes for motors

Sam TAN - Dec 14, 2022, 8:32 PM CST

Title: Codes

Date: 12/07/2022

Content by: Sam

Present: Shreya, Meteo, Sam, Dashigaa

Goals: Get codes running for the motors and the joysticks.

Content:

attached (version1 and version2)

Conclusions/action items:

Test efficiency and improvements.

Sam TAN - Dec 07, 2022, 9:00 PM CST

Download

sketch_nov28a.ino (1.62 kB)

Sam TAN - Dec 07, 2022, 9:00 PM CST

Download

sketch_dec03b.ino (379 B)

2022/12/14- Circuit design research

Sam TAN - Dec 14, 2022, 8:24 PM CST

Title: Design Research

Date: 12/14/202

Content by: Sam

Present: Mateo Shreya Darshigaa

Goals: Find ways to improve circuit

Content:

https://usa.banggood.com/Nema-23-23HS5628-2_8A-Two-Phase-Stepper-Motor-With-TB6600-Stepper-Motor-Driver-For-CNC-Part--p-1360560.html?imageAb=1&p=PW041611183930201706&custlixnkid=887394&akmClientCountry=America&a=1671070966.0643&akmClientCountry=America&cur_warehouse=CN

Conclusions/action items:

N/A

2022/12/14-Testing Code

Sam TAN - Dec 14, 2022, 9:08 PM CST

Title: Testing Code

Date: 12/14/2022

Content by: Mateo

Present: Mateo

Goals: Write codes for testing

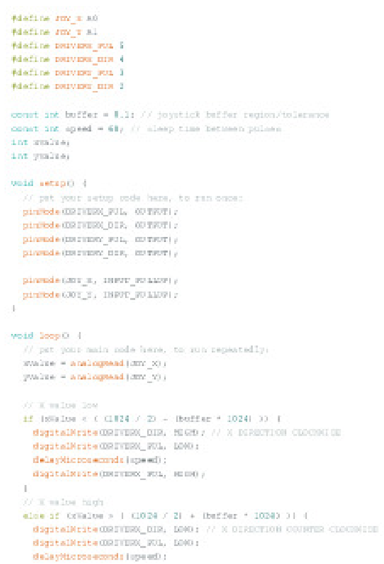
Content:

attached

Conclusions/action items:

N/A

Sam TAN - Dec 14, 2022, 9:08 PM CST



```
#define JOY_X A0
#define JOY_Y A1
#define DRIVERX_PUL 5
#define DRIVERX_DIR 4
#define DRIVERY_PUL 3
#define DRIVERY_DIR 2

const int buffer = 0.1; // joystick buffer region/tolerance
const int speed = 60; // sleep time between pulses
int xvalue;
int yvalue;

void setup() {
  // put your setup code here, to run once:
  pinMode(DRIVERX_PUL, OUTPUT);
  pinMode(DRIVERX_DIR, OUTPUT);
  pinMode(DRIVERY_PUL, OUTPUT);
  pinMode(DRIVERY_DIR, OUTPUT);

  pinMode(JOY_X, INPUT_PULLUP);
  pinMode(JOY_Y, INPUT_PULLUP);
}

void loop() {
  // put your main code here, to run repeatedly:
  xvalue = analogRead(JOY_X);
  yvalue = analogRead(JOY_Y);

  // X value low
  if (xValue < ( (1024 / 2) - (buffer * 1024) )) {
    digitalWrite(DRIVERX_DIR, HIGH); // X DIRECTION CLOCKWISE
    digitalWrite(DRIVERX_PUL, LOW);
    delayMicroseconds(speed);
    digitalWrite(DRIVERX_PUL, HIGH);
  }
  // X value high
  else if (xValue > ( (1024 / 2) + (buffer * 1024) )) {
    digitalWrite(DRIVERX_DIR, LOW); // X DIRECTION COUNTER CLOCKWISE
    digitalWrite(DRIVERX_PUL, LOW);
    delayMicroseconds(speed);
```

[Download]

Arduino_Code_for_testing.pdf (30.9 kB)

2022/12/14-Final Circuit Design

Sam TAN - Dec 14, 2022, 9:10 PM CST

Title: Final Circuit Design

Date: 12/14/202

Content by: Sam, Shreya, Darshigga, Mateo

Present: Shreya, Darshigaa, Mateo, Sam

Goals: Design circuit and build off from the design and improve design and rebuild circuit.

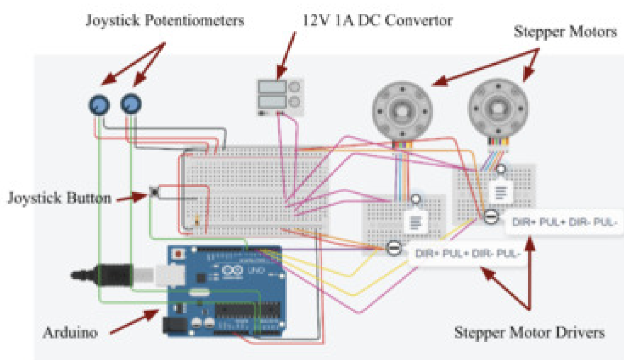
Content:

Attached

Conclusions/action items:

Testing

Sam TAN - Dec 14, 2022, 9:11 PM CST



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Screen_Shot_2022-12-14_at_9.09.06_PM.png (250 kB)

2022/12/14-Circuit

Sam TAN - Dec 14, 2022, 9:13 PM CST

Title: Circuit Built

Date: 12/14/2022

Content by: All

Present: All

Goals: Closer look at the circuit

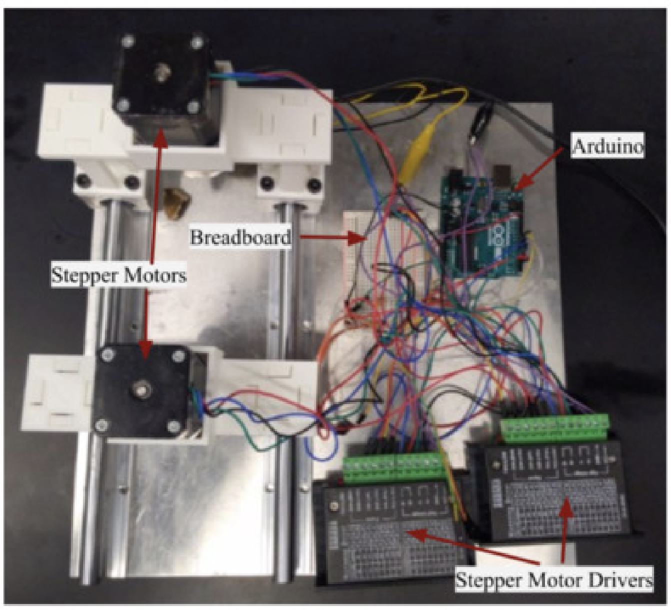
Content:

attached

Conclusions/action items:

N/A

Sam TAN - Dec 14, 2022, 9:13 PM CST



Download

Screen_Shot_2022-12-14_at_9.12.06_PM.png (1.16 MB)

2014/11/03-Entry guidelines

John Puccinelli - Sep 05, 2016, 1:18 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2014/11/03-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 9/5/2016

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.

2014/11/03-Template

SHREYA GODISHALA - Sep 13, 2022, 1:46 PM CDT

Use this as a guide for every entry

- Every text entry of your notebook should have the **bold titles** below.
- Every page/entry should be **named starting with the date** of the entry's first creation/activity, subsequent material from future dates can be added later.

You can create a copy of the blank template by first opening the desired folder, clicking on "New", selecting "Copy Existing Page...", and then select "2018/01/16-Template")

Title: Descriptive title (i.e. Client Meeting)

Date: 1/16/2018

Content by: The one person who wrote the content

Present: Names of those present if more than just you (not necessary for individual work)

Goals: Establish clear goals for all text entries (meetings, individual work, etc.).

Content:

Contains clear and organized notes (also includes any references used)

Conclusions/action items:

Recap only the most significant findings and/or action items resulting from the entry.