BME Design-Fall 2021 - MARK NEMCEK
Complete Notebook

PDF Version generated by

Nate Burkard

on

Dec 15, 2021 @12:41 PM CST

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Team contact Information

MARK NEMCEK - Sep 15, 2021, 8:16 PM CDT

Last Name	First Name	Role	E-mail	Phone	Office Room/Building
Skala	Melissa	Advisor	mcskala@wisc.edu	(608) 316-4108	Discovery Building 3262
Puccinelli	John	Client	john.puccinelli@wisc.edu	(608) 890-3573	Room: 2132 Engineering Centers Building
Nemcek	Mark	Leader	mtnemcek@wisc.edu	(262) 366-6381	
Fisher	Charlie	BPAG	ctfisher3@wisc.edu	(608) 228-2735	
Treacy	Caitriona	BSAC	ctreacy2@wisc.edu	(262) 599-4130	
Steinhauser	Corey	BWIG	steinhauser2@wisc.edu	(651) 303-4836	
Burkard	Nate	Communicator	njburkard@wisc.edu	(608) 709-6958	
Nadolski	Alex	BWIG	rnadolski@wisc.edu	(262) 229-5869	

Project description

Caitriona Treacy - Oct 19, 2021, 10:38 AM CDT

Course Number: BME 200/300

Project Name: Microscope low-cost Motorized Stage

Short Name: Motorized_Stage

Project description/problem statement:

Inverted fluorescence microscopes are currently controlled using manual translational control knobs. These manual control knobs do not allow for automated imaging and automated stitching of images. Our goal is to design, program, and fabricate a motorized stage to be used for inverted fluorescent microscopes to allow for automated imaging and automated stitching that can be integrated with the Nikon Elements imaging software. The stage must cost less than $100 and the resolution of the stages' movement should be around 1 um.

About the client:

Dr. John P Puccinelli, Associate Chair for UW-Madison's BME Undergraduate Program

https://directory.engr.wisc.edu/bme/Faculty/Puccinelli_John/

2021/21/09 Client Meeting

MARK NEMCEK - Sep 22, 2021, 7:26 PM CDT

Title: Client Meeting 1

Date:

9/21/21

Content by: Mark Nemcek

Present: Nate, Alex, Charlie, Mark

Goals:

Get to know our client and the requirements that they have. Ask any questions we have, specifically regarding the PDS.

Content:

- Design Specifications?
    - Size specifications
        - See email
    - Material specifications
        - Not a lot of requirements, does not matter if sterilized, typically light weight aluminum, black so it doesn't reflect light
    - Programming/software specifications
        - Integrated with Nikon elements imaging software. Loci? Software called micromanager
        - https://eliceirilab.org/
    - load/movement specifications
        - Needs to be able to hold low cost incubator team, 96 well plate
    - Weight
        - Needs to be relatively light weight, cannot bend
    - Precision and Accuracy?
        - Resolution of around 1 um (between 1 and 10)
- Client Specific Requirements?
    - Controlled by joystick or computer software
- Is the previous groups' work still around?
    - Teaching lab

    - rgpieper@wisc.edu
- Should we be building off of the previous design or coming up with a new design?
    - Use hardware they have,
- Online it says we have a $100 budget, is that accurate?
    - Yup, could go a bit over
- Can we see the microscopes we are making this stage for?
    - Yes, the arm moves with the stage moving forward and back?
- How often would it need to be used? Is there a recharging period needed?
    - Plugged in by USB or wall to power so it is always on. Should have switch for on and off.
- How long will it need to be on for?
    - Scan the plate and take a picture every half an hour.
- How long should it last?
    - Forever!
- How many units are needed?
    - 2
- Other Notes
    - Control mechanism
    - Integrate with hand knob
    - Teaching lab: engineering centers Building 10-12. Experimental teaching lab off glass elevator. Microscope is actually in old teaching lab on second floor off of glass elevator. Room 2005

Conclusions/action items:

Going forward the team will use this information to write the PDS and eventually to design our product.

2021/2/11 Client Meeting 2

MARK NEMCEK - Nov 04, 2021, 8:43 AM CDT

Title: Client Meeting 2

Date:

11/4/21

Content by: Mark Nemcek

Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Ask the client about next steps in the project and to confirm if our idea is a good one that he wants us to carry on with.

Content:

- Dr. Puccinelli decided he did not want us to continue with the other team's design.
- He liked our idea about making a cart and track system that moved along with the arm of the microscope.

Conclusions/action items:

Going forward the team will start buying materials to continue with our cart design.

2021/17/09 Advisor Meeting

MARK NEMCEK - Sep 17, 2021, 3:15 PM CDT

Title: Advisor Meeting 1

Date: 9/17/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with Dr. Skala for the first time
- Discussed plans for client meeting
- Discussed future meetings
- Took team picture
- 

Conclusions/action items:

Going forward the team wants to meet with our client and start working on the PDS.

2021/24/09 Advisor Meeting

MARK NEMCEK - Sep 24, 2021, 2:42 PM CDT

Title: Advisor Meeting 2

Date: 9/24/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with Dr. Skala and discussed our client meeting
- Discussed our PDS and plans to complete it.
- Discussed plans going forward such as our preliminary presentations.

Conclusions/action items:

Going forward the team wants to start thinking about designs so we can get started with our presentations.

2021/01/10 Advisor Meeting

MARK NEMCEK - Oct 19, 2021, 12:42 PM CDT

Title: Advisor Meeting 3

Date: 10/01/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with Dr. Skala and discussed our design matrix
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to start thinking about the preliminary presentation as well as the preliminary report.

2021/15/10 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:44 PM CST

Title: Advisor Meeting 4

Date: 10/15/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with Dr. Skala and discussed our lab access and client meetings
- Discussed our report and presentation slides
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to get into the lab and start gaining an understanding of the microscope

2021/22/10 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:44 PM CST

Title: Advisor Meeting 5

Date: 10/22/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed possible designs
- Discussed our report and presentation slides
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to get into the lab and start gaining an understanding of the microscope

2021/29/10 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:43 PM CST

Title: Advisor Meeting 6

Date: 10/29/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed our trip to the lab
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to research supplies that we could potentially buy

2021/5/11 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:43 PM CST

Title: Advisor Meeting 7

Date: 11/5/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed our concept design and supplies
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to buy supplies

2021/12/11 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:42 PM CST

Title: Advisor Meeting 8

Date: 11/12/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed the materials we bought this week
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to begin fabrication

2021/25/11 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:50 PM CST

Title: Advisor Meeting 9

Date: 11/26/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed the progress we have made on fabrication
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to continue working on fabrication and think about testing

2021/3/12 Advisor Meeting

MARK NEMCEK - Dec 09, 2021, 10:53 PM CST

Title: Advisor Meeting 10

Date: 12/3/21

Content by: Mark Nemcek

Present: Mark, Nate, Corey, Caitriona, Alex, Charlie

Goals:

Meet and discuss the project with our advisor Dr. Skala

Content:

- Met with the client and discussed our testing procedure
- Discussed the future of our project and deadlines coming up in the future

Conclusions/action items:

Going forward the team wants to start testing and continue working on our final deliverables

2021/30/09 Design Matrix

MARK NEMCEK - Dec 12, 2021, 5:20 PM CST

Title: Design Matrix

Date:

9/30/21

Content by: Mark Nemcek

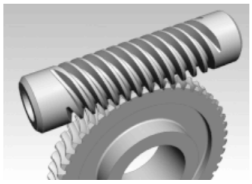
Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Brainstorm ideas for designs, discuss design criteria, rate our designs based on these criteria.

Content:

- Link to our Design Matrix Page: https://docs.google.com/document/d/1TQr9r9WgFazGO2zckNPS9tDrJVDsrEQy3ESrkYWn2hA/edit?usp=sharing

	Replaceable Stage		Worm Drive		Attachable Gearbox	
Design Criteria						
	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accuracy (25)	5/5	25	4/5	20	3/5	15
Cost (20)	1/5	4	3/5	12	3/5	12
Detachability (20)	2/5	8	4/5	16	3/5	12
Ease of Use (15)	3/5	9	5/5	15	5/5	15
Longevity (10)	5/5	10	4/5	8	5/5	10
Safety (5)	4/5	4	3/5	3	3/5	3
Ease of Fabrication (5)	1/5	1	3/5	3	5/5	5
Total (100)		61/100		77/100		72/100

Conclusions/action items:

Going forward the team will use the design matrix to guide and fabricate our actual design.

2021/12/12 Final Expenses

MARK NEMCEK - Dec 12, 2021, 5:20 PM CST

Title: Final Expenses

Date:

12/12/21

Content by: Mark Nemcek

Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Document the final expenses for the design project.

Content:

- Link to our expenses sheet:
  - https://docs.google.com/spreadsheets/d/1ryz8A2ewLk9osB2f8uRgx5Gjmx40_gJnR1v2Fk_4mJw/edit?usp=sharing

Item	Quantity	Price
2X SBR12 Linear Rail Guide	1	$30.74
AllPoints 26-4004 – GEAR, BRASS WORM - MAIN SHAFT BRASS WORM GEAR.	2	$16.08 (Price incorporates shipping cost)
Analog 2-axis Thumb Joystick with Select Button + Breakout Board	1	$16.72
3D Printing Makerspace	2	$2.08
	Total:	$81.71

Conclusions/action items:

The team will use this document to track how much was spent throughout the course of the semester.

2021/2/12 Fabrication

MARK NEMCEK - Dec 10, 2021, 11:01 AM CST

Title: Fabrication documentation

Date:

12/2/21

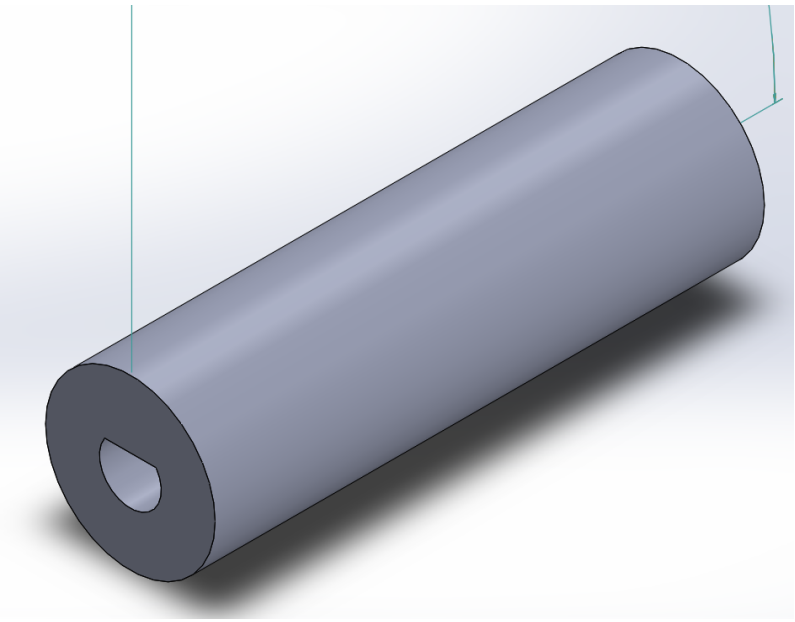
Content by: Mark Nemcek

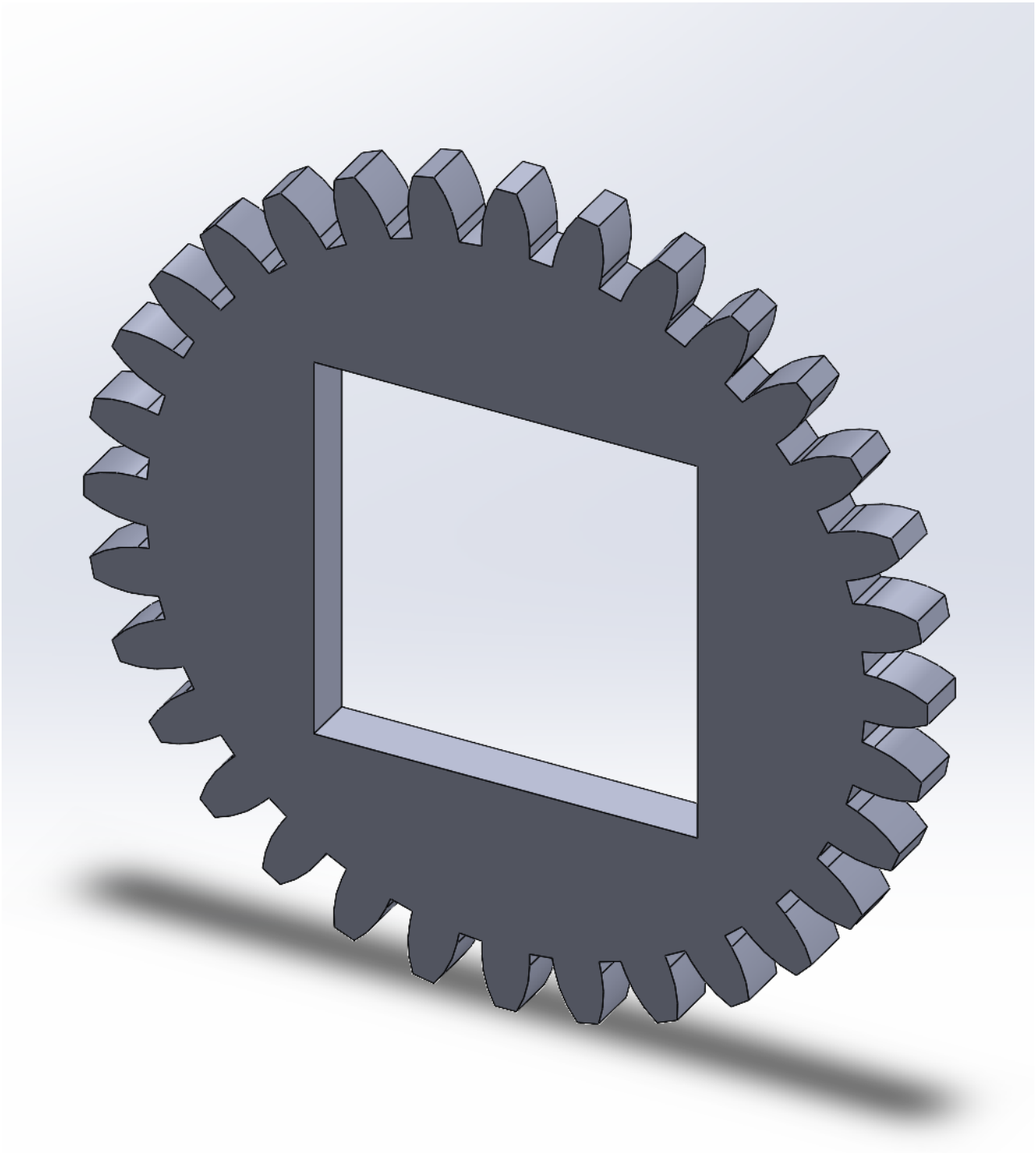
Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

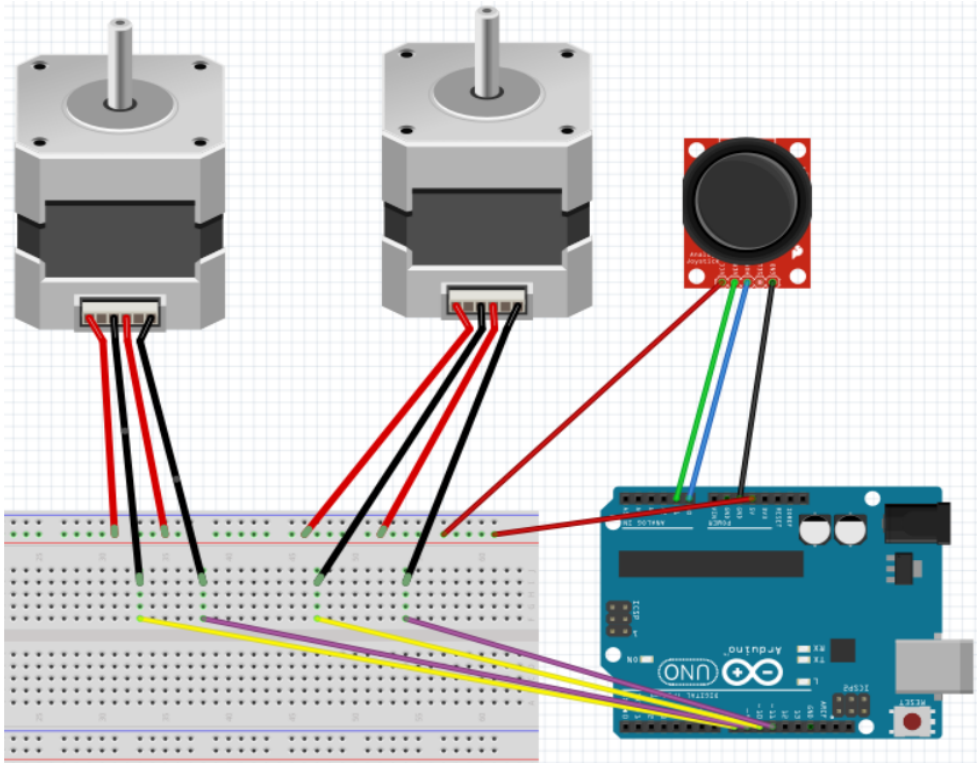
Document fabrication process

Content:

- 
    - Picture of 3D printed adapter piece in Solidworks



-
    - Picture of laser-cut gear in solidworks
-

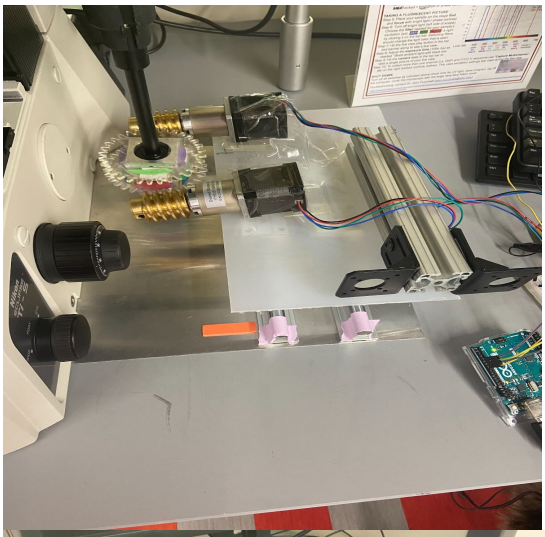


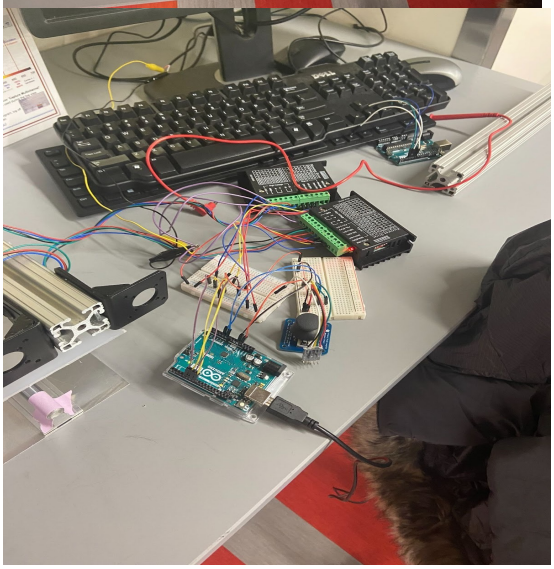
- Picture of electrical circuitry setup

- 

  - Picture of sliding linear rails used to move in the y-direction

-





- Picture of final design setup

Conclusions/action items:

Going forward the team will begin testing our prototype

2021/2/12 Testing Procedure

MARK NEMCEK - Dec 09, 2021, 11:21 PM CST

Title: Testing Procedure

Date:

12/2/21

Content by: Mark Nemcek

Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Document Testing Procedure

Content:

1. Photograph the sample at position 1
2. Set the motor to a constant speed for 15 seconds
3. Photograph the sample at position 2
4. Import images into ImageJ and calculate the distance traveled of one of the dots, knowing that each dot was 6µm in length

Conclusions/action items:

Going forward the team will make our final poster and write our final report

2021/2/12 Experimentation

MARK NEMCEK - Dec 10, 2021, 11:10 AM CST

Title: Experimentation

Date:

12/2/21

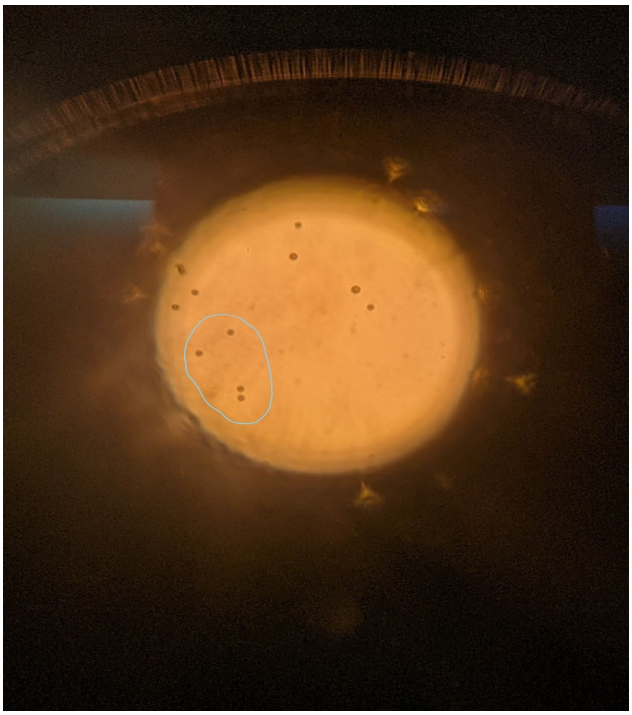
Content by: Mark Nemcek

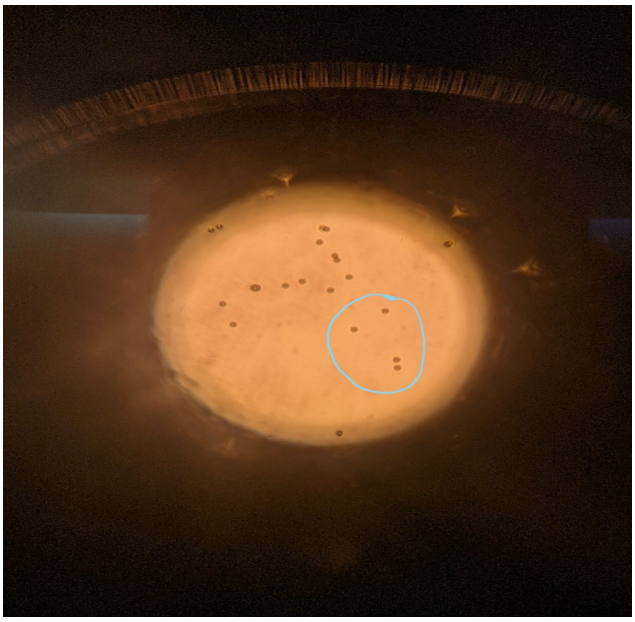
Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Document Testing Procedure

Content:

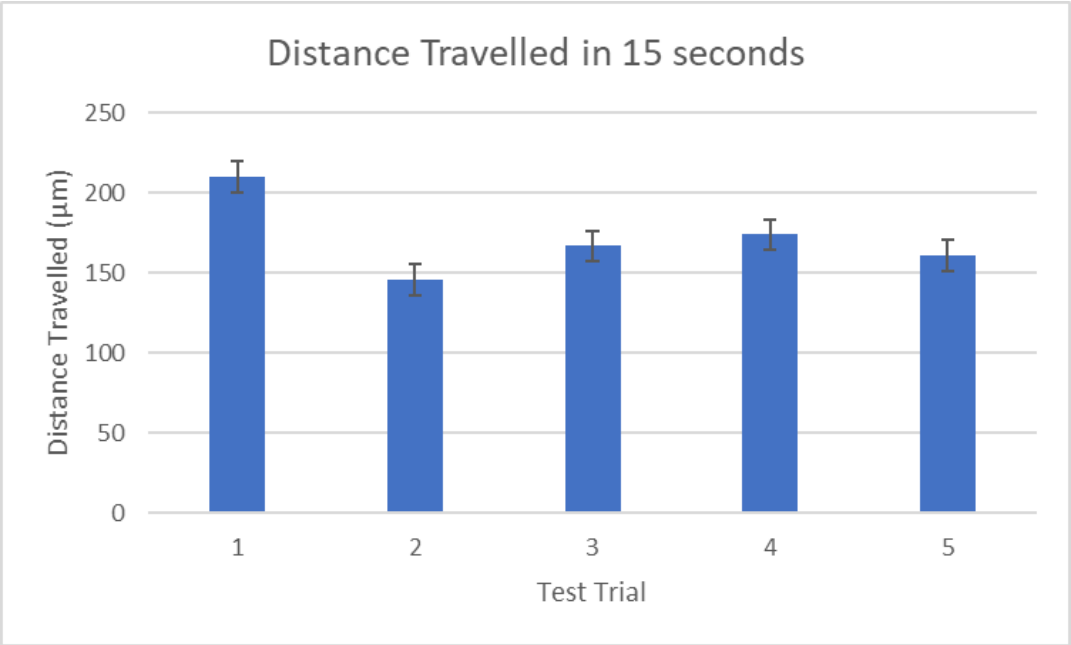
- 



- Pictures of the microscope before and after 15 seconds of movement

Seconds:	Distance (um):	Test Trial:	
15	210	1	
15	146	2	
15	167	3	
15	174	4	
15	161	5	
Mean	171.6		
Standard Error	9.527224		

- Data collected during testing
-



- Five trials were run, with the results displayed on a bar graph. In 15 seconds, there was an mean of 171.6 µm of movement with a standard error of 9.53 µm. This translates to a mean speed of 11.44 µm/second

Conclusions/action items:

Going forward the team will make our final poster and write our final report

2021/24/09 Product Design Specifications

MARK NEMCEK - Dec 12, 2021, 7:38 PM CST

Title: Product Design Specifications

Date: 9/24/21

Content by: Mark Nemcek

Present: Nate Burkard, Alex Nadolski, Charlie Fisher, Mark Nemcek, Caitriona Treacy, Corey Steinhauser

Goals:

To create the product design specifications for the project, which we will use throughout the rest of the project.

Content:

- Link to PDS google document.
    - https://docs.google.com/document/d/1IAl3zItfUe-1ma7cqFh4ZNIqrCeQ0npSk5U2M4_8sNM/edit?usp=sharing
- Also attached as a PDF below.

Conclusions/action items:

Going forward the team will use this PDS to guide us throughout the project and eventually to design our product.

MARK NEMCEK - Oct 19, 2021, 9:44 PM CDT

Microscope Low-Cost Motorized Stage Product Design Specifications
September 24th

Client: Dr. John Puccinelli
Advisor: Dr. Melissa Skala

Team Members:
Mark Nemcek (Team Leader) mjnemcek@wisc.edu
Nate Burkard (Communicator) njburkard@wisc.edu
Corey Steinhauser (BWIG) steinhauser2@wisc.edu
Charlie Fisher (BPAG) cffisher2@wisc.edu
Caitriona Treacy (BSAC) ctreacy2@wisc.edu
Alex Nadolski (BWIG) nadolski@wisc.edu

Function:

Inverted fluorescence microscopes are currently controlled using manual translational control knobs. These manual control knobs do not allow for automated imaging and automated stitching of images. Our goal is to design, program, and fabricate a motorized stage to be used for inverted fluorescent microscopes to allow for automated imaging and automated stitching that can be integrated with the Nikon Elements imaging software. The stage must cost less than $100 and the resolution of the stages' movement should be around 1 um.

Client Requirements:

- The movements of the stage should be able to be controlled by joystick or computer software.
- The program should be able to perform automated imaging and stitch images together.
- Team must create a motorized mechanism that moves and controls the stage.
- The movements of the stage should be within a resolution of 1-10 microns in x and y direction.
- There needs to be a fast and slow mode for the joystick.
- Should be powered by a wall outlet, and there needs to be a switch to turn the device on and off.

Product_Design_Specifications.docx_-_Google_Docs.pdf(113.9 KB) - download

2021/15/10 Preliminary Presentation

MARK NEMCEK - Dec 12, 2021, 7:38 PM CST

Title: Preliminary Presentation

Date: 10/15/21

Content by: Mark Nemcek

Present: Nate Burkard, Alex Nadolski, Charlie Fisher, Mark Nemcek, Caitriona Treacy, Corey Steinhauser

Goals:

Create a presentation that demonstrates the work we have done thus far in the project as well as where the team will go from this point on.

Content:

- Link to Preliminary Presentation google slides.
    - https://docs.google.com/presentation/d/1KlmUzKCiqer8VpQjFUXtB6DGeknih1_CTtO-GLXC-sU/edit?usp=sharing

Conclusions/action items:

This preliminary presentation will help the team to move forward with the project and help the client to gain a better understanding of the work the group has done.

2021/20/10 Preliminary Report

MARK NEMCEK - Dec 12, 2021, 7:38 PM CST

Title: Preliminary Report

Date: 10/20/21

Content by: Mark Nemcek

Present: Nate Burkard, Alex Nadolski, Charlie Fisher, Mark Nemcek, Caitriona Treacy, Corey Steinhauser

Goals:

Create a report that demonstrates the work we have done thus far in the project as well as where the team will go from this point on.

Content:

- Link to Preliminary report google doc.
    - https://docs.google.com/presentation/d/1KlmUzKCiqer8VpQjFUXtB6DGeknih1_CTtO-GLXC-sU/edit?usp=sharing
- PDF is attached below

Conclusions/action items:

This preliminary report will help the team to move forward with the project and help the client to gain a better understanding of the work the group has done.

MARK NEMCEK - Oct 19, 2021, 10:00 PM CDT

Microscope Low-Cost Motorized Stage

Preliminary Product Design Specifications

Biomedical Engineering 300/200: Biomedical Engineering Design

Date: 10/20/2021

Client: John Puccinelli

Team Members: Mark Nemcek, Nate Burland, Corey Steinhauser, Alex Nadolski, Caitriona Treacy, Charlie Fisher

Preliminary_Report.pdf(1.2 MB) - download

2021/15/12 Final Report

MARK NEMCEK - Dec 12, 2021, 7:41 PM CST

Title: Final Report

Date: 12/15/21

Content by: Mark Nemcek

Present: Nate Burkard, Alex Nadolski, Charlie Fisher, Mark Nemcek, Caitriona Treacy, Corey Steinhauser

Goals:

Create a report that demonstrates the work we have done this semester.

Content:

- Link to final report google doc.
    - https://docs.google.com/document/d/1jVS4jSeqIC293quXYgARhp-Q2QxLGKygx9HRW0Djx2k/edit?usp=sharing
- PDF is attached below

Conclusions/action items:

This final report will serve as a reference point for future groups and as documentation of the work we have done thus far this semester.

MARK NEMCEK - Dec 12, 2021, 7:42 PM CST

Microscope Low-Cost Motorized Stage

Biomedical Engineering 200/300: Biomedical Engineering Design

Date: December 15, 2021

Client: Dr. John Puccinelli, PhD, Department of Biomedical Engineering, UW-Madison

Advisor: Dr. Melissa Skala, PhD, Department of Biomedical Engineering, UW-Madison

Team Members: Mark Nemcek - Team Leader, Nate Burkard - Communicator, Corey Steinhauser - BWIG, Alex Nadolski - BWIG, Caitriona Treacy - BSAC, Charlie Fisher - BPAG

Low_Cost_Motorized_Stage-Final_Report.pdf(3.5 MB) - download

2021/9/12 Final Poster

MARK NEMCEK - Dec 12, 2021, 7:51 PM CST

Title: Final Poster

Date: 12/9/21

Content by: Mark Nemcek

Present: Nate Burkard, Alex Nadolski, Charlie Fisher, Mark Nemcek, Caitriona Treacy, Corey Steinhauser

Goals:

Create a poster that demonstrates the work we have done this semester and where the project could go in the future.

Content:

- Link to final poster
    - https://docs.google.com/document/d/1jVS4jSeqIC293quXYgARhp-Q2QxLGKygx9HRW0Djx2k/edit?usp=sharing

Conclusions/action items:

This poster provides a brief, graphic overview of the project and the work done this year.

MARK NEMCEK - Dec 12, 2021, 7:47 PM CST

Low-Cost_Motorized_Microscope_Stage_Poster.pptx.pdf(2.2 MB) - download

9/14/21 Similar Research Projects

MARK NEMCEK - Oct 14, 2021, 12:13 PM CDT

Title: Similar Research Projects

Date: 9/14/21

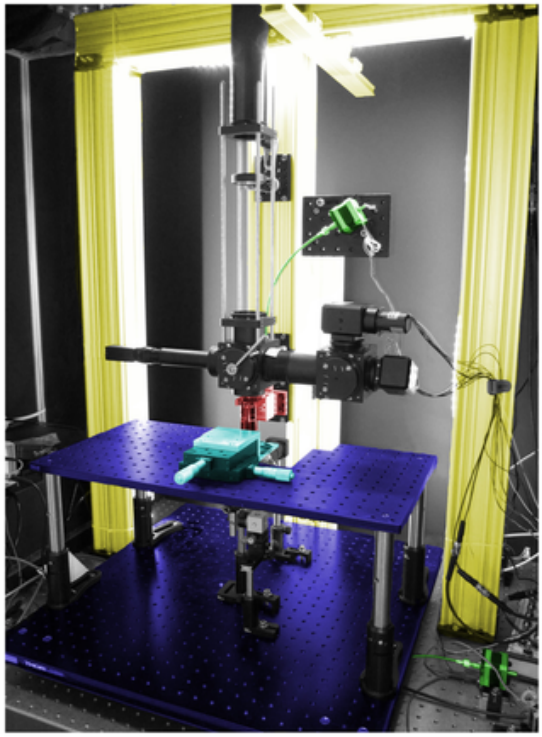
Content by: Mark Nemcek

Present:

Goals:

To document any findings about published research similar to the project which we are currently working on.

Content:

- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0088977
  - Gives very good insight into the hardware used as well as the results and accuracy obtained by this research group.
  - 
- https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S2468067219300495?via%3Dihub
  - Offers good detail of the hardware and motors.
  - Highlights the low cost of the motorized stage.
- https://www-sciencedirect-com.ezproxy.library.wisc.edu/science/article/pii/S0098300404000615
  - In depth details of how the stage moves and rotates.
  - Also provides great detail on the software used.
  - 
- https://www.sciencedirect.com/science/article/pii/S095656631631106X
  - If we wanted to go the route of 3D printing the stage this article would be extremely useful.
- https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.589.55&rep=rep1&type=pdf

- Another great research article. Provided is data to back up their claims as well as step by step process of the software.

Conclusions/action items: Use the research found today as possible inspiration, while being cautious of possible patents as well as being too reliant on one single solution.

9/14/21 Products on Market Research

Title: Products on the Market Research

Date: 9/14/21

Content by: Mark Nemcek

Present:

Goals:

To document any findings about products on the market that are similar to the project which we are currently working on.

Content:

- https://www.prior.com/product-category/motorized-stages?gclid=Cj0KCQjw1ouKBhC5ARIsAHXNMI9_AsBqKR83FdP0QIOnJo6ztnDI9AJOTtT2zUPyA
  - Prior Scientific provides a wide arrange of motorized stages with various specifications and uses.
  - States the load bearing capabilities and the movement capabilities.
- https://www.zaber.com/products/scanning-microscope-stages?gclid=Cj0KCQjw1ouKBhC5ARIsAHXNMI8xM7fyPfPMtl4Z2PLk3b6S0vbxZQyjxwAC0S
  - Zaber also provides many different motorized stages.
  - States the resolution size, which could be useful.
  - States the software used in the stage.
- https://discover-echo.com/?utm_source=google&utm_medium=search&utm_campaign=11380688541&utm_term=motorized%20microscope%20stage&utm_content=505993872
  GGZ8iVymvGb_l_qPeDi7caAgf1EALw_wcB#headerAnchor
  - Echo provides extremely advances microscopes.
  - Offers a touchscreen.
  - Completely customizable, which is making it hard to find specifications.
- https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=5360
  - Thor labs provides a specs page which provides easy layout for finding the information we need.
  - Provides the motor type, which could be useful for our group.
- https://www.marzhauser.com/en/products/microscope-stages/motorized-microscope-stages.html
  - Offers good insight into the hardware that goes into the motorized stages on the site.

Conclusions/action items: Use the research found today as possible inspiration, while being cautious of possible patents as well as being too reliant on o

9/14/21 Patent Research

MARK NEMCEK - Sep 16, 2021, 9:31 AM CDT

Title: Patent Research

Date: 9/14/21

Content by: Mark Nemcek

Present:

Goals:

To document any findings about products on the market that are similar to the project which we are currently working on.

Content:

- Personal interface device for positioning of a microscope stage.
  - This patent is for an controller for positioning of the motorized stage.
  - The patent expired in 2014.
  - https://patents.google.com/patent/US5557456A/en?q=motorized+microscope+stage&oq=motorized+microscope+stage

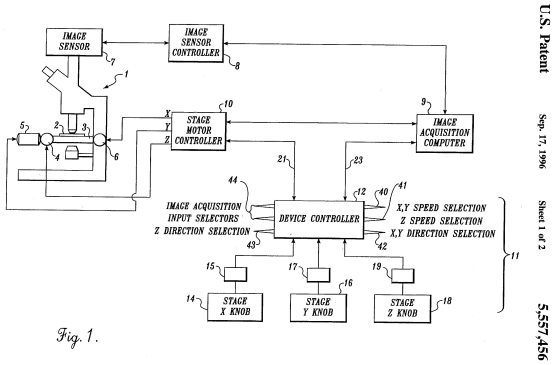
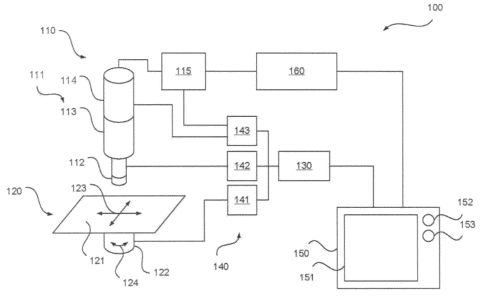


Fig. 1.

- Microscope Having a touch screen.
  - Patent relates to the microscope having a touch screen that is associated with a control device and an operating method.
  - The patent is currently active.
  - https://patents.google.com/patent/US9329375B2/en?q=motorized+microscope+stage&oq=motorized+microscope+stage



- Integrated, automated system for the study of cell and tissue function

- https://patents.google.com/patent/WO2010022391A2/en?q=motorized+microscope+stage&oq=motorized+microscope+stage
- Patent relates to the full automated framework for cell analysis and manipulation using various automated technology.

Conclusions/action items: Use the research found today as possible inspiration, while being cautious of possible patents as well as being too reliant on one single solution.

10/19/21 Olympus IX71 Research

MARK NEMCEK - Oct 19, 2021, 10:40 PM CDT

Title: Olympus IX71 Research

Date: 10/19/21

Content by: Mark Nemcek

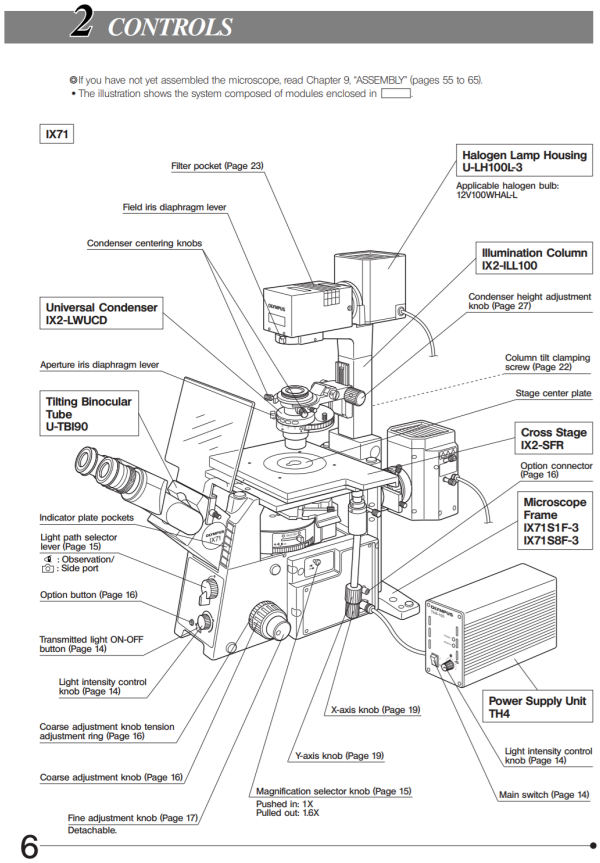
Present:

Goals:

To gain valuable information about the type of microscope for which the group is trying to make a stage.

Content:

- Link to Olympus IX71 manuals
  - https://www.ucc.ie/en/media/academic/anatomy/imagingcentre/icdocuments/OLYMPUSIX71_manual.pdf
    - Extensive manual for the Olympus IX71. Gives valuable information regarding the make of the microscope and how it is controlled.



  - https://www.olympus-lifescience.com/data/olympusmicro/brochures/pdfs/ix71.pdf?rev=EABE
    - Looks like this is a combined IX71/IX81 page, but seems to be more focused on IX81 design.

Conclusions/action items: Use the information about this microscope to help better understand the problem at hand as well as develop a prototype for the design which the group chose.

10/19/21 Nikon Eclipse Ti-U Research

MARK NEMCEK - Oct 19, 2021, 10:40 PM CDT

Title: Nikon Eclipse Ti-U Research

Date: 10/19/21

Content by: Mark Nemcek

Present:

Goals:

To gain valuable information about the type of microscope for which the group is trying to make a stage.

Content:

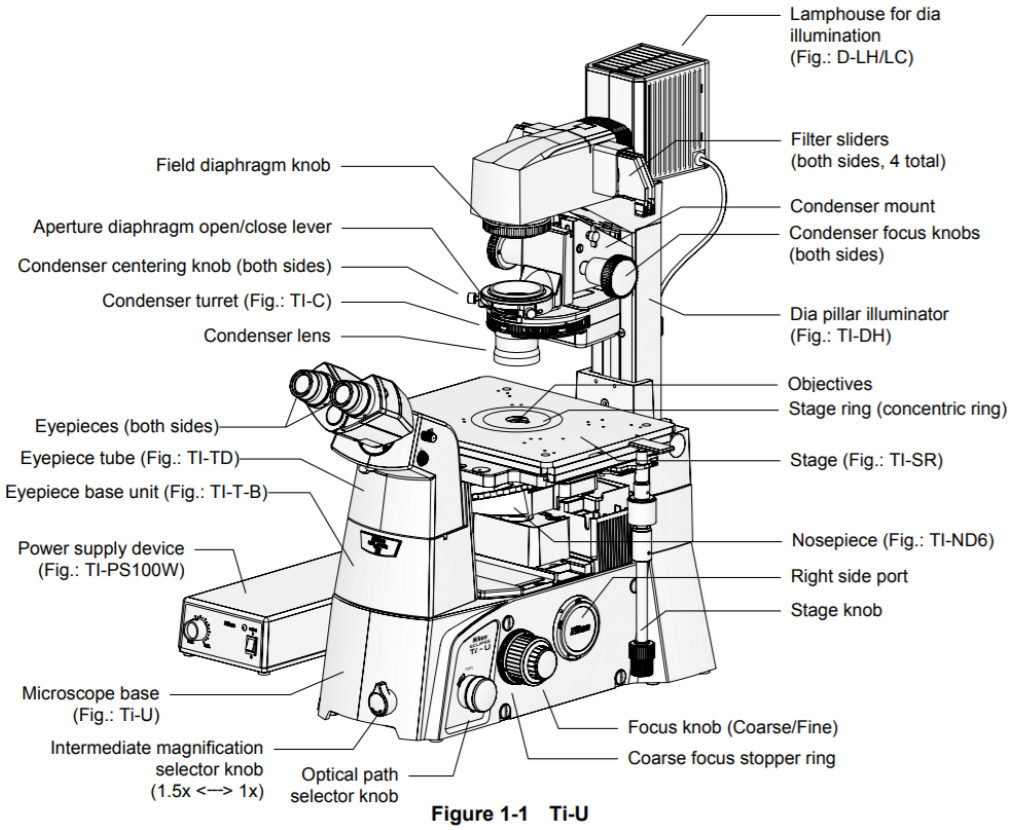
- Link to Nikon Eclipse Ti-U manual
  - https://eliceirilab.org/sites/default/files/2016-09/Nikon%20Eclipse%20Ti-U%20Manual.pdf
  - The lab manual provides extensive detail on the Nikon Eclipse Ti-U microscope including the layout and function. This will be extremely valuable information for creating the prototype of our design.
  - 

    Figure 1-1 Ti-U

Conclusions/action items: Use the information about this microscope to help better understand the problem at hand as well as develop a prototype for the design which the group chose.

11/2/21 Worm Drive Research

MARK NEMCEK - Nov 02, 2021, 9:31 AM CDT

Title: Worm Drive Research

Date: 11/2/21

Content by: Mark Nemcek

Present:

Goals:

To gain valuable information about worm drive gears and how they function

Content:

- https://www.bodine-electric.com/blog/introduction-to-worm-gearmotors/
  - Worm Drives are proven and economical for high-speed reductions in limited space.
  - It is necessary to lubricate a worm gear, which could prove to be difficult for our design
- Gear Ratio Notes
  - https://www.sae.org/binaries/content/assets/cm/content/learn/education/motortoycar-samplelessonplan.pdf
    - Gear ratio = rotations of a driver gear: rotations of a driven gear
    - Gear ratio = #teeth of driven gear: number of teeth of driver gear (inverse relationship)
  - https://khkgears.net/new/worm_gear.html
    - In worm and worm gear the ratio is obtained by dividing the number of teeth of worm gear by the number of threads in the worm.
- Not sure how to tell how big to make the teeth of gears/worm still.

Conclusions/action items: Use the information about these worm drives to help better understand the problem at hand as well as develop a prototype for the design which the group chose. I also want to look more into how to tell how big to make the teeth of gears/worm.

11/25/21 Stepper Motor Research

MARK NEMCEK - Dec 10, 2021, 10:40 PM CST

Title: Stepper Motor Research

Date: 11/25/21

Content by: Mark Nemcek

Present:

Goals:

To gain information about stepper motors to try to help Corey code the current stepper motors.

Content:

- https://www.arduino.cc/en/Tutorial/LibraryExamples/StepperSpeedControl
  - An article that provides information and a circuit for how to set up a bipolar stepper motor using Arduino UNO.
- https://www.tutorialspoint.com/arduino/arduino_stepper_motor.htm
  - Provides general information about stepper motors and how they work. Gives a circuit and Arduino Code.
- https://www.electrical4u.com/bipolar-stepper-motor/
  - Gives background information about bipolar stepper motors. Includes circuit and explains why a driver is needed to run the stepper motor.

Conclusions/action items: Use the information found today to help code the stepper motors to turn the worm drive gears.

11/4/21 Materials Research

Title: Materials to Buy Research

Date: 11/4/21

Content by: Mark Nemcek

Present:

Goals:

To research different materials that we could buy to implement our cart and track system along with worm drives.

Content:

- Worm Drive Possibilities
  - https://www.ebay.com/itm/303327497593?chn=ps&mkevt=1&mkcid=28&var=602402687251
    - This one is customizable with a different number of teeth
  - https://www.gobilda.com/2308-series-stainless-steel-mod-1-5-d-bore-set-screw-worm-6mm-bore-39mm-length/
    - Appears to be shaped for a stepper motor.
- Track and Cart Possibilities
  - General sites for electronics/tracks/wheels/shafts etc.
    - https://www.sparkfun.com/categories/330
    - https://www.allelectronics.com/item/st-3tk2/3.4-x-48-pvc-snap-track/1.html
    - https://www.digikey.com/en/products/filter/structural-motion-hardware/586?s=N4IgTCBcDaIO4AsCmSA2IC6BfIA
    - https://www.digikey.com/en/products/detail/tripp-lite/SRCTMTR600TL/15298450
    - https://www.digikey.com/en/products/detail/schroff/61000007/4210082
      - Possibility for a plate
  - Sites for sliding rail system
    - https://www.vevor.com/products/sbr20-1000mm-2xlinear-rail-set-4x-bearing-block-square-type-20mm-sbr20uu-updated?gclid=Cj0KCQjw5oiMBhDtARIsAJi0qk14gP5kpLnSXxKY1hxr3sYMhxqtZJL5fk-2gqzsAH6Q_QjtD88llEUaAnMBEALw_wcB
    - https://www.ebay.com/itm/313728086854?chn=ps&mkevt=1&mkcid=28&var=612507496410
      - Most likely going to use this one
    - https://www.vexrobotics.com/plates.html?q=&locale.name=English
      - Another Possibility for a plate to hold together.
- Joystick/Controller Possibilities
  - https://www.adafruit.com/product/512?gclid=Cj0KCQjw5oiMBhDtARIsAJi0qk3Mf-twwWf1YX6bwzC8EWZvcZpRYln8URsV3wK_OZHM3GmFP6rxY2AaAq1CEALw_wcB
  - https://www.amazon.com/SMAKN-Joystick-Breakout-Arduino-arduino/dp/B014MJLHC4/ref=asc_df_B014MJLHC4/?tag=hyprod-20&linkCode=df0&hvadid=198063088238&hvpos=&hvnetw=g&hvrand=16129232338592437567&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvc318862085479&psc=1
  - https://www.bananarobotics.com/shop/ITEAD-Joystick-Shield?gclid=Cj0KCQjw5oiMBhDtARIsAJi0qk2yFjh3hcM7hJZFM42iIKG3W7OsD5s9QLF
    - Has buttons which we liked as a group since it gives us more options
  - https://www.aliexpress.com/item/32879305230.html?src=google&aff_fcid=7522d273874a4ba28f9fe3d2faa03c84-1635991964966-00764-UneMJZVf&aff_fsk=UneMJZVf&aff_platform=aaf&sk=UneMJZVf&aff_trace_key=7522d273874a4ba28f9fe3d2faa03c84-1635991964966-00764-UneMJZVf&terminal_id=13ac14149a424af984dd80d91244a256
    - Also has buttons but is honestly suspiciously cheap

Conclusions/action items: Use this materials research to go ahead and buy materials for the project.

2021/30/09 Design Matrix

MARK NEMCEK - Oct 19, 2021, 10:01 PM CDT

Title: Design Matrix

Date:

9/30/21

Content by: Mark Nemcek

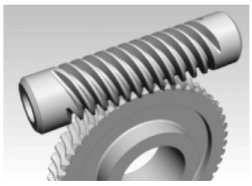
Present: Nate, Alex, Charlie, Mark, Caitriona

Goals:

Brainstorm ideas for designs, discuss design criteria, rate our designs based on these criteria.

Content:

- Link to our Design Matrix Page: https://docs.google.com/document/d/1TQr9r9WgFazGO2zckNPS9tDrJVDsrEQy3ESrkYWn2hA/edit?usp=sharing

	Replaceable Stage		Worm Drive		Attachable Gearbox	
Design Criteria						
	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accuracy (25)	5/5	25	4/5	20	3/5	15
Cost (20)	1/5	4	3/5	12	3/5	12
Detachability (20)	2/5	8	4/5	16	3/5	12
Ease of Use (15)	3/5	9	5/5	15	5/5	15
Longevity (10)	5/5	10	4/5	8	5/5	10
Safety (5)	4/5	4	3/5	3	3/5	3
Ease of Fabrication (5)	1/5	1	3/5	3	5/5	5
Total (100)		61/100		77/100		72/100

Conclusions/action items:

Going forward the team will use the design matrix to guide and fabricate our actual design.

2021/4/11 Cart Design Idea

MARK NEMCEK - Nov 04, 2021, 8:46 AM CDT

Title: Cart Design Idea

Date:

11/4/21

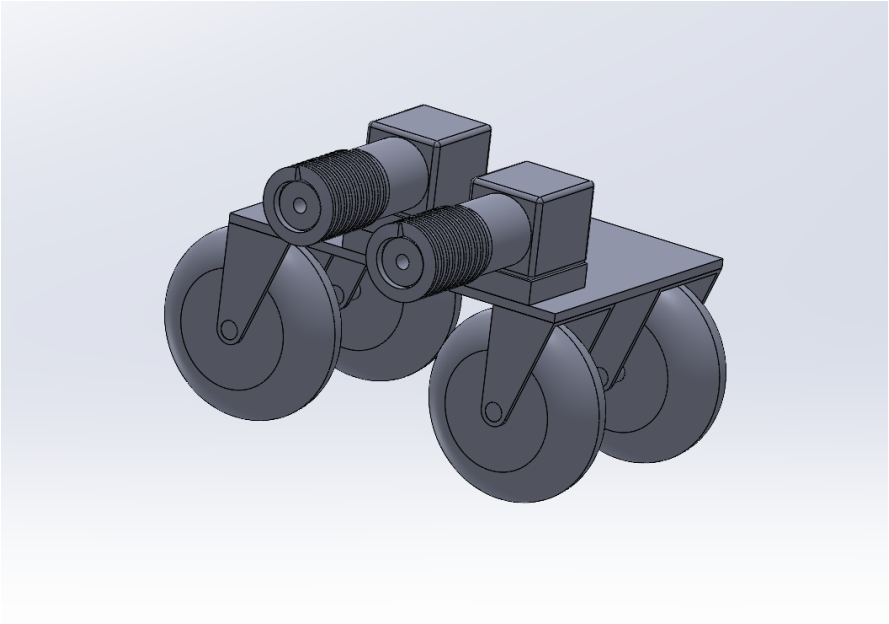
Content by: Mark Nemcek

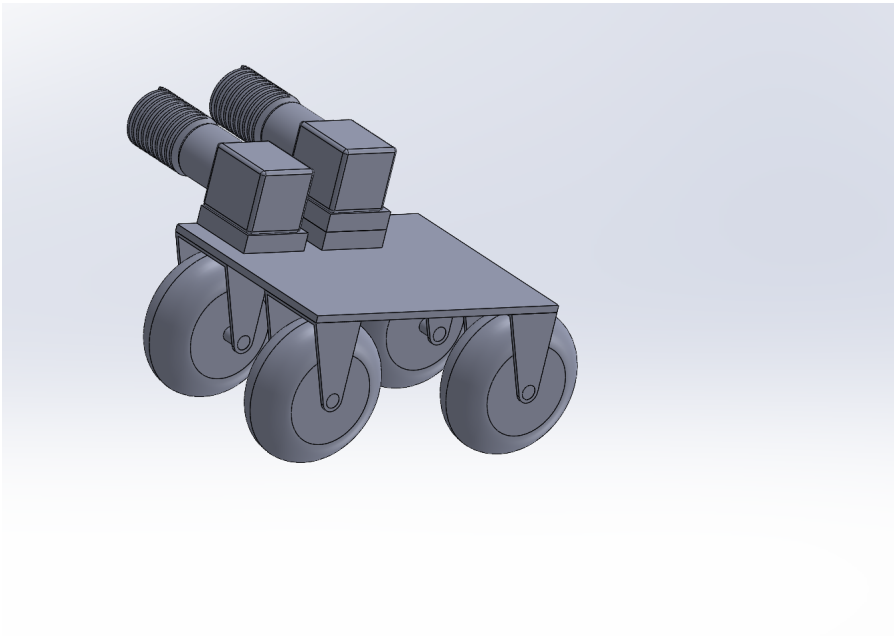
Present:

Goals:

Make a prototype for the cart that the team is going to build for the microscope.

Content:

- 



-

Conclusions/action items:

Going forward I will use this concept design to brainstorm further and to buy materials to make a prototype.

2021/4/11 Brainstorming w/ Nate

MARK NEMCEK - Nov 04, 2021, 8:51 AM CDT

Title: Brainstorming with Nate

Date:

11/4/21

Content by: Mark Nemcek

Present: Nate

Goals:

To further brainstorm and plan out our idea for the cart and track system.

Content:

- During this brainstorming session, Nate and I came up with a much much better idea for the cart and track system.
- This system involves a sliding track system similar to the one seen below.

  - The motors will be attached to one of these sliding pieces and will move almost frictionlessly along the rail.

Conclusions/action items:

Going forward I think the team will use this new idea to buy materials to make a prototype.

9/14/21 Mark Nemcek Training Documentation

MARK NEMCEK - Sep 14, 2021, 8:33 PM CDT

Title: Training Documentation

Date: 9/14/21

Content by: Mark Nemcek

Present:

Goals:

To document my training and certifications.

Content:

Link to training website: https://apps.research.wisc.edu/TILT

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

This certifies that Mark Nemcek has completed training for the following course(s):

Course	Assignment	Completion	Expiration
Biosafety 106: Autoclave Use	Biosafety 106: Autoclave Use: Safety and Efficacy - Verification Quiz	3/31/2021	
Biosafety Required Training	Biosafety Required Training Quiz	2/20/2021	
Chemical Safety: Cryogen Safety Training	Part 1 Final Quiz	3/31/2021	
Chemical Safety: Cryogen Safety Training	Part 2 Final Quiz	3/31/2021	
Chemical Safety: Fume Hood Safety Training	Fume Hood Final Quiz	2/20/2021	
Chemical Safety: The OSHA Lab Standard	Final Quiz	2/20/2021	
Disposing of Hazardous Chemicals	Final Quiz	3/31/2021	
Performing a Risk Assessment	Survey	3/1/2021	

Data Last Imported: 14/09/2021 08:30 PM

Conclusions/action items: Going forward I want to use these trainings and apply them to the design project when needed.

9/14/21 Mark Nemcek Permit Training Documentation

MARK NEMCEK - Sep 14, 2021, 8:42 PM CDT

Title: Permit Training Documentation

Date: 9/14/21

Content by: Mark Nemcek

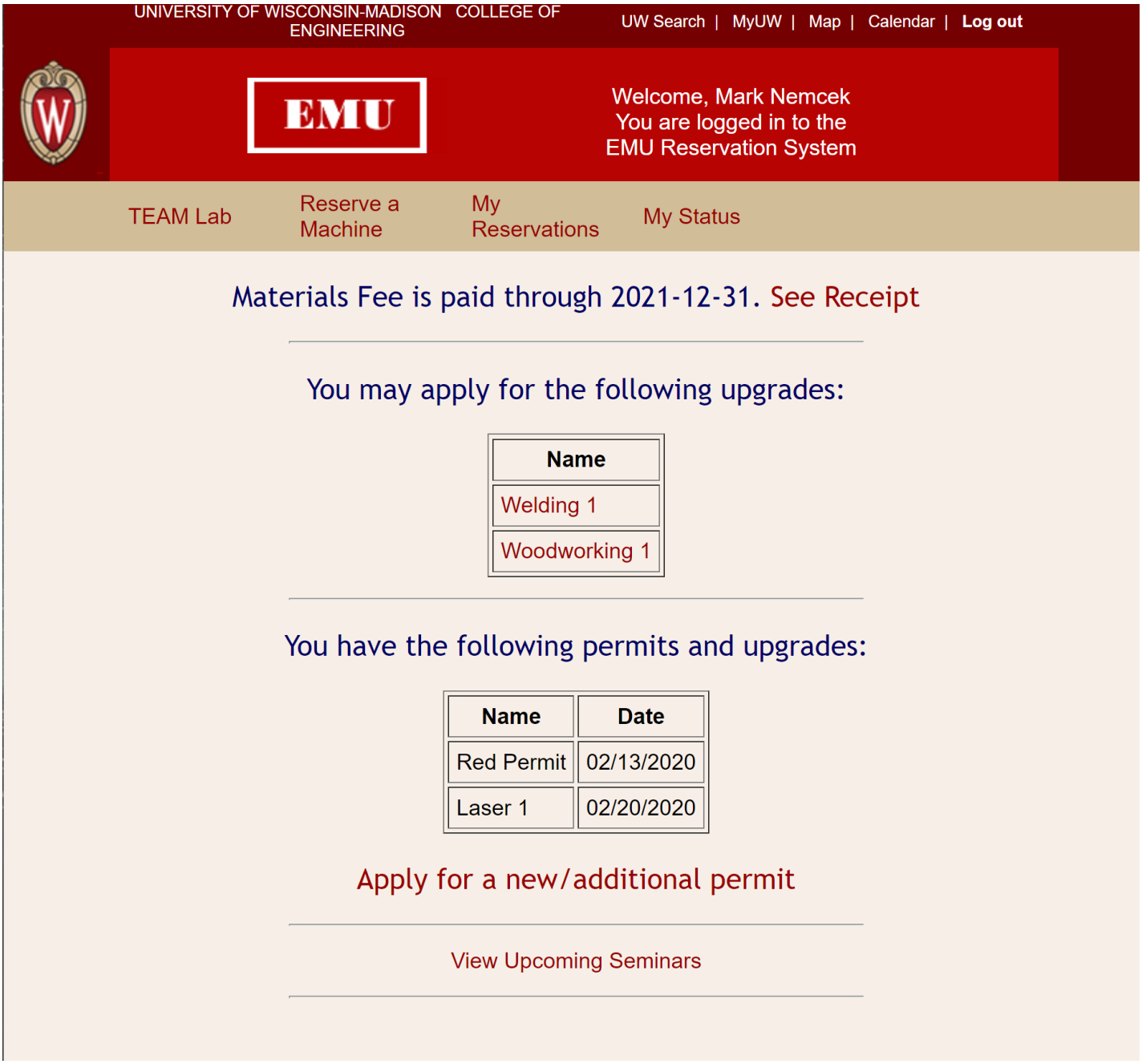
Present:

Goals:

To document my permits and upgrades.

Content:

Link to training website: https://emu.engr.wisc.edu/emu/users/milestone_tracker.php



Conclusions/action items: Going forward I want to use these permit trainings and apply them to the design project when needed.

2021/22/9 Microscope Pictures

MARK NEMCEK - Oct 19, 2021, 10:16 PM CDT

Title: Microscope Pictures

Date: 9/22/21

Content by: Mark Nemcek

Present:

Goals:

Take pictures of the microscope that we are building the stage for. This will help the team to get a better understanding of what we are trying to make and how we should design our motorized stage.

Content:

- 
- 
- 
- 
- 

Conclusions/action items:

These pictures will be used to better understand the layout of the microscope and to create designs.

2021/27/11 Laser Cut Gear

MARK NEMCEK - Dec 10, 2021, 11:02 AM CST

Title: Laser Cut Gear

Date:

11/27/21

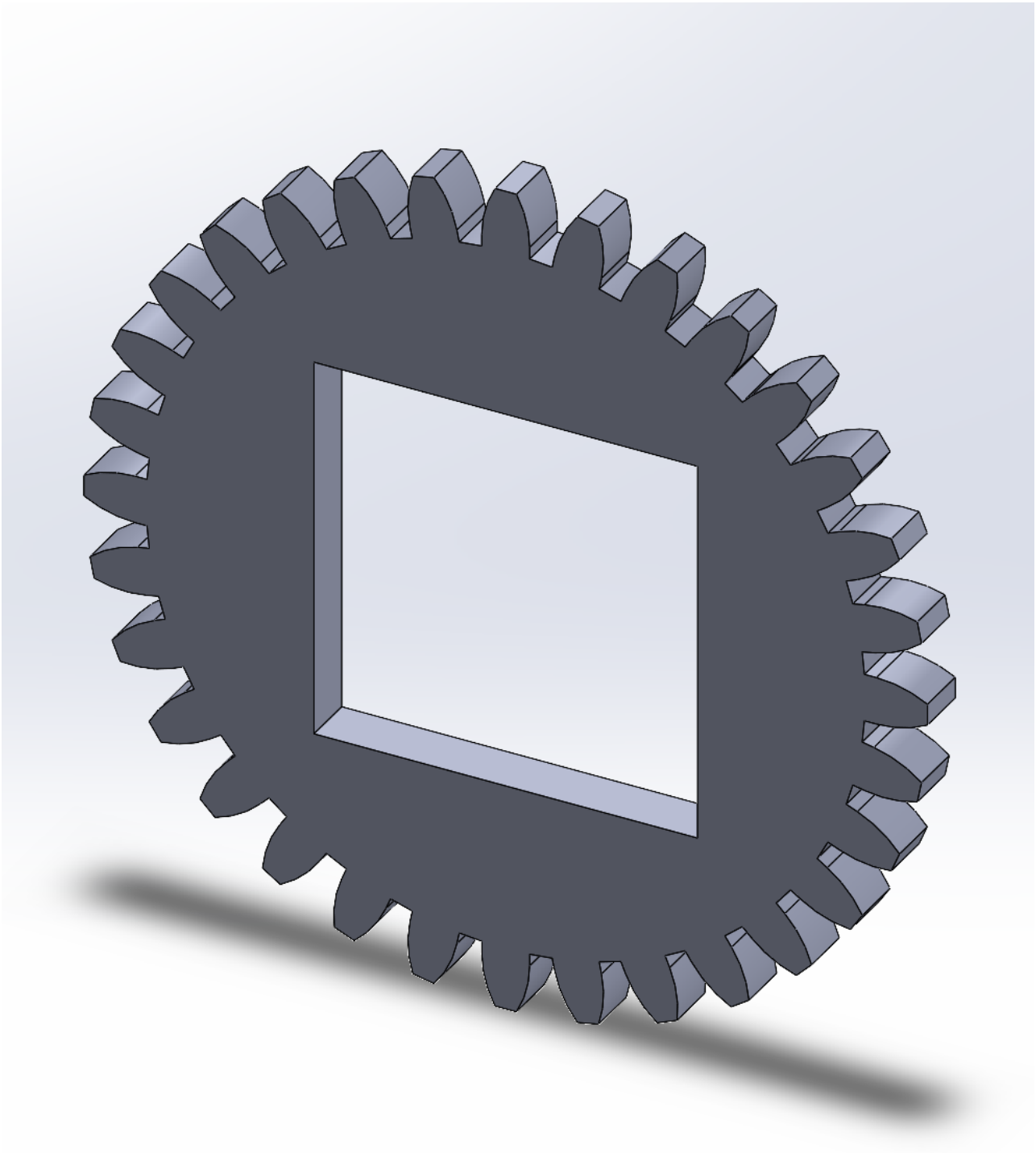
Content by: Mark Nemcek

Present:

Goals:

To make a new set of gears that fit with the gear ratio of the worm drive gear

Content:



- This gear was laser cut twice and will eventually be used in the final design

Conclusions/action items:

Going forward I will incorporate these gears into the final design and create our final prototype with them

11/18/21 Materials List

MARK NEMCEK - Dec 10, 2021, 10:19 PM CST

Title: Materials List

Date: 11/18/21

Content by: Charlie Fisher (and partially Mark Nemcek)

Present:

Goals:

To list the materials list and expenses of the group.

Content:

- **$15**- Lab notebook.

  $30.74- 2X SBR12 Linear Rail Guide

  https://www.ebay.com/itm/313728086854?chn=ps&mkevt=1&mkcid=28&var=612507496410

  $32.17- AllPoints 26-4004 – GEAR, BRASS WORM - MAIN SHAFT BRASS WORM GEAR.
  Quantity- 2 (factored into price)

  https://www.kitchenrestock.com/allpoints-26-4004-gear-brass-worm-main-shaft-brass-worm-gear-1-7-16-dia-od-x-5-8-id-x-1-3-4-long-has-2-set-screws-for-main-shaft-model-n-7.html?gclid=Cj0KCQjwrJOMBhCZARIsAGEd4VG1O4FfuptVcZK8yC_KiH6fTSPYAYSQ4MH0UegaHeqLIK7Qzu-XccwaAgddEALw_wcB

  $16.72- Analog 2-axis Thumb Joystick with Select Button + Breakout Board

  https://www.adafruit.com/product/512?gclid=Cj0KCQjw5oiMBhDtARIsAJi0qk3Mf-twwWf1YX6bwzC8EWZvcZpRYln8URsV3wK_OZHM3GmFP6rxY2AaAq1CEALw_wcB

  Total: $94.63

Conclusions/action items: Use the materials that we bought to start fabrication.

2021/2/12 Fabrication

MARK NEMCEK - Dec 10, 2021, 11:06 AM CST

Title: Fabrication documentation

Date:

12/2/21

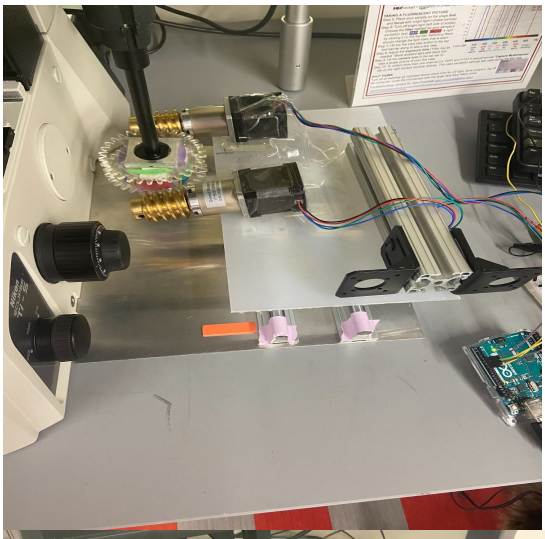
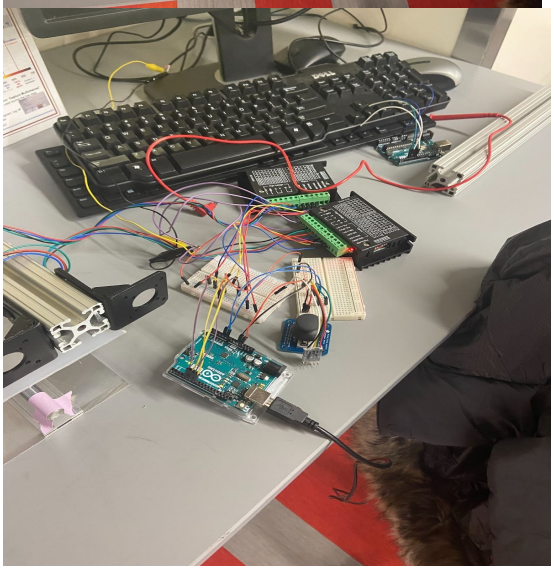
Content by: Mark Nemcek

Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Document fabrication process

Content:

- 


The team got into the lab and fully designed our final prototype. The final design incorporates the full circuit, new laser cut gears, new worm gears, new linear rail system, and a 3D printed adaptor piece so that the motors could turn the worm drive gears

Conclusions/action items:

Going forward the team will begin testing our prototype

2021/2/12 Experimentation and Data

MARK NEMCEK - Dec 10, 2021, 11:09 AM CST

Title: Experimentation

Date:

12/2/21

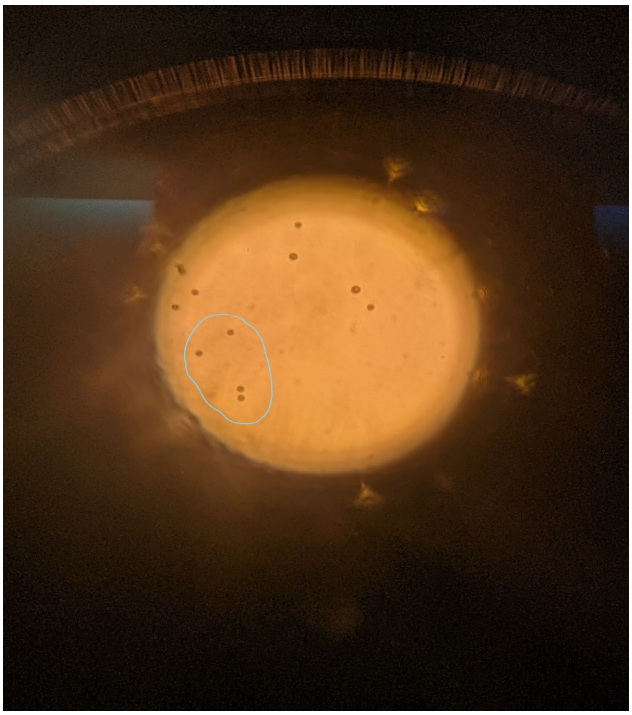
Content by: Mark Nemcek

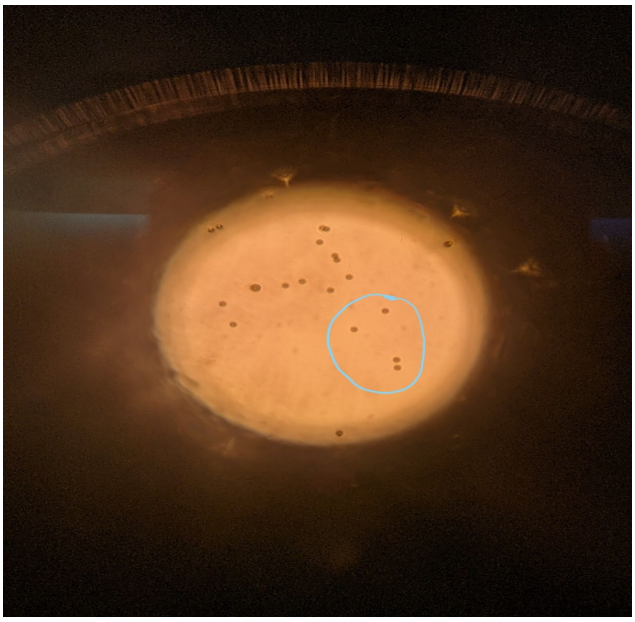
Present: Nate, Alex, Charlie, Mark, Caitriona, Corey

Goals:

Document Testing Data

Content:

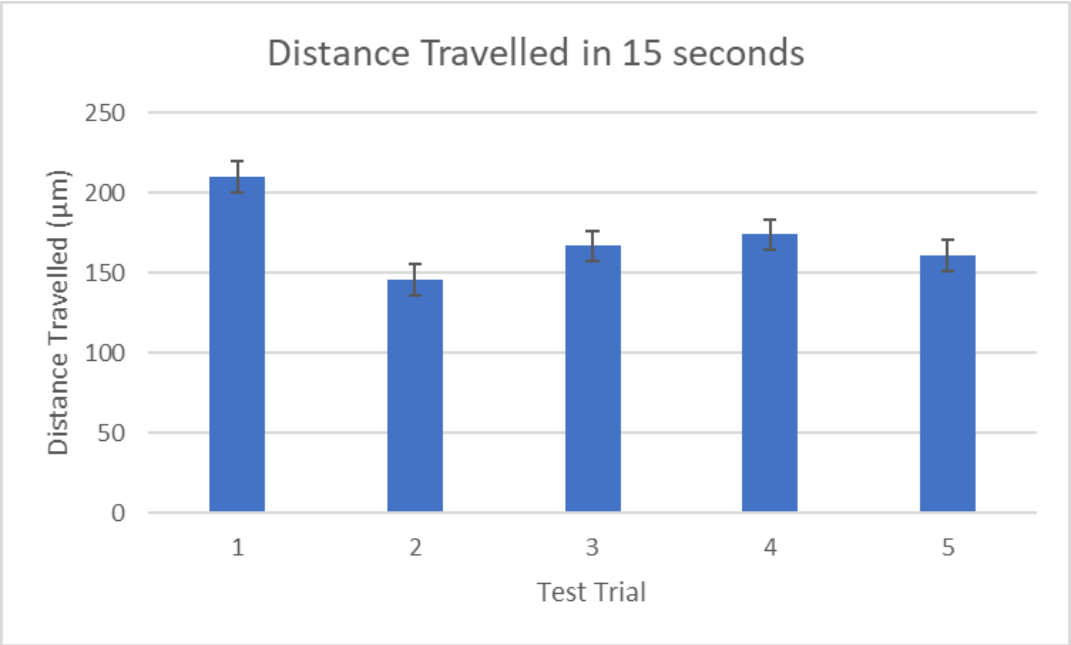
- 



- Pictures of the microscope before and after 15 seconds of movement

Seconds:	Distance (um):	Test Trial:	
15	210	1	
15	146	2	
15	167	3	
15	174	4	
15	161	5	
Mean	171.6		
Standard Error	9.527224		

- Data collected by the team during testing
-



- Five trials were run, with the results displayed on a bar graph. In 15 seconds, there was a mean of 171.6 µm of movement with a standard error of 9.53 µm. This translates to a mean speed of 11.44 µm/second

Conclusions/action items:

Going forward the team will make our final poster and write our final report

2021/10/13 Nikon Ti-U Inverted Fluorescence Microscope

COREY STEINHAUSER - Oct 13, 2021, 10:34 AM CDT

Title: Nikon Ti-U Inverted Fluorescence Microscope

Date: 10/13/21

Content by: Corey

Present:

Goals: Understand the microscope that our device will attach to

Content:

The microscope is equipped with the TI-SR Rectangular Mechanical Stage. The stage knob is connected to the rack which is attached to the stage. The stage knob can control the movement of the stage in both the x and y directions. The knob does not move when changing the x-direction of the stage, but it does move with the stage when controlling the y-direction.

https://eliceirilab.org/sites/default/files/2016-09/Nikon%20Eclipse%20Ti-U%20Manual.pdf

Conclusions/action items:

Create a device that can control both the x and y directions using the stage knob already on the microscope. It must follow the movement of the knob in the y direction.

2021/10/19 Olympus IX71 Inverted Fluorescence Microscope

COREY STEINHAUSER - Oct 19, 2021, 9:29 PM CDT

Title: Olympus IX71 Inverted Fluorescence Microscope

Date: 10/19/21

Content by: Corey

Present:

Goals: Understand one of the microscopes in the BME teaching labs that will use our device

Content:

The Olympus IX71 inverted fluorescence microscope used the IX-MVR mechanical stage and can be controlled laterally in the x and y directions using the stage knob.

“Instructions IX71/IX51 - University College Cork.” [Online]. Available: https://www.ucc.ie/en/media/academic/anatomy/imagingcentre/icdocuments/OLYMPUSIX71_manual.pdf. [Accessed: 20-Oct-2021].

Conclusions/action items:

2021/10/19 Fluorescence Microscopy

COREY STEINHAUSER - Oct 20, 2021, 12:34 AM CDT

Title: Fluorescence Microscopy

Date: 10/19/21

Content by: Corey

Present:

Goals:

Content:

Fluorescence microscopy is important in biology. The microscope send light at cells with fluorescence and they emit some light back, making them able to be viewed and studied. Fluorescent labels can be placed on cells that are not naturally fluorescent. These labels can be either fluorescent proteins or antibodies. Fluorescence microscopy is useful because it allows a single or a few cells to be studied, which can be difficult to do with other methods.

K. Thorn, “A quick guide to light microscopy in cell biology,” *Molecular biology of the cell*, 15-Jan-2016. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4713126/. [Accessed: 20-Oct-2021].

Conclusions/action items:

2021/12/14 Stepper motor

COREY STEINHAUSER - Dec 14, 2021, 9:57 AM CST

Title: Stepper Motor

Date: 12/14/21

Content by: Corey

Present:

Goals: Understand stepper motors in order to use them in the design

Content:

Stepper motors work by receiving impulses. The frequency of these impulses determines the rate at which the motor will turn. There is a magnet in the shaft that responds to electricity going through the two coils, making them act as magnets. With the two coils turning on and off, it will spin the shaft. Because we have bipolar stepper motors, we must use drivers in order to reverse the polarity of the coils. Microstepping is the word used to describe how far the shaft should turn with each "step," or impulse received by the stepper motor. This allows for more accuracy with the stepper motor.

DroneBot Workshop, “Stepper motors with Arduino – Bipolar & Unipolar,” *DroneBot Workshop*, 28-Sep-2021. [Online]. Available: https://dronebotworkshop.com/stepper-motors-with-arduino/. [Accessed: 14-Dec-2021].

Conclusions/action items:

The arduino will need to be programmed to send impulses to the driver at a determined rate to keep the accuracy of the design in the required range. Also, the driver will need to be set to a reasonable microstepping setting to again ensure the accuracy.

2021/10/13 Belt Design

COREY STEINHAUSER - Oct 19, 2021, 9:41 PM CDT

Title: Belt Design

Date: 10/13/21

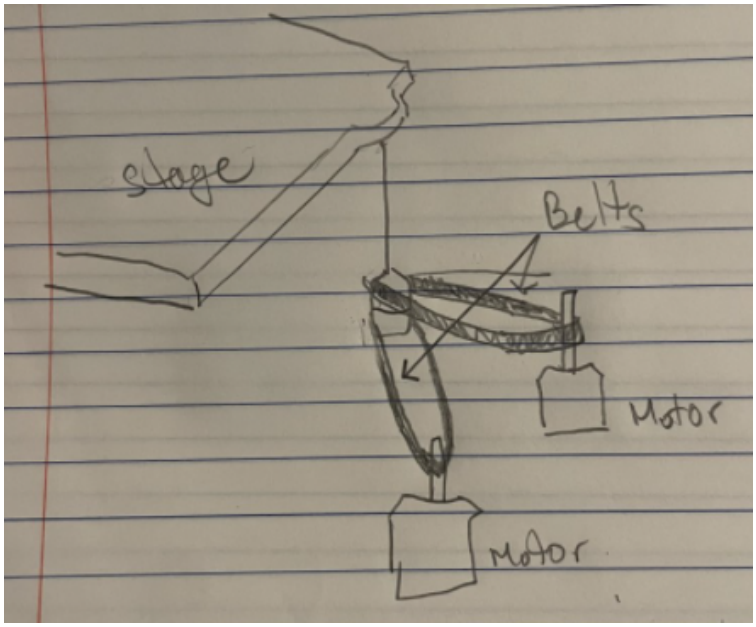
Content by: Corey

Present: Entire design group

Goals: Determine whether this design has any legitimacy

Content:

The design used two motor which will each control the rotation of a small rod. This rod will have an elastic belt of some sort (example would be a rubber band) which will go around the rod and the stage knob (one on the x control, one on the y control). The motor would turn the rod and subsequently turn the belt and stage knob. The idea is there the belt would have enough elasticity to allow some movement of the knob in the y-direction, the direction that moves the stage knob with the stage.



Conclusions/action items:

2021/10/13 Attachable Gear Box Design

COREY STEINHAUSER - Oct 19, 2021, 9:32 PM

Title: Attachable Gear Box Design

Date: 10/12/21

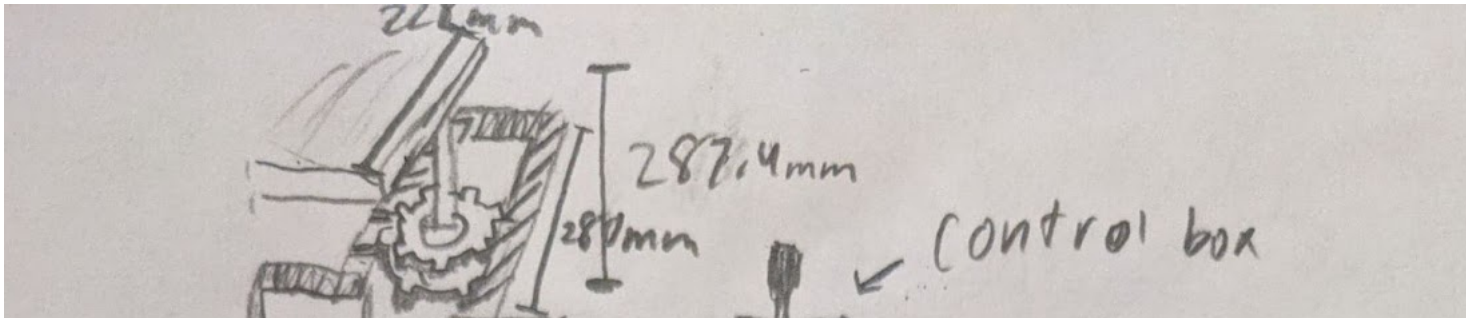
Content by: Corey

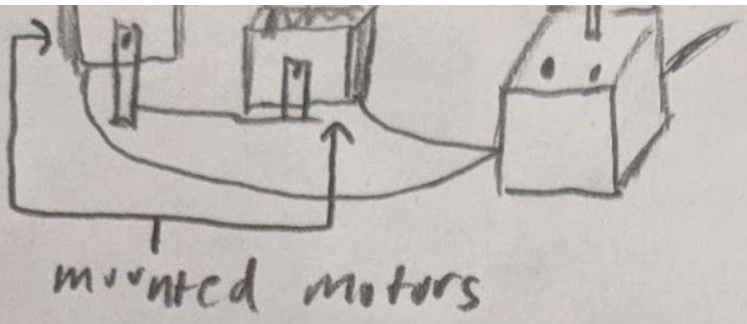
Present: Entire Design Group

Goals: Determine the validity of the design

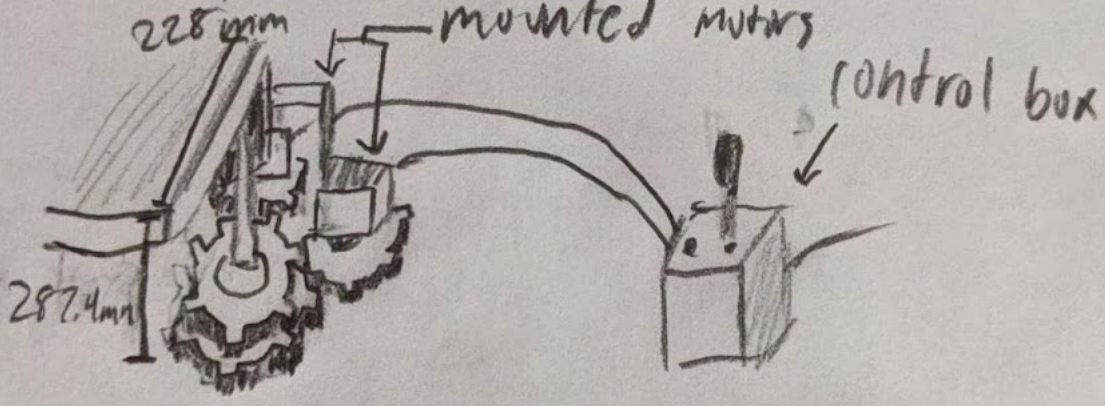
Content:

The Attachable Gear Box Design would consist of two motors that each have gears on the end of their shafts. The motors would be attached to the stage knob and each the x-direction control the y-direction control would also have gears attached. The motors would be plugged into and controlled by a microprocessor (Arduino). The gears on the end of each motor shaft would conne their respective gears on the stage knob to control both directions. The mechanism would be able to move with the knob as there would only be wires connecting the motors and the microprocessor.





Attachable Gearbox



Conclusions/action items:

2021/10/19 Worm Drive Design

COREY STEINHAUSER - Oct 19, 2021, 9:4

Title: Worm Drive Design

Date: 10/19/21

Content by: Corey

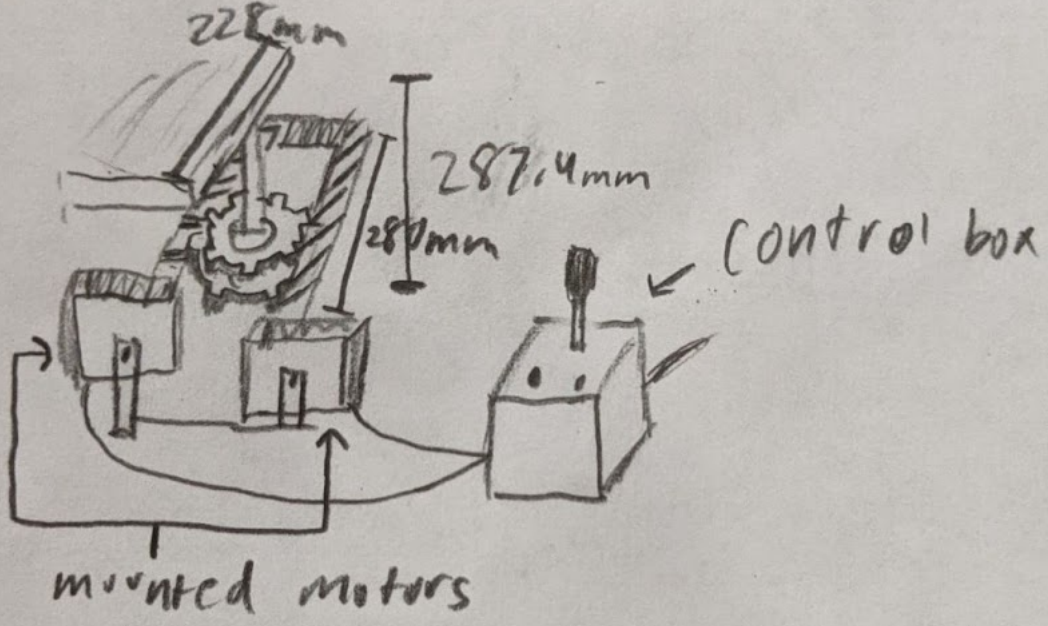
Present:

Goals:

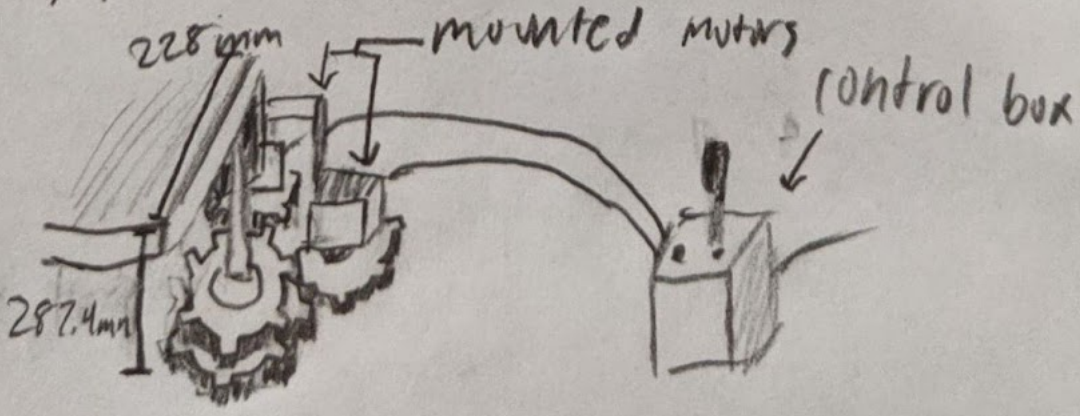
Content:

The Worm Drive Design consists of two motors that each control a worm drive gear. Each part of the stage knob (the x control and the y control) will have a gear that connects to the worm driv
worm drive deals with this problem of the stage knob moving with the stage in the y direction.

Worm Drive



Attachable Gearbox



Conclusions/action items:

2021/10/19 Replaceable Stage

COREY STEINHAUSER - Oct 19, 2021, 9:38 PM CDT

Title: Replaceable Stage Design

Date: 10/19/21

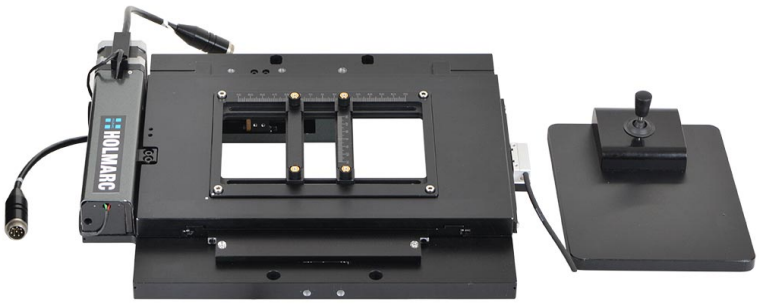
Content by: Corey

Present:

Goals:

Content:

The replaceable stage design would entail completely replacing the current stage on the microscopes with a new stage that we engineer to move with a joy stick.



Conclusions/action items:

2021/12/06 Circuit with Joystick

COREY STEINHAUSER - Dec 06, 2021, 1:51 PM CST

Title: Circuit with Joystick

Date: 12/6/21

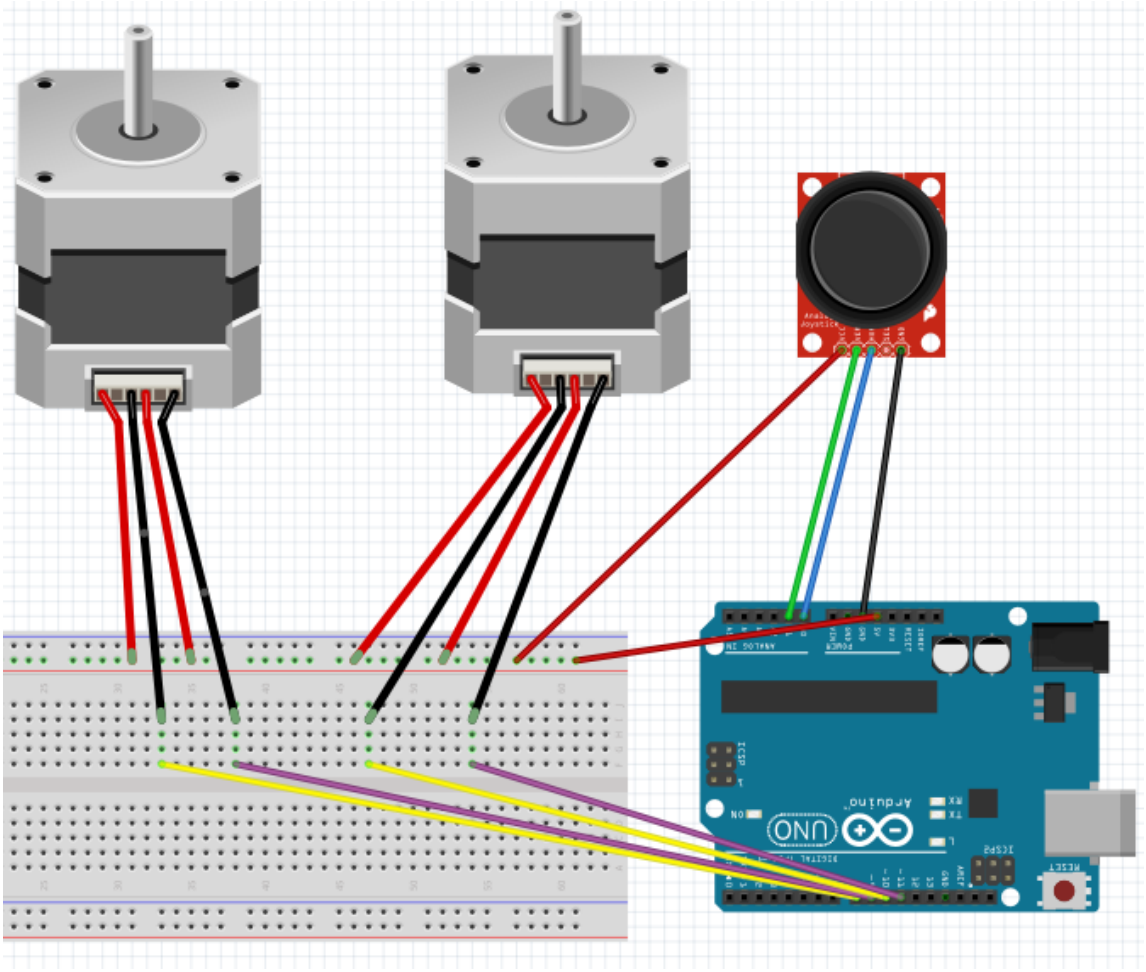
Content by: Corey

Present:

Goals:

Content:

The arduino was receiving power from my laptop, and the motors were receiving power from a 12V power supply.



Conclusions/action items:

2021/12/06 Circuit for Testing

COREY STEINHAUSER - Dec 06, 2021, 1:51 PM CST

Title: Circuit for Testing

Date: 12/6/21

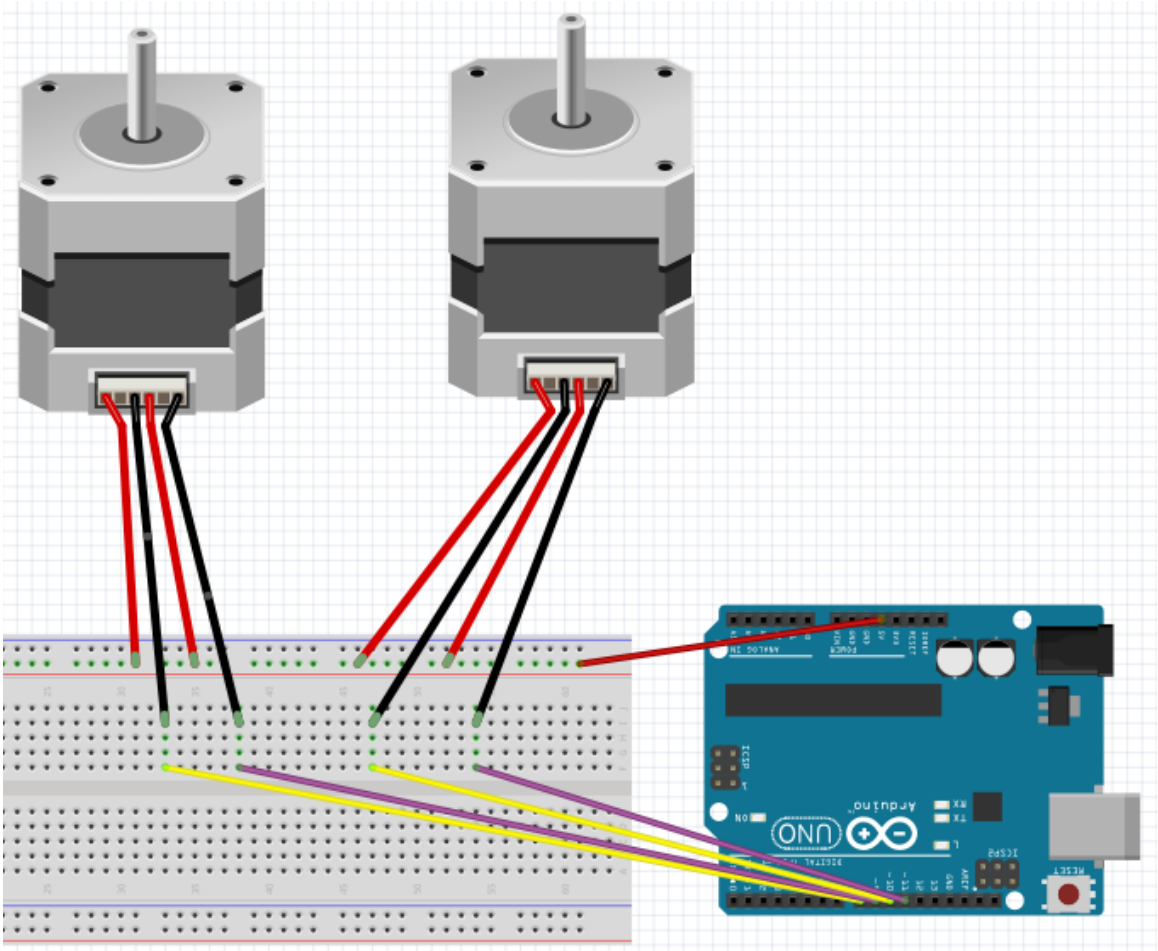
Content by: Corey

Present:

Goals:

Content:

The arduino was receiving power from my laptop, and the motors were receiving power from a 12V power supply.



Conclusions/action items:

2021/12/14 Arduino Code for Project

COREY STEINHAUSER - Dec 14, 2021, 10:00 AM CST

Title: Arduino Code for Project

Date: 12/14/21

Content by: Corey

Present:

Goals:

Content:

```
int xPul = 8;
int xDir = 9;
int yPul = 10;
int yDir = 11;


void setup() {
  // set digital pins to output
  pinMode(xPul, OUTPUT);
  pinMode(xDir, OUTPUT);
  pinMode(yPul, OUTPUT);
  pinMode(yDir, OUTPUT);
}


void loop() {
  int analogValX = analogRead(A0); // reads ADC value from pin A0
  float voltageValX = analogValX * 5 / 1023.0; // converts ADC to voltage
  int analogValY = analogRead(A1); // reads ADC value from pin A0
  float voltageValY = analogValY * 5 / 1023.0; // converts ADC to voltage


  digitalWrite(xPul, LOW);
  digitalWrite(yPul, LOW);


  if(voltageValX > 4) { // checks if the joystick is tilted in positive x direction
    digitalWrite(xDir, LOW); // sets motor to turn the stage in positive x direction
    while(voltageValX > 4) {
      digitalWrite(xPul, HIGH);  // sends impulse to driver
      delay(1);
      digitalWrite(xPul, LOW);
```

```
    analogValX = analogRead(A0);  // reads voltage output from joystick x output
    voltageValX = analogValX * 5 / 1023.0;
   }
  }
  else if(voltageValX < 1.5) { // checks if joystick is tilted in negative x direction
   digitalWrite(xDir, HIGH); // sets motor to turn stage in negative x direction
   while(voltageValX < 1.5) {
    digitalWrite(xPul, HIGH); // sends impulse to driver
    delay(1);
    digitalWrite(xPul, LOW);
    analogValX = analogRead(A0); // reads voltage output from joystick x direction
    voltageValX = analogValX * 5 / 1023.0;
   }
  }
  else { // joystick is not tilted on x axis
   digitalWrite(xPul, LOW);
   digitalWrite(xDir, LOW);
  }



  if(voltageValY > 4) { // checks if joystick is titled in positive y direction
   digitalWrite(yDir, LOW); // sets motor to turn stage in positive y direction
   while(voltageValY > 4) {
    digitalWrite(yPul, HIGH); // sends impulse to driver
    delay(1);
    digitalWrite(yPul, LOW);
    analogValY = analogRead(A0); // reads voltage output from joystick y direction
    voltageValY = analogValX * 5 / 1023.0;
   }
  }
  else if(voltageValY < 1.8) { // checks if joystick is titled in negative y direction
   digitalWrite(yDir, HIGH); // sets motor to turn stage in positive y direction
   while(voltageValY < 1.8) {
    digitalWrite(yPul, HIGH); // sends impulse to driver
    delay(1);
    digitalWrite(yPul, LOW);
    analogValY = analogRead(A0); // reads voltage output from joystick y direction
    voltageValY = analogValY * 5 / 1023.0;
   }
  }
  else {  // joystick is not tilted on y axis
   digitalWrite(yPul, LOW);
   digitalWrite(yDir, LOW);
  }



  delay(1);
}
```

Conclusions/action items:

Code works, but does not allow for diagonal translation. Also, the voltage thresholds could be optimized.

2021/12/14 Arduino Code for Testing

COREY STEINHAUSER - Dec 14, 2021, 10:01 AM CST

Title: Arduino Code for Testing

Date: 12/14/21

Content by: Corey

Present:

Goals:

Content:

```
int xPul = 8;
int xDir = 9;
int yPul = 10;
int yDir = 11;



void setup() {
  // initialize all digital pins to output
  pinMode(xPul, OUTPUT);
  pinMode(xDir, OUTPUT);
  pinMode(yPul, OUTPUT);
  pinMode(yDir, OUTPUT);
}



void loop() {



   digitalWrite(xDir, LOW); // set motor to turn stage in positive x direction



   for (int i = 0; i < 10000; i++){ // loops 10000 times, each lasting 1.5 microseconds for a total of 15 seconds
     digitalWrite(xPul, HIGH); // sends impulse to driver
     delayMicroseconds(750);
     digitalWrite(xPul, LOW);
     delayMicroseconds(750);
   }



   digitalWrite(xDir, HIGH); // set motor to turn stage in negative x direction



   for (int i = 0; i < 10000; i++){ // 15 seconds
```

```
    digitalWrite(xPul, HIGH); // sends impulse to driver
     delayMicroseconds(750);
     digitalWrite(xPul, LOW);
     delayMicroseconds(750);
   }

}
```

Conclusions/action items:

Simple test, move in x-direction for 15 seconds, then go the opposite way for 15 seconds. Take measurements at ends of each cycle.

Fluorescence Imaging Overview

Nate Burkard - Oct 18, 2021, 10:09 PM CDT

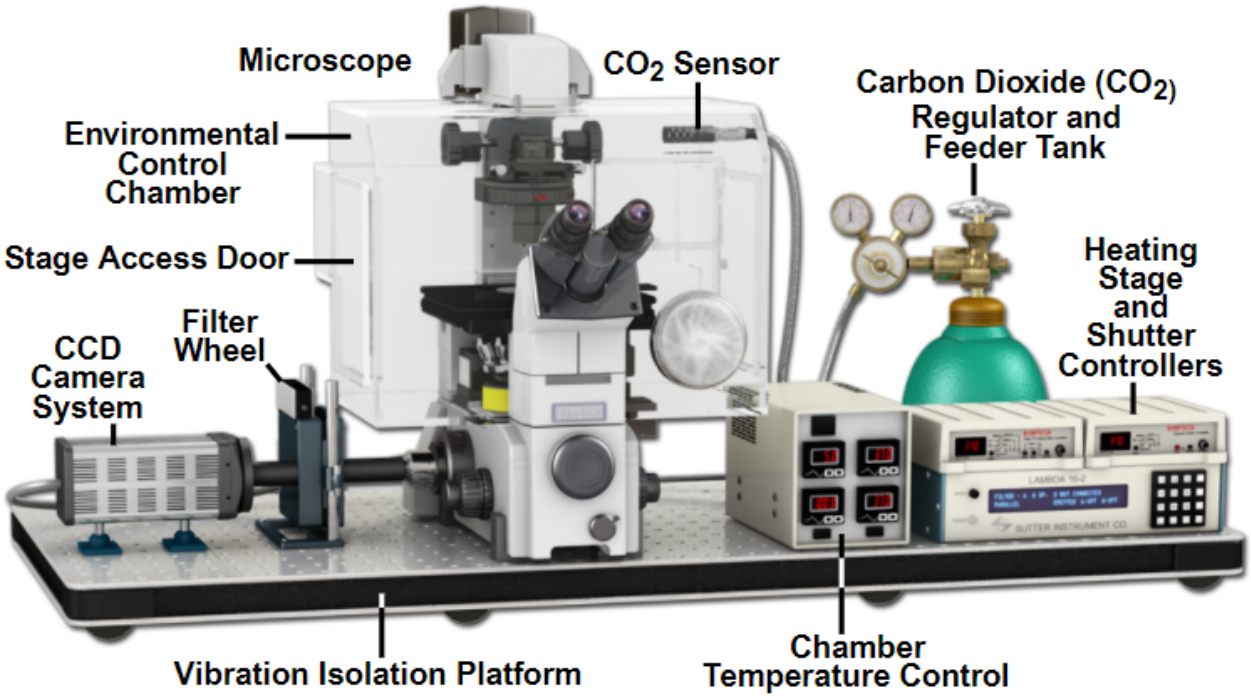
Title: The Automatic Microscope

Date: 9/16/21

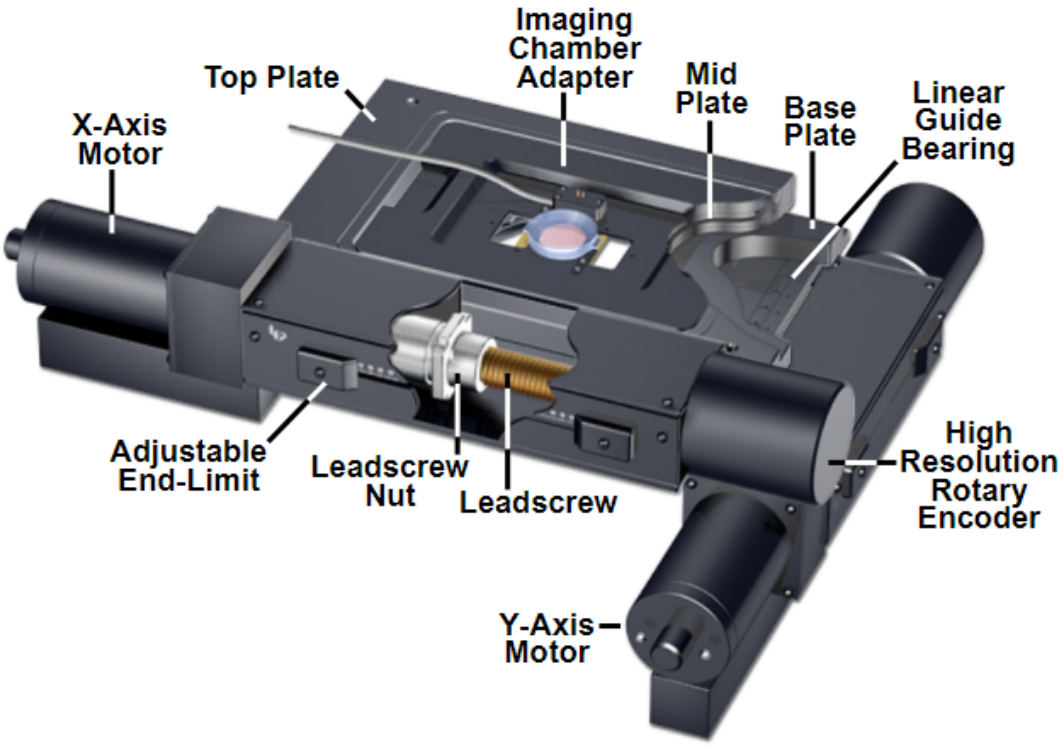
Content by: Nate Burkard

Goals: To learn about fluorescence imaging microscopy

Content:



Goes through the setup of a microscope capable of fluorescence imaging microscopy.



This stage is the set up of how their stage looked, and how it controlled the movement of the x and y axis, as well as where all the other parts of the stage.

Conclusions/action items:

This mostly goes through the different parts of the setup and all the parts that go into it. The only helpful part includes the stage that they use. Their stage would correspond to a replaceable stage for us, since the stage has built in motors for automatically moving it.

https://www.microscopyu.com/applications/live-cell-imaging/the-automatic-microscope

MIST: Microscopy Image Stitching Tool

Nate Burkard - Oct 18, 2021, 10:42 PM CDT

Title: MIST: Microscopy Image Stitching Tool

Date: 9/26/21

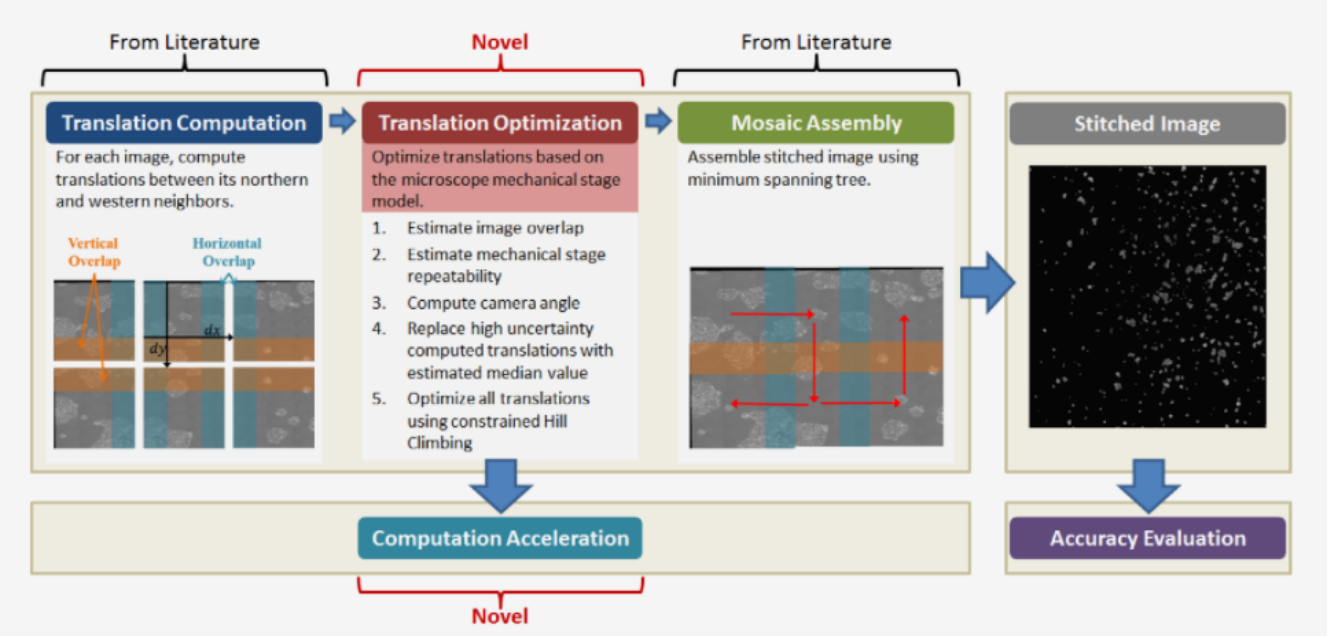
Content by: Nate Burkard

Goals: Learn about an image stitching program used.

Content:

Microscopy Image Stitching Tool (MIST), is a stitching tool for 2D grids of images. MIST estimates the stage mechanical model (actuator backlash, stage repeatability 'r', etc.) from computed pairwise translations and then minimizes stitching errors by optimizing the translations within a (4r)^2 square area. This minimizes the maximum uncertainty related to the translation computation for any pair of images.

With new microscope technologies, scientists are acquiring terabyte-sized datasets to cover large area of their experiments. An automated optical microscope acquires images of a cell cultures specimen. The microscope acquires a grid of partially overlapping images because the microscope field of view is much smaller than the dimensions of the specimen being imaged. This process generates hundreds of thousands of images that need to be stitched into a large mosaic to derive meaningful information. Some of these large mosaics are sparse, mainly at the beginning of an experiment before cells grow and cover more areas. This creates overlapping areas with no foreground pixel intensities to compute the translations between tiles, which increases the translation computation uncertainty for the entire mosaic. Moreover, stitching such large image mosaic is computationally taxing; this becomes overwhelming for live cell experiments.



Conclusions/action items:

This is an option for which stitching tool to integrate into our design.

ImageXpress Pico Automated Cell Imaging System

Title: ImageXpress Pico Automated Cell Imaging System

Date: 10/1/21

Content by: Nate Burkard

Goals: Find competing designs.

Content:

This machine does high powered imaging, and image analysis. Operates in colorimetric, bright field, fluorescence, or Digital Confocal 2D on-the-fly image
CellReporterXpress software. Easily generate heatmaps, scatter plots, and bar charts from analyzed image data in just a few clicks. This machine says it c

Conclusions/action items:

Costs way too much money, they advertise under $50,000. Not sure if there is image stitching to create one large image. Does way more than what we ne

https://www.moleculardevices.com/en/assets/promotion/dd/img/imagexpress-pico?cmp=7010g000000nNGE&utm_source=AdWords&utm_medium=cpc&ut
{adgroup}&utm_location=9018948&utm_keyword=automated%20imaging&utm_device=c&utm_devicemodel=&utm_placement=&utm_adpostion=&utm_tar
oO5QkcnaKSBEaDzNCylvh9PTYaAqcOEALw_wcB

Echo Bioco Company

Title: The Automated Microscope for Life Science Research

Date: 10/3/21

Content by: Nate Burkard

Goals: Research a competing design.

Content:

Build:

Microsoft Surface Studio
28" PixelSense TM Touch Display
4500 x 3000 (192 PPI) Resolution

Multi Dimensional Imaging:
Time Lapse, Multi-Point, Mosaic, Multi-Channel, Z-Stack

Motorized Epi-Fluorescence:
5 Channels - Mercury Free LED illumination with
50,000 hour lifespan

Objectives:
Olympus 1.25x-100x Plan Achromat, Fluorite, and Apochromat
Intelligent Nosepiece

Cameras:
Brightfield: 5MP CMOS Color (2048 x 1536 : 3.45um pixels)
Fluorescence: 5MP sCMOS Mono (2048 x 1536 : 3.45um pixels)

Cost: $69,950.

Live Cell Imaging:

View and capture live samples with automated time-lapse microscopy.

Stage Top Incubator:

Ensures optimal conditions for maintaining specimen viability.

Multi-Channel:

Capture and overlay multiple wavelengths in Fluorescence.

Multi-Point:

Set multiple aquisition points to view and revisit over time.

Image Stitching:

Capture and stitch to form large FOV high resolution images.

Z - Stack:

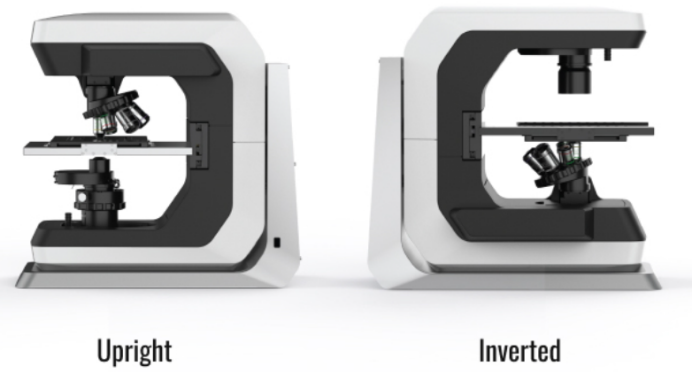
Acquire and stack images at multiple focal planes.

Auto Focus:

Automatically find and track best Z-plane(s) for focus.

Hyperscan:

High-speed image stitching.



Conclusions/action items:

It costs way too much, it is not feasible at all. Has a lot of the features we want, including the imaging, and image stitching.

https://discover-echo.com/revolution?utm_source=google&utm_medium=search&utm_campaign=11736234910&utm_term=image%20stitching%20microscope&utm_content=506118732912&g

Prior Scientific

Nate Burkard - Oct 19, 2021, 9:53 PM CDT

Title: Prior Scientific

Date: 9/30/21

Content by: Nate Burkard

Goals: Research Another Competing Design

Content:

Prior Scientific produces a wide range of motorized stages, for use with a wide range of applications including live cell imaging. Prior stages offer Ultra high precision scanning and processing for multiple samples. They have several different kinds of stages that can be used while imaging.

One Example:

Image	Part Number	Travel (x)mm	Travel (y)mm	Drive	Applications	Encoders	Max Load kg
	HLD117	120	72	Linear Motor	Ultra high precision scanning and processing	Yes	6

Conclusions/action items:

The company Prior Scientific has plenty of replaceable stage designs for creating automatic motorized stages. This is an option for what to do with the microscopes here, we just need to add a software connected to it to automatically image and stitch images.

Creating Worm Drive Adaptor

Nate Burkard - Dec 14, 2021, 8:38 PM CST

Title: Creating Worm Drive Adaptor

Date: 11/27/21

Content by: Nate Burkard

Goals: Create an adaptor for the worm drive

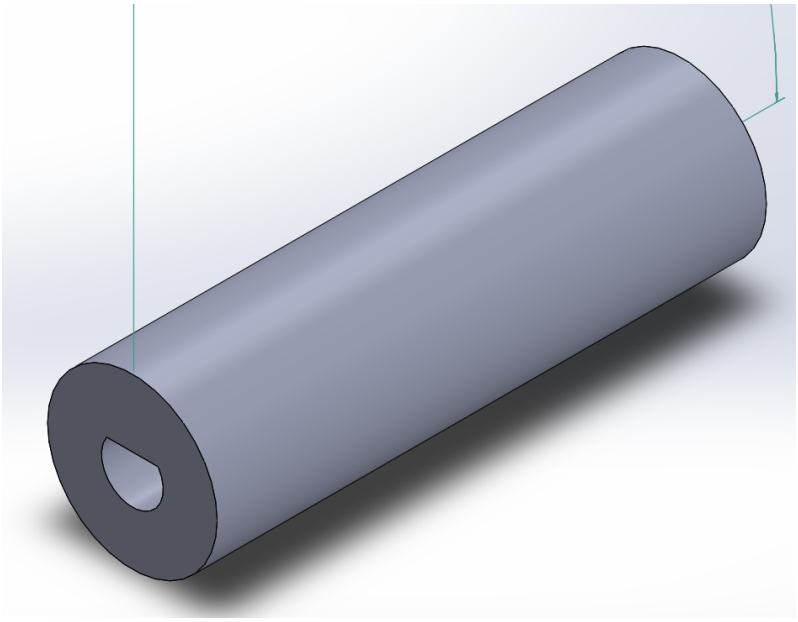
Content:

Flat edge diameter: 7.05mm

Shaft diameter: 8.05 mm

Diameter: 15.5 mm

Length: 40 mm



Conclusions/action items:

The adaptor that goes inside the worm drive to connect the worm drive to the motors. The adaptor was 3D printed in the makerspace.

Microscope stage research

Charlie Fisher - Oct 20, 2021, 2:38 AM CDT

Title: Microscope Stages

Date: 10/19

Content:

Purpose of Motorized Stage:

It helps smooth, quick, and repeatable data capture. This helps when experimentation is a long process and would otherwise require a lot of manual movement. A joystick is much more smooth and accurate as well as easier to operate. Motorized stages also allow for a computer software to operate idependently.

They include the following.

- Motorized XY stage
- Motorized Z (focus)
- Motorized add-on focus drive
- Stage controllers, such as an external control box or internal PC card
- Joystick for XY control
- Focus control
- Digital camera for automated image acquisition
- Control software

Allow for smooth stitching of images.

Conclusions/action items:

These are all things we would like to replicate with our design, however we need to do it with much less money.

https://www.prior.com/blog/upgrade-your-microscope-from-manual-to-motorized-with-an-xy-stage

Worm Drives

Charlie Fisher - Dec 15, 2021, 10:38 AM CST

Title: Worm Drive Research

Date: 10/19

Goals: Determine worm drive mechanics

Content:

Worm drives are gears that run side by side with another gear and move in a way where the other gear spins slower than the worm drive, and the same worm drive grooves are quickly moved from one tooth to the next.

Conclusions/action items:

We have to keep this in mind when thinking about how fast the x and y knobs will turn on microscope.

3D Printing Materials

Charlie Fisher - Dec 15, 2021, 10:45 AM CST

Title: 3D Printer Materials

Date: 12/15/21

Goals: To determine the difference between materials used in 3D printing and determine which is best for our project.

Content:

ABS- Tough, low cost, durable. Think about Lego material.

Flexible- Great for elasticity and bending.

PLA- The most common material. Very easy to use, cheap, and accurate.

HIPS- Lightweight, dissolvable

PETG- Easy to print, smooth finish, water resistant

Nylon- Tough and durable, however it is flexible

Carbon Fiber Filled- strong and stiff, not sure how realistic it would be here

ASA- great UV, temperature, and impact resistance

Polycarbonate- very strong and durable, also good heat resistance, top choice for tough environments

Polypropylene- weak, semi-flexible, lightweight

Metal Filled- very heavy

Wood Filled- wooden look and feel

PVA- dissolvable

Conclusions/action items:

PCA, or polycarbonate would be a good choice for this project due to its strength, durability, and high heat resistance.

https://www.simplify3d.com/support/materials-guide/

Competing Design Research- Zaber

Charlie Fisher - Oct 19, 2021, 7:21 PM CDT

Title: Competing Design Research 1

Date: 10/19/21

Content by: Charlie Fisher

Goals: Determine some qualities of different types of microscope stages.

Content:

X-ADR-AE

1. 130 x 100 mm or 250 x 100 mm travel.
2. 750 mm/s speed
3. 5 µm accuracy, 500 nm repeatability, 50 nm incremental move
4. asdg
5. Built in controller.

X-ASR-E

1. 50-350 mm travel per axis.
2. Up to 12 µm resolution, 2 µm repeatability, 85 mm/s
3. Built in controller.

X-ASR

1. 50-350 mm travel per axis.
2. Up to 12 µm resolution, 2 µm repeatability, 85 mm/s
3. Built in controller.

ASR-E

1. 50-350 mm travel per axis.
2. Up to 12 µm resolution, 2 µm repeatability, 85 mm/s
3. Designed to be used with X-MCC2 controller or any other two phase stepper motor controller.

ASR

1. 50-350 mm travel per axis.
2. Up to 12 µm resolution, 2 µm repeatability, 85 mm/s
3. Designed to be used with X-MCC2 controller or any other two phase stepper motor controller.

Conclusions/action items:

We would like our stage to be close in qualifications and aspects to these different types of microscopes.

Sources

“Motorized Microscope Stages,” *Zaber Technologies*. [Online]. Available: https://www.zaber.com/products/scanning-microscope-stages. [Accessed: 19-Oct-2021].

Idea1_WormDriveGears

Charlie Fisher - Dec 15, 2021, 10:35 AM CST

Title: Idea Brainstorm for Project

Date: 12/15

Goals: Come up with some potential ideas for project.

Content:

Worm Drive Gear- Could have a long one that runs parallel to the whole length of the y-axis

- Or it could be attached or suspended and run perpendicular

Belt system- The runs parallel and has grooves in it that fit on gears left behind.

Normal gears- Suspended from above that are fixed and stay in contact with gears whole time.

(Not very detachable however)

Conclusions/action items:

The worm drive would be the best option for the results we are looking for. Also it is hard to find worm gears that are longer than a couple of inches, so it would be best to have them perpendicular.

9/28/21 Low Cost Shifter Microscope Stage

Caitriona Treacy - Oct 19, 2021, 9:57 PM CDT

Title: Low Cost Shifter Microscope Stage Design

Date: 9/28/21

Content by: Caitriona

Goals: Gather background information about other products that are related to the project we are working on.

Content:

- The design described by this article relates specifically to the motorization of a stage to enhance the process of crystal-mounting in the lab. While this is not the specific intended use of the microscope apparatus we will be designing, it is beneficial to understand the various strategies that can be implemented to motorize a stage, regardless of design motivation.

- The name of the mechanism in this article is "the Shifter." The Shifter was specifically designed with the intention for a low cost option that could be readily commercialized. Furthermore, the article states that "the versatile hardware design allows use beyond fragment screening and protein crystallography.

- The design (the Shifter) is operated using a touch-screen PC which directs the movement of the stage. If the team decides to pull inspiration from this design, it would be most likely applied in the form of a replaceable stage which would require a more intensive reconfiguration of the microscope itself, something that the client did request that the team avoids. Nonetheless, it is still beneficial to understand the apparatus and possible mechanistic features that could be implemented in an alternative design.

- Materials used include a metal enclosure which acts as the stage and is mounted on a track-like apparatus to support the movement of the stage in the x and y directions. The x-axis carriage moves in tracks which are located lower on the base bearings while the y-axis carriage tracks are positioned on top of the x-axis carriage. This configuration and construction is different from that of a typical, more expensive motorized stage setup.

- The motor control is coordinated through Windows Framework, but the article states that the Shifter any user interface or workflow could be implemented, resulting in the potential for wider application.

Citation:

https://onlinelibrary.wiley.com/iucr/doi/10.1107/S2059798320014114

APA citation: Wright, N. D., Collins, P., Koekemoer, L., Krojer, T., Talon, R., Nelson, E., . . . Von Delft, F. (2021). The low-cost shifter microscope stage transforms the speed and robustness of protein crystal harvesting. *Acta Crystallographica Section D: Structural Biology, 77*, 62-74. doi:10.1107/S2059798320014114

Conclusions/action items: Although it is unlikely that the team decides to proceed with a design which includes a replaceable stage, it is beneficial to understand the way in which this design idea could function, in case there are elements of the motorization that the team decides to pull inspiration from.

9/30/21 Openstage Design

Caitriona Treacy - Oct 19, 2021, 11:35 AM CDT

Title: Openstage Motorized Stage Design

Date: 30 September 2021

Content by: Caitriona Treacy

Goals: Gather information about design currently available, taking note of strategies used to reduce overall cost.

Content:

- Drawbacks of mechanisms such as motorized translators and controller boxes are that they can often be very expensive and are not easily altered to fit specific microscope stages.

- Hardware costs for this specific project are decreased by using **stepper motors** rather than linear actuators.

- The accuracy achieved by the Openstage also satisfies the design specs we were given, with an additional measurement of accuracy in the z direction: 1 µm in the x/y direction and 0.1 µm in the z direction. Movement is achieved through the use of a handheld control pad with an alternative option of control from a PC serial port.

- A 3-axis motorized stage enables applications of the microscope that include time-lapse imaging of a larger sample, automated tracking, construction of image mosaics, and volume data. (Note: The BME design project does not require consideration of the third z axis movement, and thus some of the functions listed above do not apply. Time lapse imaging of a sample is most pertinent to the current project.)

- The Openstage design assembly costs a total of $1000, a price significantly higher than the given budget in this project, but understanding the mechanism and strategies to control cost is still beneficial.

- **Unidirectional positioning repeatability** is extremely important in time-lapse imaging - the accuracy with which the stage can return repeatedly to the same position when approached from the same direction.

- The Openstage controller includes storage of up to four different stage positions which can be easily returned to. Might be beneficial to ask the client if this is a feature that would be desired for the project.

- One secondary goal that the Openstage design project team had was to make it easy for others to modify and enhance the system through the usage of stricly open-source hardware and software. This might be another beneficial thing for our team to consider, as it might be beneficial to make the mechanism easy to modify if it is to be implemented in the teaching lab on campus. This may or may not be a realistic goal if our software is to be compatible with the imaging software used with the specific Nikon in the lab.

-The X/Y drive system includes a mechanism that is made up of a linear translator and a stepper motor connected by a flexible shaft.

-Micrometer actuated linear translators are motorized using a stepper motor connected to the micrometer.

- The resolution and speed of the drive system are affected by the specific stepper motor used in the mechanism. **Resolution is affected by both step size and torque.** A motor with higher torque may result in higher resolution because if the net load on the motor exceeds the torque exerted by one microstep (varies depending on the specific stepper motor), multiple microsteps may need to be taken in order for the motor to move. **A motor's torque decreases as speed increases;** some motors with a high holding torque may not be able to produce high speeds.

- For the Openstage group, a closed loop control was not necessary to achieve reliable positioning, so an open-loop stepper motor solution worked well. Note: Closed loop control is more expensive and harder to implement.

- It will be necessary for the team to conduct and record testing on the position repeatability in both the x and y directions as part of the semester project.

- **Backlash** (a form of hysteresis that occurs when a drive direction manifests itself as a hesitation in motion) is a possible challenge that should be considered by the team regardless of whichever design is chosen to proceed with. It affects bidirectional repeatability, something that should be maintained to ensure the accuracy of the design.

Citation:

Campbell RAA, Eifert RW, Turner GC (2014) Openstage: A Low-Cost Motorized Microscope Stage with Sub-Micron Positioning Accuracy. PLoS ONE 9(2): e88977. https://doi.org/10.1371/journal.pone.0088977

Conclusions/action items:

Strategies utilized by this product to reduce cost are strategies that the team could consider implementing this semester as well. Specifically, I would be interested in conducting more research on the uses of stepper motors and the feasibility of incorporating one or more of these into our design. This would entail understanding how these motors work and whether their accuracy and cost satisfy the needs of this project.

10/7/21 Worm Drive Research

Caitriona Treacy - Oct 19, 2021, 1:42 PM CDT

Title: Worm Drive Research

Date: 7 October 2021

Content by: Caitriona Treacy

Goals: Gather information about the assembly and functionality of a worm drive as it relates to our design.

Content:

- Worm gears are used to transfer power in perpendicular shafts.

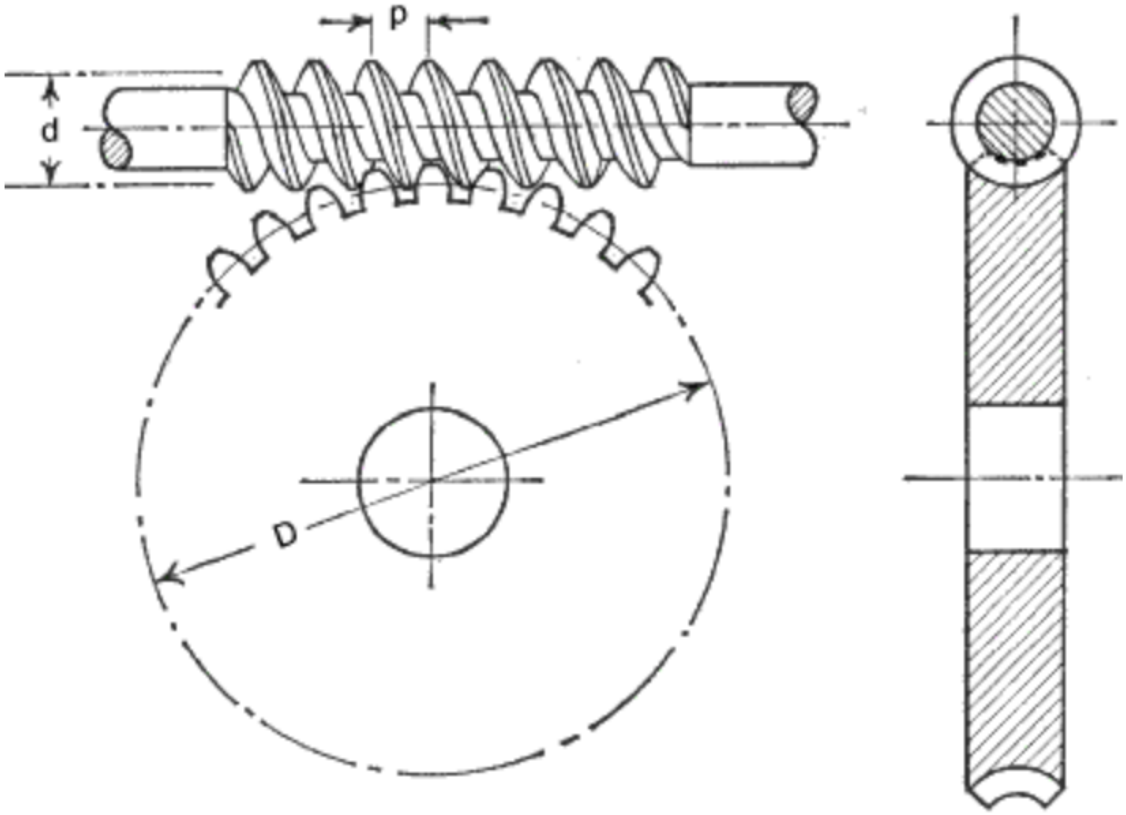
- Advantages of the worm gear include: Self-locking, space efficiency, good meshing effectiveness, can be used to reduce speed and increase torque, and potential for high velocity ratio of the order of 100 to be obtained in a single step.

- Some disadvantages of the worm gear include: Expensive materials, high power losses, potential for considerable sliding action (results in low efficiency), and heat production. [1]

- A worm drive consists of a large diameter worm wheel with a perpendicular worm screw. As the worm is rotated, the worm wheel rotates due to the screw like action of the worm. **The size of the worm gear set is usually based on the distance between the center of the worm and the worm wheel.**

- Single enveloping gear sets require accurate alignment of the worm wheel to ensure full line tooth contact

- A double enveloping gear set option would have nearly zero capability for backlash (see research on Openstage design) and would increase the shelf life of the mechanism, but would be a lot more difficult to fabricate and set up.



- The efficiency of a worm gear increases with lower gear ratios.

- The worm box MUST be designed to disperse heat and the mechanism requires lubrication. (Note: not sure whether this bullet will relate specifically to the design that we have given that the mechanism will not be experiencing any extreme loads.)

- The worm gear action is a sliding action which results in significant frictional losses. However, this is a much more important consideration when coming up with material combinations for gear boxes experiencing comparatively heavy loads. [2]

Citations:

[1] https://www.green-mechanic.com/2014/05/advantages-and-disadvantages-of_7.html

[2] https://roymech.org/Useful_Tables/Drive/Worm_Gears.html

Conclusions/action items:

The goal of this research was to understand the mechanism of a worm gear setup better. Although many of the advantages and disadvantages listed above likely won't apply to the microscope, they are good things to keep in mind when we start fabricating the prototype.

12/5/21 Fabrication Documentation - Top View of Gear Setup

Caitriona Treacy - Dec 14, 2021, 7:54 PM CST

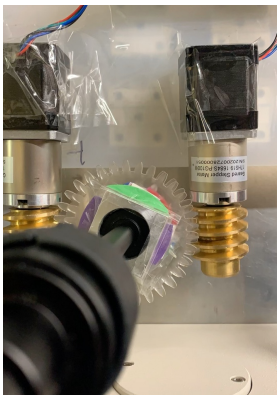
Title: Fabrication Documentation - Top View of Gear Setup

Date: 5 December 2021

Content by: Caitriona Treacy

Goals: Document fabrication progress and provide another view of how the mechanism is assembled.

Content:



Description: Figure shows picture taken from the top of the microscope arm containing the two manual control knobs that hangs off of the side of the Nikon Eclipse Ti-U. A clear laser-cut gear has been fastened to each manual control knob using the metal gear holders from last semester's team. Each of the stepper motors on either side of the manual knob arm meshes with one of these laser cut gears, one controlling the x-directional knob and one controlling the y-directional knob.

Conclusions/action items: This is the setup that the team kept intact for the final prototype. The top view provides a more clear image of how the assembly works together to form the entire mechanism.

11/30/21 Caitriona Treacy Training Documentation

Caitriona Treacy - Dec 14, 2021, 9:18 PM CST

Title: Training Documentation

Date: 11/30/21

Content by: Caitriona Treacy

Goals:

To document my training and certifications.

Content:

You have the following permits and upgrades:

Name	Date
Lab Orientation	03/24/2021

Link to training website: https://apps.research.wisc.edu/TILT

Zaber X-ADR-AE stage

Alex NADOLSKI - Oct 19, 2021, 11:59 PM CDT

Title: Zaber X-ADR-AE stage

Date: 10/16/21

Content by: Alex Nadolski

Goals: Research a competing design.

Content:

- Comes with a built-in controller

- Integrates with imaging software easily

- Fully programmable library

- Takes up a relatively little amount of space

-Specifications:

Built-in Controller	Yes	
Accuracy (unidirectional)	5 µm	0.000197"
Repeatability	< 0.5 µm	< 0.000020"
Minimum Incremental Move	50 nm	
Maximum Speed	750 mm/s	29.528"/s
Minimum Speed	0.61 nm/s	
Speed Resolution	0.61 nm/s	
Encoder Type	Linear analog encoder	
Encoder Count Size	1 nm	
Peak Thrust	20 N	4.5 lb
Maximum Continuous Thrust	13 N	2.9 lb
Communication Interface	RS-232	
Communication Protocol	Zaber ASCII (Default)	
Maximum Cantilever Load	500 N·cm	708.1 oz·in
Guide Type	Crossed-Roller Bearing	
Pitch	0.025°	0.436 mrad
Yaw	0.01°	0.174 mrad
Maximum Current Draw	2300 mA	
Power Supply	24-48 VDC	
Motor Type	Moving Magnet Track Linear Motor	
Force Constant	5.5 N/A	1.2 lbs/A
Data Cable Connection	Locking 4-pin M8	
Limit or Home Sensing	Optical Index Mark	
Axes of Motion	2	

LED Indicators	Yes	
Mounting Interface	Separate mounting adaptors available	
Operating Temperature Range	0 to 50 °C	
Vacuum Compatible	No	
RoHS Compliant	Yes	
CE Compliant	Yes	
Digital Input	1	
Digital Output	2	

[1]

Citations:

Zaber.com. 2021. *Zaber Technologies*. [online] Available at: <https://www.zaber.com/products/scanning-microscope-stages/X-ADR-AE/specs> [Accessed 20 October 2021].

Conclusion / Action Items: Very well built and sleek design. Moving parts are hidden in the build itself which is an idea worth considering. The price and complications of the device are extreme.

10/12/21 Nikon Elements Software

Alex NADOLSKI - Oct 19, 2021, 11:36 PM CDT

Alex NADOLSKI - Oct 19, 2021, 11:57 PM CDT

Title: Nikon NIS-Elements Software

Date: 10/12/21

Content by: Alex Nadolski

Goals: Familiarize with the program the client prefers.

Content:

- The system is being upgraded constantly in order to keep up with research standards

- interfaces with many different devices in order to produce results

- system can be fine-tuned in order to meet specific standards

- capable of image stitching and 3d-rendering

- useful for many small scale biology applications

- advanced systems may have the ability to object track

Citations:

Nikon Instruments Inc. 2021. *NIS-Elements | NIS-Elements Advanced Research*. [online] Available at: <https://www.microscope.healthcare.nikon.com/products/software/nis-elements/nis-elements-advanced-research> [Accessed 20 October 2021].

Conclusion / Action Items: Our device may have an initial barrier to being able to interface with the software, but after that barrier, our device can perform much more than basic functions.

11/20/21 Printing plastic

Alex NADOLSKI - Dec 14, 2021, 11:48 PM CST

Title: Printing Plastic

Date: 11/20/21

Content by: Alex Nadolski

Goals: Determine the best plastic to use for the required part in the assembly

Content:

There are a variety of options for 3D printing plastics that would suit my needs. PLA is high strength and does not warp after the print has finished. The material is also biodegradable, which allows for some environmentally conscious considerations. It does tend to warp while in contact with water, which may cause an issue in a lab environment if water is spilled on it, but it is not a high concern.

CPE+ is another option available in the maker space, which is a possible option. The CPE+ is very chemically resistant and durable, allowing for some abuse without breaking the part. The chemical resistance is also ideal for a lab setting when the device may be accidentally spilled on, which would cause damage in the long-term use.

[1]“3D Printing Materials Guide: Plastics,” 3Dnatives, Jun. 08, 2020. https://www.3dnatives.com/en/plastics-used-3d-printing110420174/#.

[2]“Ultimaker CPE+ material: 3D print tough and functional prototypes,” ultimaker.com. https://ultimaker.com/materials/cpe-plus (accessed Dec. 15, 2021).

Conclusion:

CPE+ is likely the best option due to its high chemical resistance and durability in use.

10-16-21 Stepper Motor research

Alex NADOLSKI - Oct 19, 2021, 7:39 PM CDT

Alex NADOLSKI - Oct 20, 2021, 12:00 AM CDT

Title: Stepper motor research

Date: 16 October 2021

Content by: Alex Nadolski

Goals: Determine the application of stepper motors and their potential use in the design.

Content:

- stepper motors have the capability of small incremented movements while maintaining power

- has equal capability to move in quick succession by alternating magnetic pulses quickly. Speed also depends on the type of stepper motor

- Has more capability for precision than a servo motor

-Often cost more due to more complex wiring and more involved manufacturing process

Citations:

ElProCus - Electronic Projects for Engineering Students. 2021. *Stepper Motor : Construction, Working, Types and Its Applications*. [online] Available at: <https://www.elprocus.com/stepper-motor-types-advantages-applications/> [Accessed 20 October 2021].

Conclusion: The stepper motor is a very good fit for our project and is capable of maintaining the high degree of precision required to properly maneuver the microscope

10-18-21 Worm Drive Research

Alex NADOLSKI - Oct 20, 2021, 12:02 AM CDT

Title: Worm Drive Research

Date: 18 October 2021

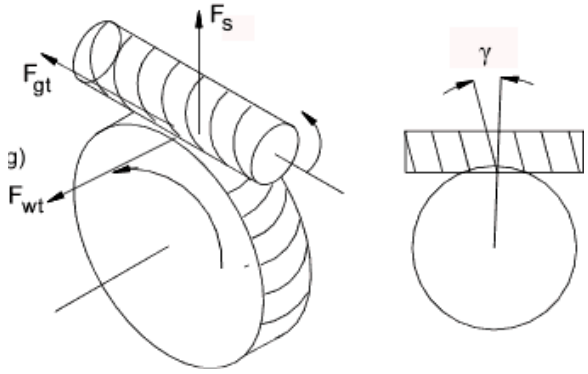
Content by: Alex Nadolski

Goals: Determine the functionality of the worm drive and potential use in the design.

-Worm Drive gears have the ability to mitigate the issue of translation in the Y direction

- The worm gears have increased friction compared to standard gears due to increased surface contact between the worm gear and moving worm wheel.

- The speed is also compromised due to the friction, but this is irrelevant to the final design as speed is not a factor of product success.



Citations:

Roymech.org. 2021. *Worm Gears - Roy Mech*. [online] Available at: <https://roymech.org/Useful_Tables/Drive/Worm_Gears.html> [Accessed 20 October 2021].

Conclusion / Action Items: This mechanism would work very well for our system due to its precision. Some of the downfalls are also mitigated due to the scale and potential load of the microscope.

11-15-21 Potential worm drive purchases

Alex NADOLSKI - Dec 07, 20

Title: Worm Drive Research

Date: 15 November 2021

Content by: Alex Nadolski

Goals: determine options for purchasing or printing worm drive gears

Content:

Potential purchase links

https://www.ebay.com/itm/303977543313?chn=ps&_trkparms=ispr%3D1&amdata=enc%3A1_En9hW0_T9ytU1AlEwox2Q76&norover=1&mkevt=1&mkrid=711-21372
0&mkcid=2&itemid=303977543313&targetid=4580702890871448&device=c&mktype=&googleloc=&poi=&campaignid=418640321&mkgroupid=1233652283797640
4580702890871448&abcId=9300602&merchantid=51291&msclkid=5448746951d4157af04c15d95e7206d4

https://www.gobilda.com/2308-series-stainless-steel-mod-1-5-d-bore-set-screw-worm-6mm-bore-39mm-length/

https://www.kitchenrestock.com/allpoints-26-4004-gear-brass-worm-main-shaft-brass-worm-gear-1-7-16-dia-od-x-5-8-id-x-1-3-4-long-has-2-set-screws-
model-n-7.html?gclid=Cj0KCQjwrJOMBhCZARIsAGEd4VG1O4FfuptVcZK8yC_KiH6fTSPYAYSQ4MH0UegaHeqLIK7Qzu-XccwaAgddEALw_wcB

potential methods of design:

https://www.ondrivesus.com/documents/categories/gears-worm-wheel-WG.pdf

Conclusion: Purchasing the worm drive gears would be much easier than designing and machining ones. This would also save time and resources that ca
elsewhere.

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

Nate Burkard - Dec 14, 2021, 8:16 PM CST

Title:

Date:

Content by:

Present:

Goals:

Content:

Conclusions/action items: