Department of
Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

Microscope Low Cost Motorized Stage

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Presentation Overview

- Problem Statement
- Background Information
- Product Design Specifications
- Preliminary Designs
- Design Matrices
- Future Work
- References and Acknowledgements

Problem Statement

- Creation of a device to motorize and automate the inverted fluorescence microscopes in the BME teaching lab.
- Fabrication of replicates must be possible within a $100 budget.
- This device must be controllable by entering coordinates or moving a joystick, and must include image stitching capabilities.

Background

- Microscope set up:
    - Nikon Eclipse TI-U
    - Olympus IX71
    - hanging X and Y control knobs
- All available motorized models are:
    - expensive
    - require stage alteration/replacement
- The current microscopes do interface with Nikon elements software, but do not possess image sequencing capabilities.

Figure 1: Nikon TI-U Microscope [1].

Figure 2: Olympus IX71 microscope set up [1].

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Competing Designs- Julia

- OpenFlexture project - open source
    - Open source
    - 3D printed microscope and stage
    - sub-micron (<0.1 μm) mechanical positioning
    - Approximately $200 [1].
- ASR series motorized XY microscope stages by Zaber [2]. - market available
    - rebuild/replace stage
    - accurate with in 12 μm
    - cost between $5,000-$9,000
- open source 3D printed inverted fluorescence microscope stage.
    - Accuracy:
        - X- (5.1 ± 1.8 μm; −4.9 ± 1.9 μm)
        - Y- (3.5 ± 2.2 μm; −5.0 ± 1.1 μm)
    - includes all materials list, instructions, software and CAD files [3].
    - altered existing stage

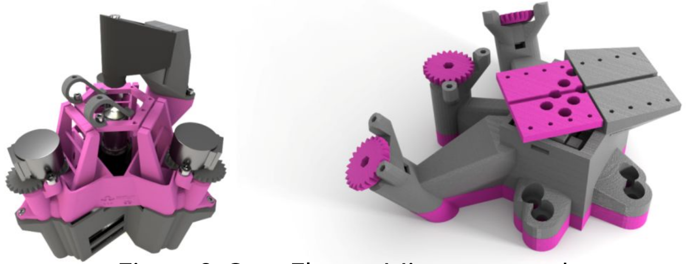

Figure 3: OpenFlexure Microscope and motorized stage [1].

Figure 4: Zaber's ASR series motorized XY microscope stages [2].

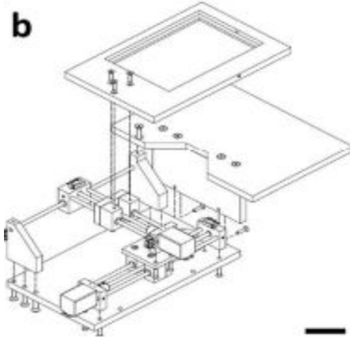

Figure 5: Open source 3D printed motorized positioning stage for automated high-content screening microscopy [3].

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Product Design Specifications

Performance

- The device should adjust the stage in the x and y directions
- The device should be controllable by arrow keys or integrated joystick
- Accuracy to 1μm
- Withstand many rotations

Size/ Mechanical Integration

- Should not interfere with movement of microscope stage
- Preferably attached to the microscope
- Take up little to no space next to microscope

Cost

- Should be affordable
- Total Cost Under $100

Materials

- 3D Printed and laser cut
- Gear materials should be able to withstand friction and heat
- Material should not deform under torque or pressure

Spur Gear Design

- Attaches directly to the stage
- Reduce Size of device and space it occupies on the countertop
- One motor per control knob
- Spur Gears attached to control knobs
- Interacts with control surface already present

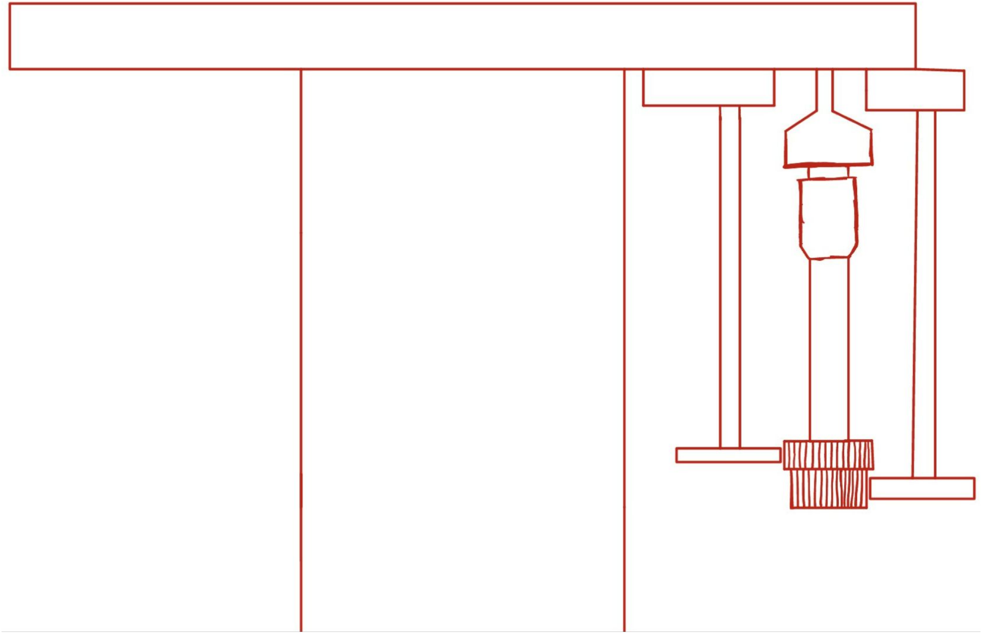

Figure 6: A front view of the Spur Gear Design

Worm Drive Design

- Tower containing stacked stepper motors-reduce space
- Worm gears extend from motors to spur gears mounted on control knobs
- Includes screw thread locations in 3d print file-stability/strength

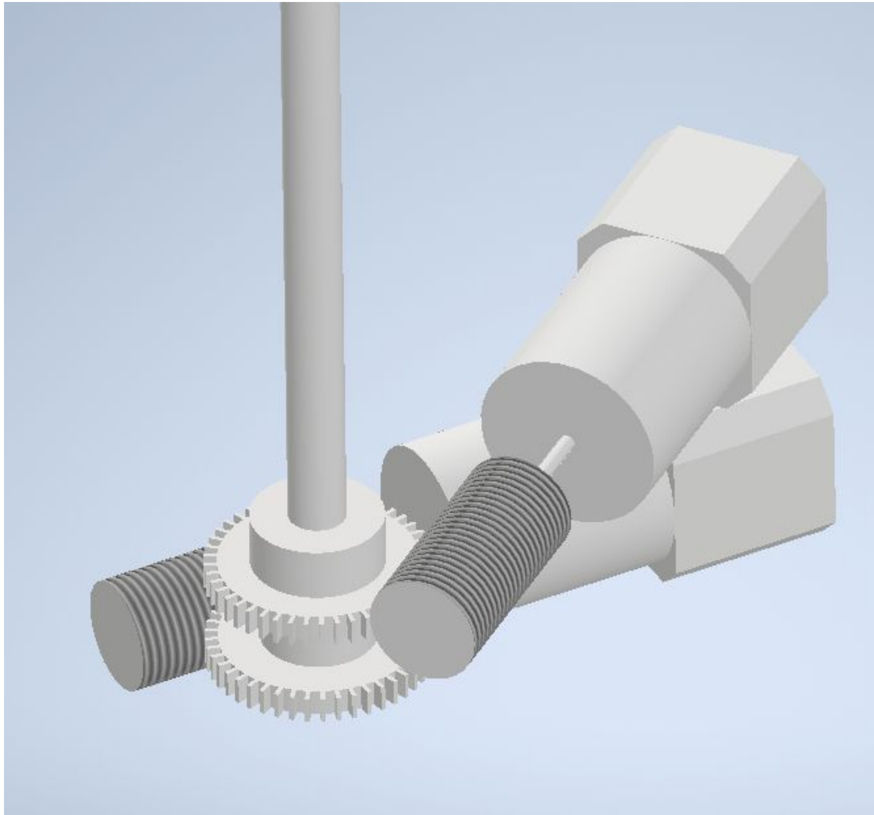

Figure 7: The Worm Gear Design.

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Linear Rails Design

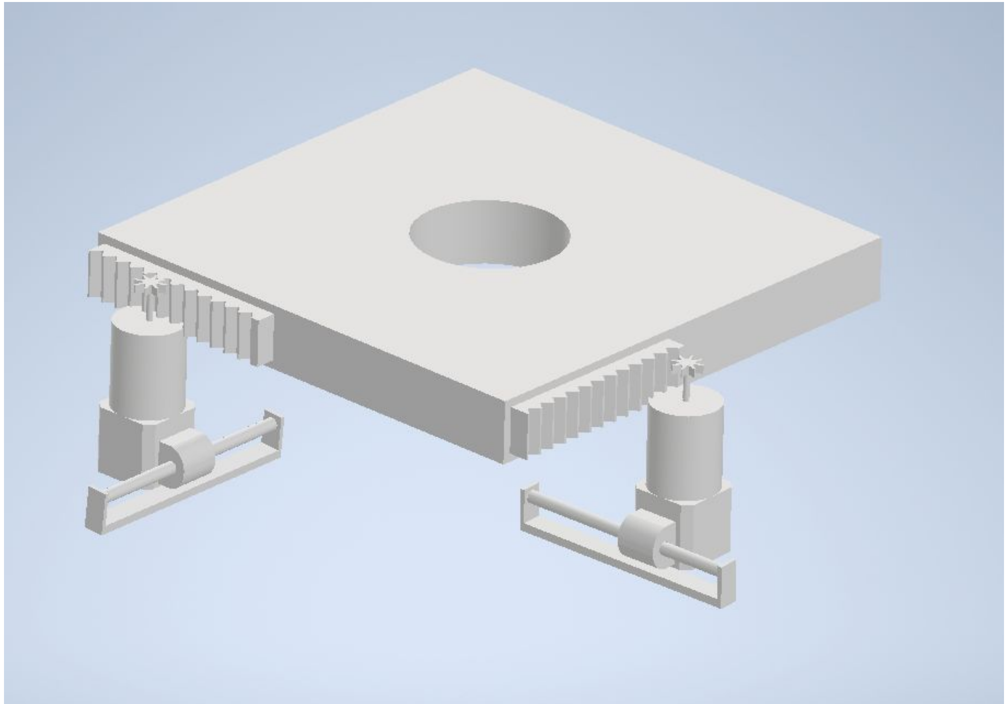
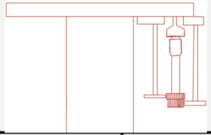
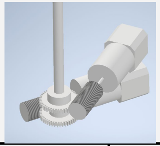
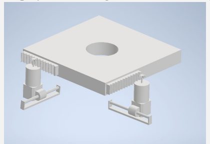


Figure 8: The Linear Gear Design.

- Not attached to manual knob
- More complicated design
- A lot of unknowns

Design Matrix

Table 1: Design matrix for the evaluation of 3 proposed designs.

Design Categories (Weight)	**Design 1: Spur Gears** 		**Design 2: Worm Drive** 		**Design 3: Linear Rails** 	
Performance (30)	4/5	24	3/5	18	5/5	30
Cost (20)	4/5	16	3/5	12	3/5	12
Mechanical Integration (17.5)	5/5	17.5	4/5	14	2/5	7
Ease of Fabrication (15)	4/5	12	4/5	12	3/5	9
Size (12.5)	5/5	12.5	3/5	7.5	4/5	12.5
Safety (5)	4/5	4	4/5	4	5/5	5
Total Points:	86		67.5		75.5	

Future Work

- Finalize Spur Gear Design
  - number of gears
  - size of gears
- Fabrication
- Software development
  - allow users to input coordinates
  - image stitching
  - user interface
- Prototyping and testing
  - Accuracy/Resolution of movements

Figure 9: Image stitching example [5].

Acknowledgements

- Dr. Joshua Brockman, UW-Madison, Department of Biomedical Engineering
- Dr. John Puccinelli, UW-Madison, Department of Biomedical Engineering

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References:

Questions?