Microscope Low-Cost Motorized Stage Product Design Specifications

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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.

Design Requirements:

1. **Physical and Operational Characteristics:**

    a. *Performance Requirements:* The product must be able to automatically take pictures, and stitch them together. This device will be used often, and should be easy to put on and remove as an attachment. Should be powered by a wall outlet, but needs to have a switch to turn the device off. The device should be able to take images and stitch it in a 30 minute cycle.

    b. *Safety:* It is important for the team to keep moving elements of the stage enclosed, such as gears. Additionally, it is vital that any high-voltage elements be insulated and well organized, as to not cause any danger to the user.

    c. *Accuracy and Reliability:* The stage should have an ideal movement resolution of around 1 um. The client specifically requested that the stage have a resolution between 1 and 10 um. Cannot drift during imaging cycles to prevent faulty imaging.

    d. *Life in Service:* The microscope stage should be able to be used for as long as the microscope is in use. Since the microscopes have never had to be replaced in the past, the goal for our shelf life would be forever. A quantifiable goal would be at least 20 years of quality use.

    e. *Shelf Life:* When not in use, the device should be stored at room temperature and in a dry environment. The device will not require batteries as it will use standard wall power to run.

    f. *Operating Environment:* This device should be able to withstand similar temperatures to the microscope at 0℃-40℃ and less than 60% Humidity [1]. The device will be used inside where it will spend most time at room temperature, so it does not need to withstand a fluctuating temperature or environment.

    g. *Ergonomics:* The mechanical elements should not be able to be manipulated manually and should only be controlled using the provided controller or designed software.

    h. *Size:* Should be able to be easily attached and removed and should not inhibit the movement of the stage in any direction. If we decide to replace the current stage plates, the new plates must not be taller than the current plates, otherwise the inverted fluorescent microscope will be inaccurate.

    i. *Weight:* The weight of the stage should be small enough that it does not affect the balance or the mechanical properties of the microscope.

    j. *Material:* There are not any restrictions, however typically light weight aluminum is used. Given the emphasis on keeping costs low, finding a material that functions well while also minimizing overall costs will be beneficial.

k. *Aesthetics:* Stage should be black in color, so it does not reflect light from the inverted fluorescence microscope. Stage should not be too bulky, as it needs to be able to be used practically with a classroom.

2. **Production Characteristics:**

   a. *Quantity:* The client wants us to aim for an end goal of two units since there are two similar microscopes in the teaching lab, but he would be happy if we made one as long as it is functioning as desired.

   b. *Target Product Cost:* The product must be less than $100. Client stated if necessary the group could go slightly over the target product cost, but does not expect this to be necessary.

3. **Miscellaneous:**

   a. *Standards and Specifications:* Microscope stages do not need FDA approval as they are device class 1, which makes them exempt [2]. Nikon Ti-U Inverted Fluorescence Phase Contrast Microscope Pred Ti2 is the microscope that we will be using. Standard microscope safety procedures should not be compromised by the product.

   b. *Customer:* Our customer would like us to have our design able to be controlled by a joystick as well as a computer program that can operate independently.

   c. *Patient-related concerns:* Needs to be intuitive so that students who use the teaching lab will be able to use it for years to come. With the ongoing pandemic, the device needs to be able to be easily cleaned.

   d. *Competition:* A couple of companies are selling work that is similar to our own. One of these companies is Zaber [3]. Some other companies doing this type of work are Prior Scientific [4] and Echo [5].

Works Cited: IEEE format

[1] "ECLIPSE Ti2 SERIES: SPECIFICATIONS," *Nikon Instruments Inc.* [Online]. Available: https://www.microscope.healthcare.nikon.com/products/inverted-microscopes/eclipse-ti2-series/specifications. [Accessed: 22-Sep-2021].

[2] “Product classification,” *accessdata.fda.gov*, 20-Sep-2021. [Online]. Available: https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpcd/classification.cfm?id=5177. [Accessed: 24-Sep-2021].

[3] *Zaber Technologies*. [Online]. Available: https://www.zaber.com/products/scanning-microscope-stages?gclid=Cj0KCQjwqKuKBhCxARIsACf4XuFgEuegCULlyzycG19HIr-bf7WOgpQ68wCHPqkBGRQRDXsFb2vVrIkaAlLpEALw_wcB. [Accessed: 23-Sep-2021].

[4] “Microscope motorized stages, XY stages, precision stages,” *Prior Scientific*. [Online]. Available: https://www.prior.com/product-category/motorized-stages?gclid=Cj0KCQjw1ouKBhC5ARIsAHXNMI9_AsBqKR83FdP0QIOnJo6ztnDI9AJOTtT2zUPyAKtAoAT4fysqFrsaAqnMEALw_wcB. [Accessed: 24-Sep-2021].

[5] “Redefining microscopy for life science research,” *Discover Echo*. [Online]. Available: https://discover-echo.com/?utm_source=google&utm_medium=search&utm_campaign=11380688541&utm_term=motorized+microscope+stage&utm_content=505993872680&gclid=Cj0KCQjw1ouKBhC5ARIsAHXNMI_3xPRL8j0lS98sKdirvi69QyfNvPLfS-GGZ8iVymvGb_l_qPeDi7caAgf1EALw_wcB#headerAnchor. [Accessed: 24-Sep-2021].