Microscope Slide Scanner

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Abstract

- Commercial slide scanners are available but expensive.
- There is need for a cost effective option
- The proposed design uses stepper motors to automate a microscope stage and stitching software to create whole slide images
- The pictures must be of high resolution and scan time must be shortened
- Final design consists of stepper motors and belts used to turn the knobs of a microscope to automatically move the stage
- Aruino code is used to move the stage on the desired path

Problem Statement

- Tasked with finding a more efficient or accurate way to scan microscope slides using digital scanning
- Clients current scanner is time consuming and has low quality images
- Updated scanner should improve image quality
- Reduce the time it takes to scan one slide
- Device must be easily adapted into the lab, taking minimal extra space.

Background

- Client works in a cytology lab
- Current slide scanner is time consuming and produces low quality images
- The lab needs higher quality images that show the nucleus of cells for teaching and diagnostic purposes
- Client has access to a microscope/camera that is used in the lab to capture high quality images.
- Slide scanners work by taking multiple images of a slide at high resolution and stitching them together [2]

Figure 1: Lika CS2 Scanner [1]

Design Criteria

- 10 - 15 minute per scan
- Clear images/proper stitching
- No interference or damage caused to the slide
- Must work until a new scanner can be purchased
- Scanner must not interfere with other equipment in the lab
- Follow FDA safety guidelines regarding medical related devices
- Software used to store images must be able to keep scanned slides confidential to those with approved access
- No capital purchase over $5000

Final Design

Final Design Summary

- Stepper motors and belts used to mechanically turn the knobs of microscope stage, moving the stage in the x and y directions
- Brackets used to attach stepper motors to stage
- ToupTek and µManager used to automate stage movement and image collection
- ImageJ used to stitch images together

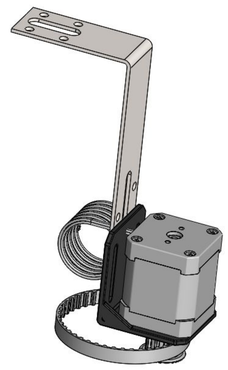

Figure 2: Mounting Device for Stepper Motors

Figure 3: Fully Assembled Final Prototype

Circuits Summary

- Two stepper motors are attached to drivers to control the x and y axis
- The drivers are connected to 12V of power and to an arduino
- The arduino controls the movement of each stepper motor
- The code allows each motor to turn ⅛ of a revolution to allow for overlap

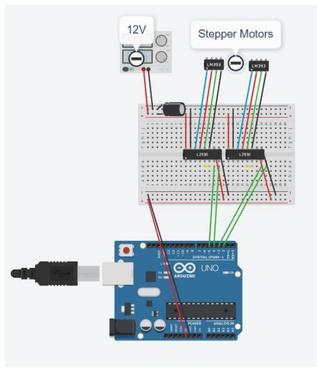

Figure 4: Circuit Diagram

Testing

- Picture overlap test:
  - A slide was allowed to run under the microscope and the amount each stepper motor needed to turn was calculated through observation to allow for approximately 20% of overlap on each edge of the frame
- ImageJ test:
  - A picture of a cytology slide was cropped and stitched back together with different amounts of overlap using ImageJ
  - The stitched photos achieved higher similarity to the original the more overlap was present

Figure 5: Test 2 Stitched Image without Overlap

Figure 6: Test 1 Stitched Image without Overlap

Results

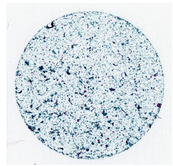

Figure 7: Test 1 Stitched Image with Overlap

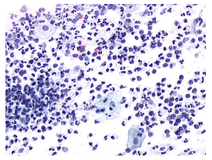

Figure 8: Test 2 Stitched Image with Overlap

Overlap:Similarity
Test 1:
- 20%: 0.9931
- 10%: 0.9928

Test 2:
- 20%: 0.9722
- 10%: 0.7740

Discussion

- Stepper motors were successfully mounted onto microscope stage and retain belt tension
- Final code allows for movement in the x and y directions across the whole microscope slide
- Unable to accomplish automated image stitching
- Issues occurred with integrating multiple softwares
- Improvements could be made to durability and structural integrity of fully assembled prototype

Future Work

- Connecting the motors with µManager
- Integrate ToupTek with µManager
- Customize ramps controller board to connect with µManager
- Perform testing on image stitching accuracy
- Perform testing on stepper motor accuracy
- Test usability with multiple computers and clients
- Edit arduino code to specifics for microscope slides
- Improve Design:
  - Find new means to attach mounting devices
  - Attach end stops
  - Determine more efficient way to capture photos

Acknowledgements

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References

[1] "APERIOCS2 Highly Reliable, Desktop Digital Pathology Scanner." Accessed: Oct. 03, 2024. [Online]. Available: https://www.leicabiosystems.com/sites/default/files/media_product-download/2023-03/Brochure_-_Aperio_CS2_Desktop_Scanner_-_EN%20_95.14550_Rev._A.pdf

[2] "Image upscaling: A comprehensive guide to classical and Ai Techniques," Uni Matrix Zero, https://unimatrixz.com/topics/ai-upscaler/upscaling-methods/ (accessed Oct. 3, 2024).