Executive Summary

The purpose of this project was to create a low cost, high precision stage capable of XYZ directional movement along with a functional user interface and image processing software. When paired with a microscope setup, the system was to allow a user to take high resolution images of computer chip surfaces. High-precision XYZ stages are currently available for purchase with the 10 micron accuracy that this project achieved. However, they cost upwards of $30,000. Therefore, the main gap that this project filled with respect to the mechanical stage itself is in the "low-cost" portion of the project. The typical user of this project would likely be a student without the resources or experience to operate such an expensive piece of equipment. Thus, fulfilling this project's purpose for under $300 solves the problem of availability in this domain.

The approach taken by the group was to first come up with an overall design and determine the necessary blocks of the system as well as break these pieces up among the different team members. It was decided that the project could be broken down into three main areas: mechanical design, user interface, and image processing. Since our group had three members, one of these major pieces was assigned to each group member.

The project partner, Dr. Vincent Immler, provided many necessary resources to get the project started. Specifically, he pointed the group towards an open-source Github repository which implemented a precise XY stage using 3D printed adapters and gears. Additionally, he provided physical components from this open-source project including a manual microscope stage, stepper-motors, a motor-control board, and some 3D printed parts. So, the initial phases of the project included working with these provided resources and determining the necessary steps to take.

During the build phase of the project, modifications were made to the 3D printed adapters/gears from the open-source project in order to make the motion smoother and allow for Z-axis motion. Additionally, custom mounts were designed to allow for fixing a precise dial gauge to the stage in order to calibrate the motor-control firmware. A PCB was created which implemented manual control knobs for moving the stage as well as limit switches for limiting the motion of the stage. A user-interface was designed using Python and Tkinter. Finally, open-source image stitching and focus stacking algorithms were integrated into the system to allow for the imaging process to take place.

Overall, the main lesson we learned as a team during the project was to always prioritize communication and make sure everyone is on the same page. Also, planning as far in advance as possible is always ideal.

Project Timeline