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Abstract

This MQP aims to develop a robotic system that collaborates with an existing SCARA-type arm to automate the loading and unloading of microplates in a conventional benchtop centrifuge. The arm can accurately pick and place microplates horizontally, but most centrifuges require either vertical insertion or deep placement in the rotor, rendering the existing arm insufficient for the task. This project will focus on designing an additional robotic mechanism that works with the arm to precisely and reliably load and unload plates into the centrifuge rotor.

Problem & Motivation

Problem

Modern lab centrifuge solutions are not robustly designed, bottlenecking automated labs

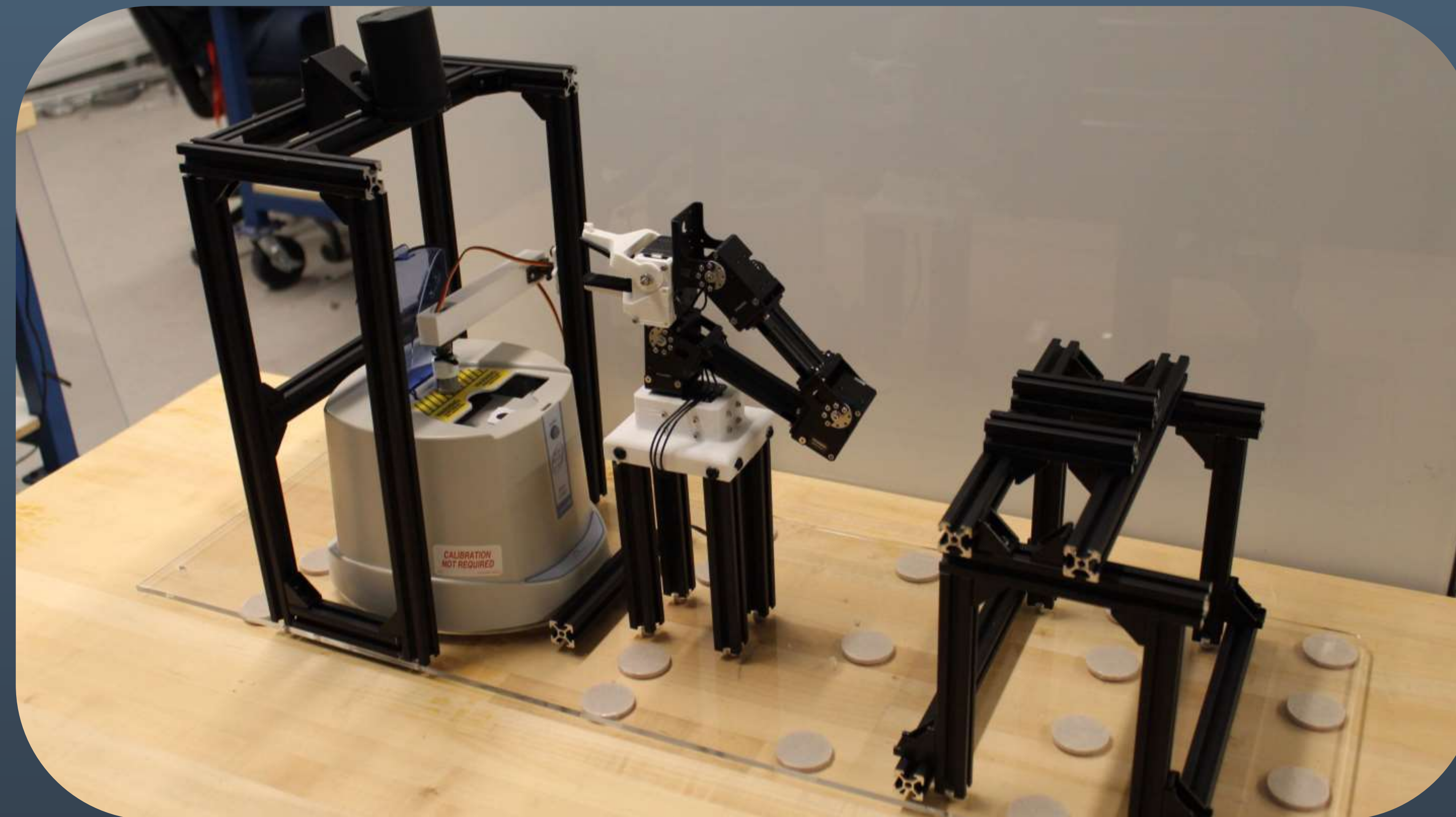
Existing solutions:

- Are expensive
- Lack available APIs
- Prioritize manual use

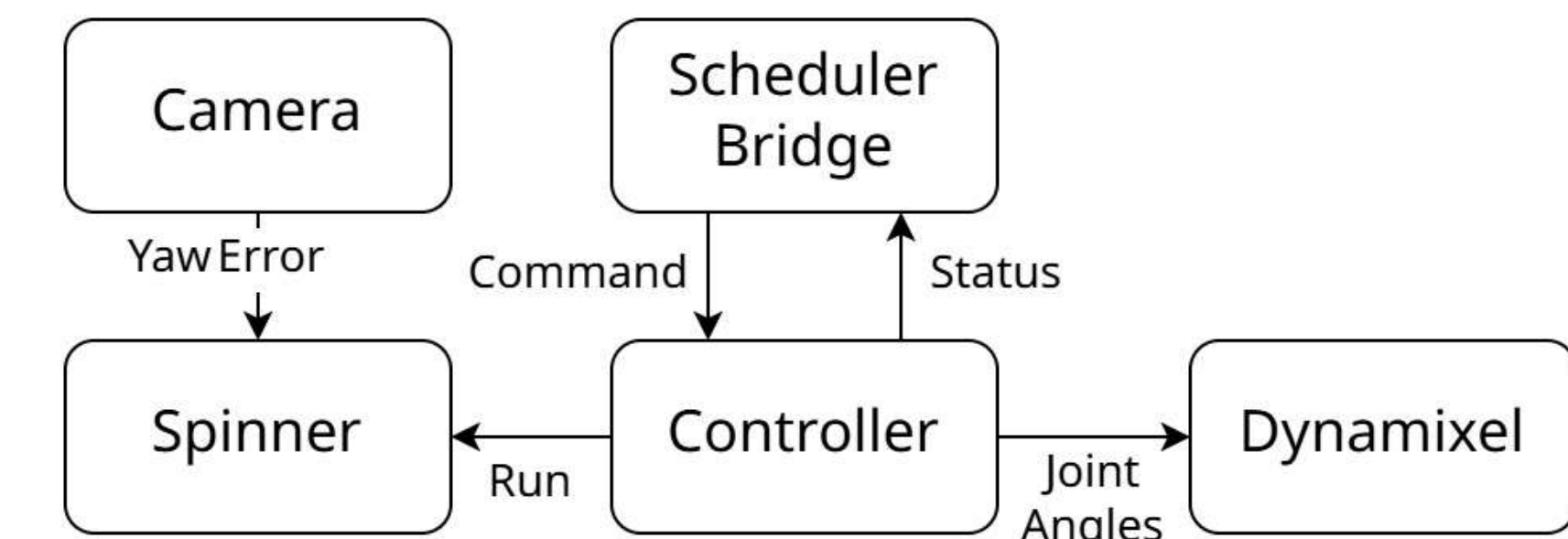


Motivation

- Achieve automation using existing centrifuges.
- Reduce cost and improve flexibility.
- Lower technical barriers for smaller automated labs.



Software Architecture



Main controller takes inputs from external scheduler and issues commands to the arm and alignment systems

Objectives

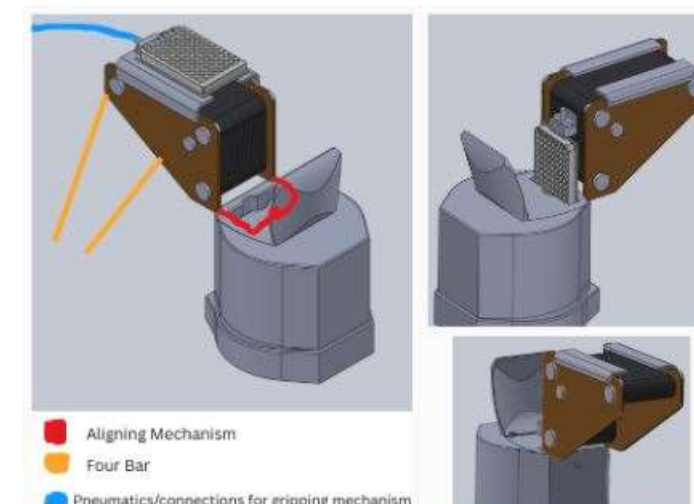
Requirements needed:

- Transport plates
- Activate and deactivate the centrifuge
- Allow connection to a PC via USB
- Present users with a simple, easy-to-use API
- Expose the API through a Web interface
- Detect and report imbalances to the user
- Ensure the safety of users through hardware and software safeguards
- Allow for easy assembly of the system through open sourcing of CAD and code

Validation and Future Recommendations

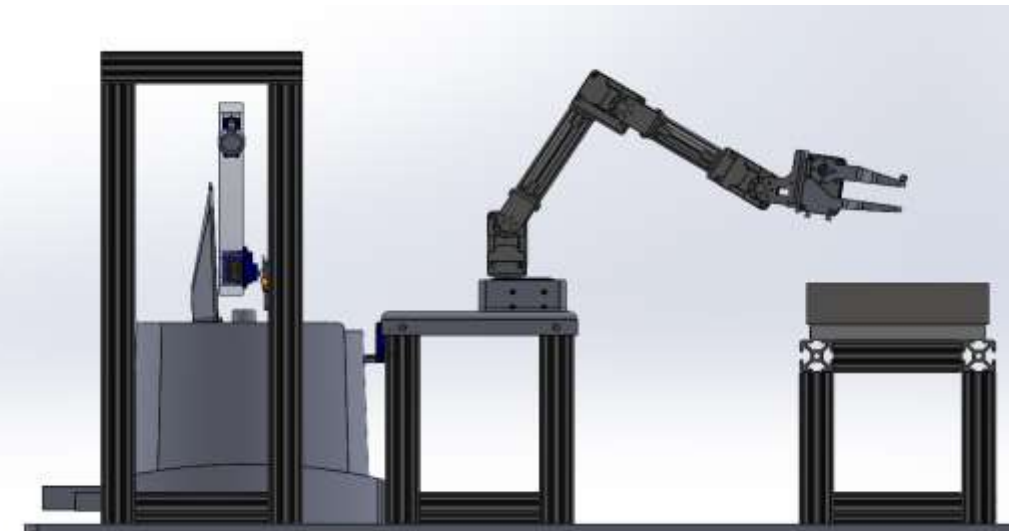
- Testing depends on completed runs and run time
- Recommend that an additional team carry on the MQP to test reliability and incorporate lab safety regulations

Mechanical Solutions



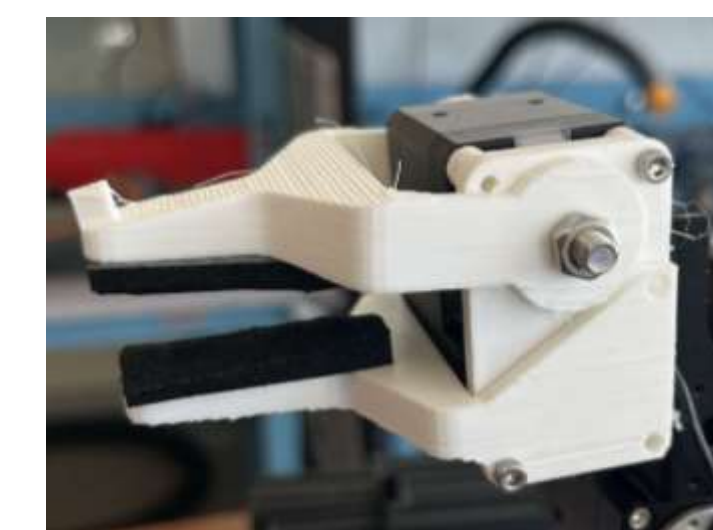
Design Iteration

The criteria for the final design focused on low complexity, affordability, and reliability. These factors drove every design choice in the process.



Final CAD Model

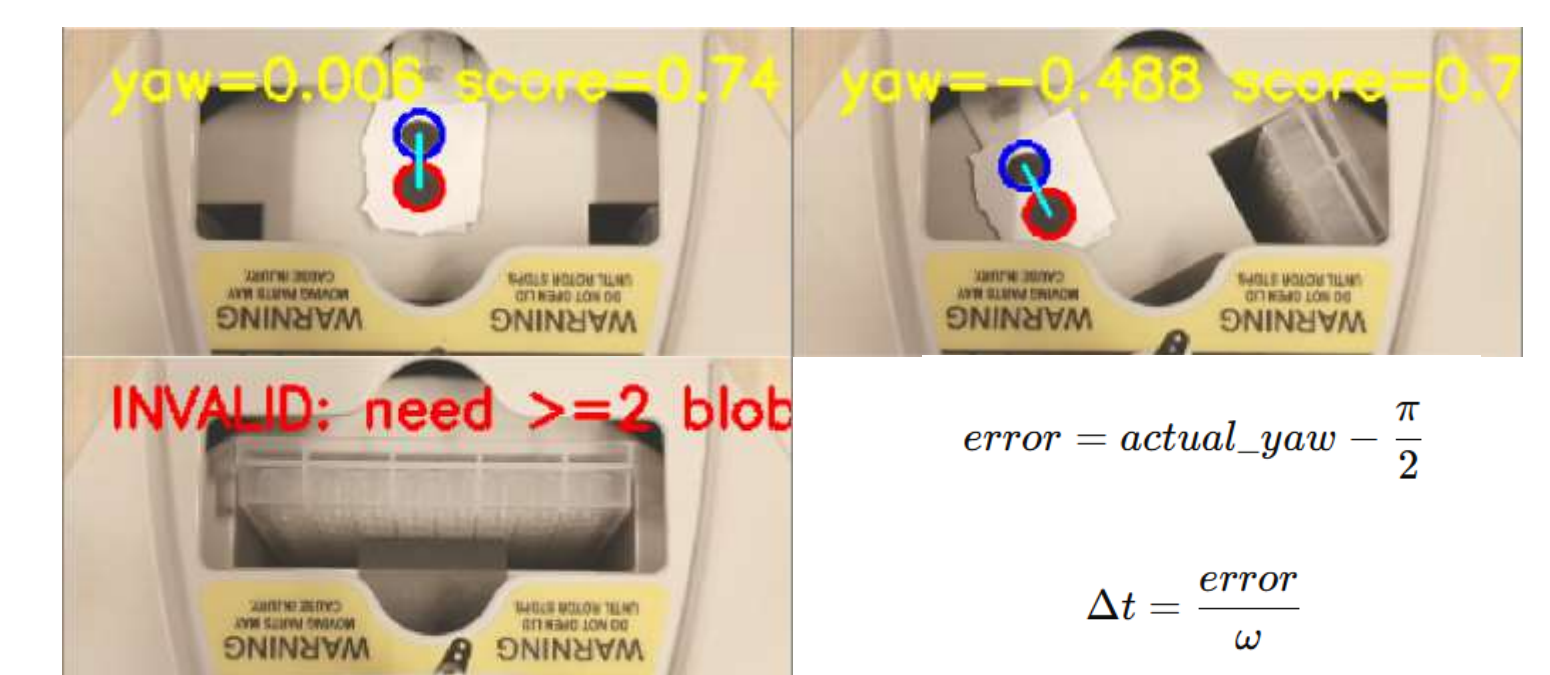
We designed a full system that included 4 parts, a gripper, a spinning mechanism, an arm, and a case. We also converted the centrifuge into a CAD model.



Customized Gripper

Redesigned to fit into the centrifuge and open the lid, the gripper uses motor and hardware from the kit gripper, minimizing additional costs.

Vision Processing



Arm Control

We used kinesthetic teaching to record primitive motions to perform pick, insert, button pressing, and lid open/closing.

