

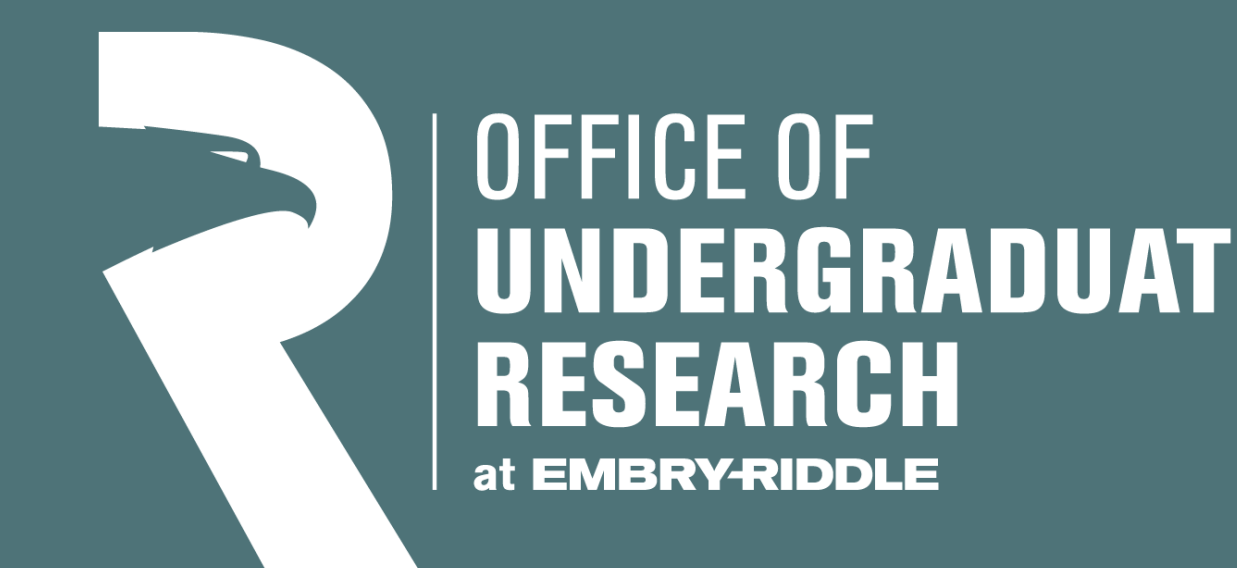


Development of a 3D Printed Clinostat

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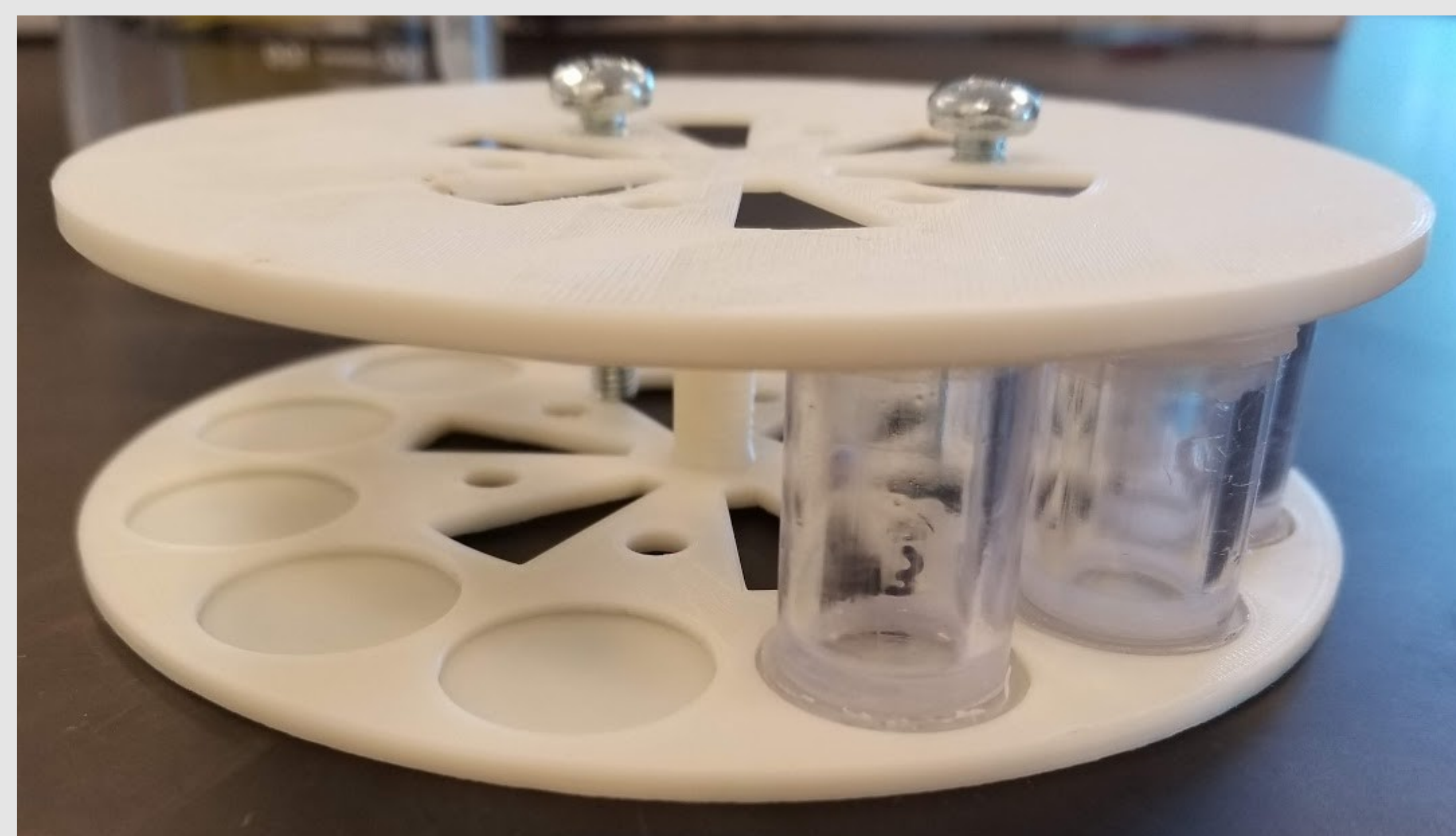
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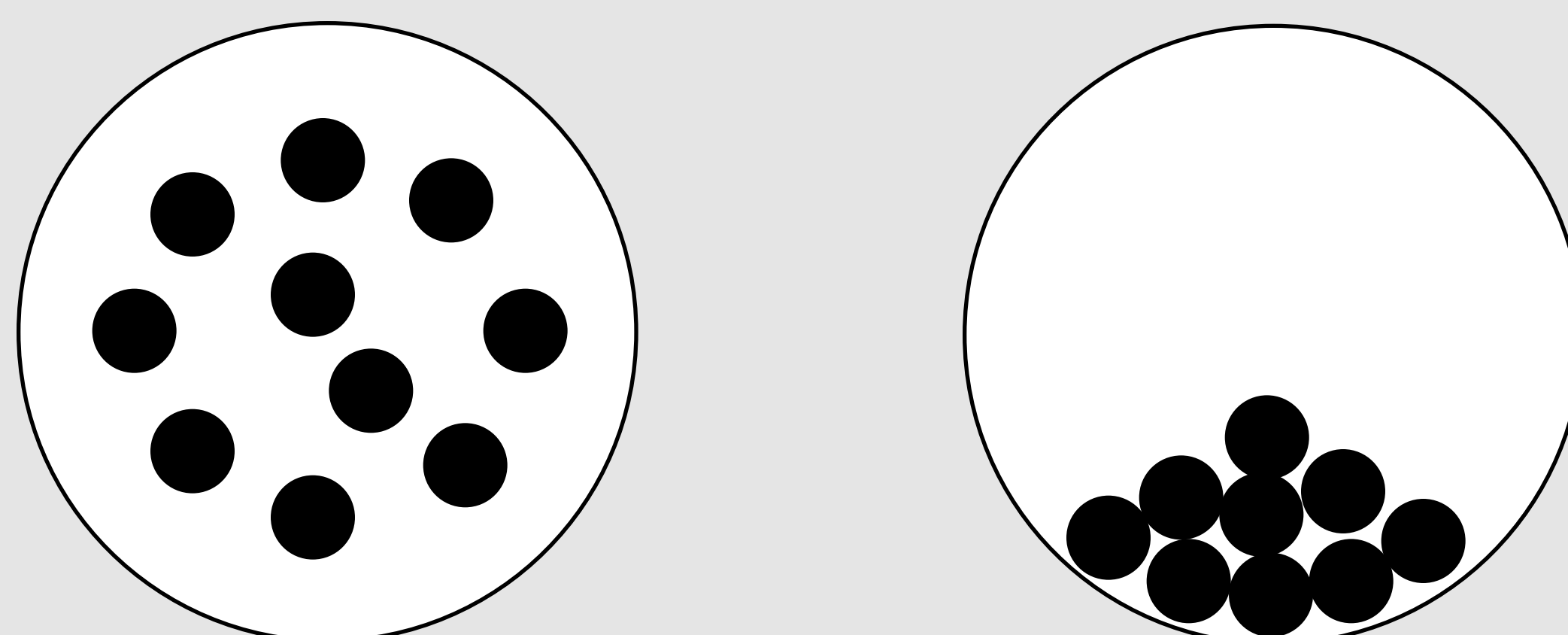


Iterative Process

- DC motors are very common and simple to use. They can also present learning experiences for beginners. The first DC motor selected was bulky and incapable of operating at a low RPM. A second DC motor was chosen for its low RPM rate but appeared to have gearing issues; causing rotation oscillations. The solution to this issue was changing to a stepper motor for its ease of use and ability to maintain an exact RPM.
- A motor controller is required to facilitate the Arduino's ability to command a motor. Originally, a circuit was designed for this purpose but could not function properly. A commercial version was purchased instead to alleviate this problem.
- By 3D printing the structure, parts can be easily adjusted. Initially, a sampling tube hold was developed for 1.5 mL Eppendorf tubes. For the upcoming research trials, small, custom, cylindrical containers are being used for samples. A new design was able to be quickly placed in CAD software and 3D printed to accommodate these new tubes.



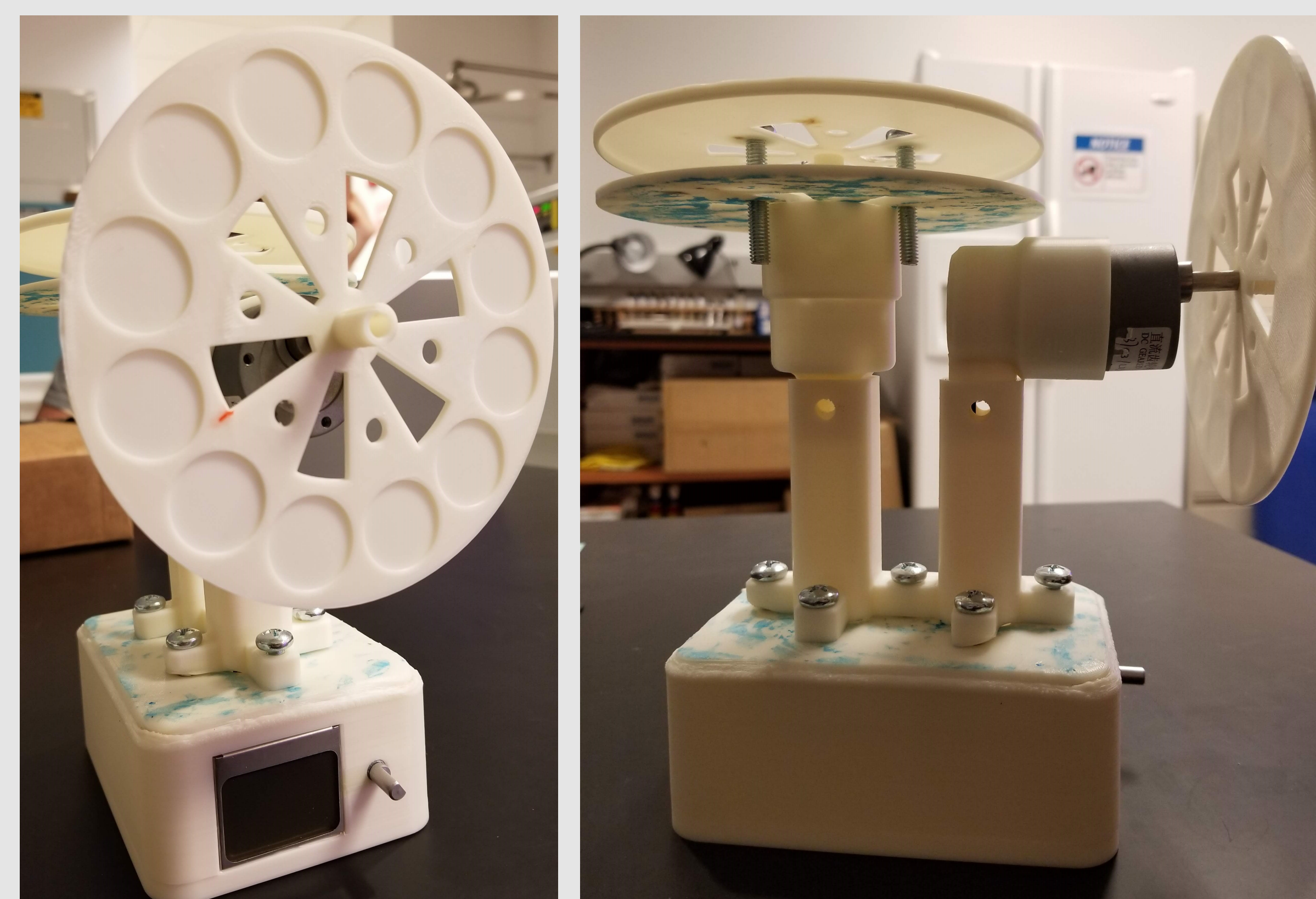
Cuvettes contained by platform



Suspended cells vs. Settled cells

Abstract

A largely unknown topic is how reduced gravity (hypogravity) effects organisms and their functionalities at a cellular level. A common method to conduct initial hypogravity testing is using a device known as a clinostat. Essentially, a culture of microorganisms or plant seeds can be placed at a specific radius perpendicular to the axis of rotation and rotated at a set Revolutions Per Minute (RPM) to simulate the experience of being in the lowered gravity environment. An issue with purchasing any commercial versions is the cost being very large for a customized system. To overcome this, multiple iterations have been developed to increasingly improve the system. Currently, the entire framework is 3D printed and manages to operate experimental and control conditions on one unit. Because of the flexibility of the design, customized parts are very easy to develop. This results in fast and low cost turnaround for new tube holders to account for any desired experiment. Future experiments will be conducted on *Arthrospira Platensis*, *Anabaena*, and varying plant seeds to estimate their viability in reduced gravity environments (e.g. Martian or Microgravity).



Cuvettes contained by platform

Electronic Systems

- Arduino is used for interpreting the user's demands into the motor's actions.
- An L298N motor driver allows for one stepper motor to function independently (Originally for using two DC motors).
- A stepper motor was introduced to ensure consistent rotation and a 10:1 step-down adapter can mitigate internal vibrations on samples.
- Nokia LCD screen and a clickable rotary encoder provide an interactive UI for RPM selection.

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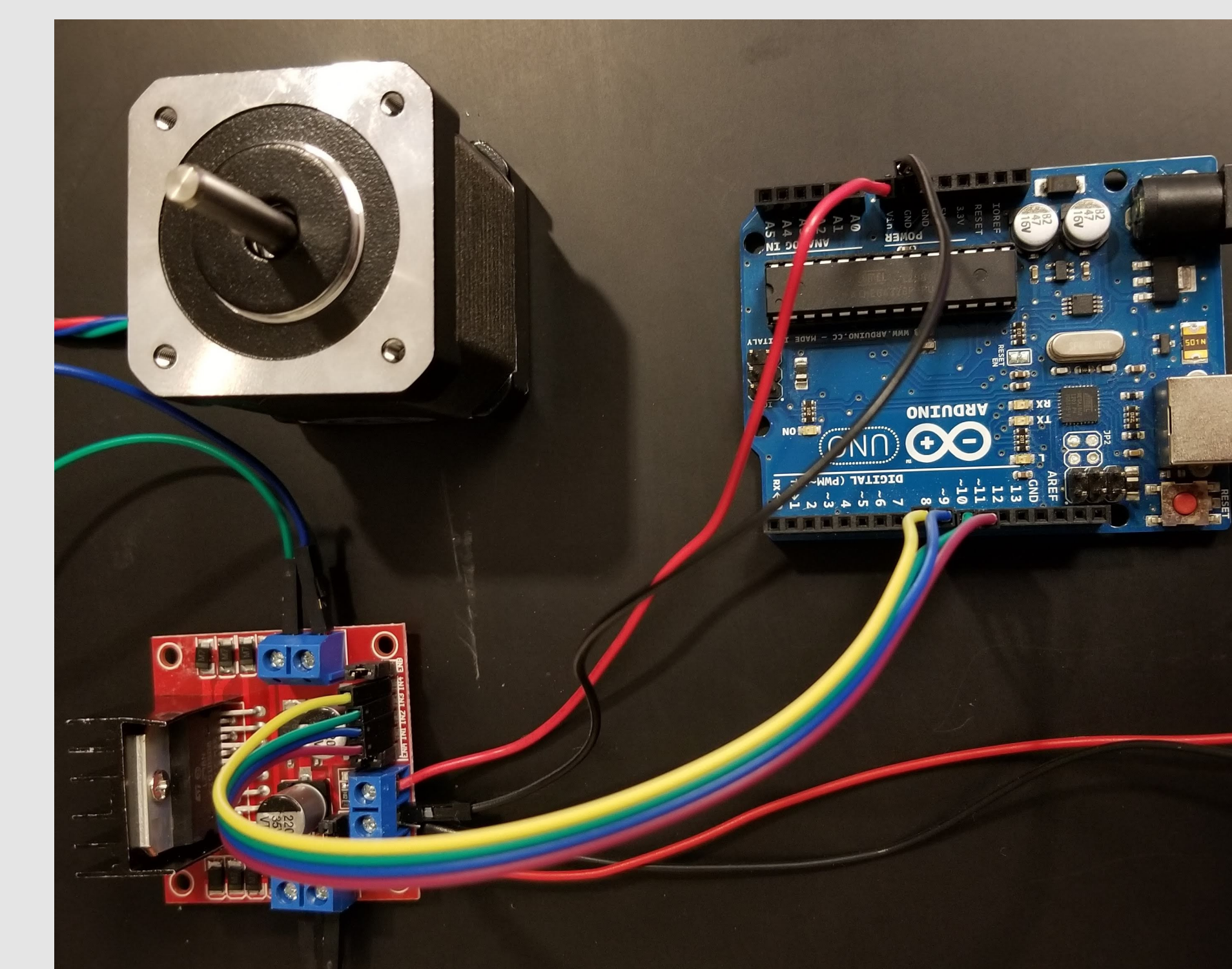
Usability of a Clinostat

Why

- Similar commercial models can cost several hundreds of dollars compared to ~\$60 for this design.
- The device is able to simulate the effects of reduced gravity. Past research has shown close similarities between clinostat trials and those completed in space.
- The devices use little benchtop space so many can be used for one experiment.

How

- Simulated gravity desired is a function of RPM and perpendicular distance from the axis of rotation.
- Cell cultures (e.g. *Arthrospira Platensis*) must be entirely immersed in media; referred to as a fully-suspended cell culture.
- Plants either as seeds or seedlings can be incorporated natively. Larger plants can also be placed on a clinostat but would require an entire unit.



Internal electronic connections

Future Work

The design process is coming to a close and the remaining tasks require fully incorporating the stepper motor into the clinostat. Once complete, all internal wiring will be reran to decrease the amount of unneeded wiring. After this, the code, parts list, and design will be finalized. Lastly, materials will need to be purchased to begin constructing at least another five clinostats. Experimentation can then begin on *Arthrospira Platensis* and *Anabaena* to look specifically at microgravity and Martian gravity conditions.