Digitally Controlled Needle Array Platform

Ozbolat Lab

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INTRODUCTION:

- In the United States, there are currently **113,000** people on the waitlist for a replacement organ; with **twenty people dying each day** [1]
- Bioprinting is a new technology that has potential to alleviate this shortage in supply through the production of customizable, biocompatible organs [2]
- The goal of my research was to improve the current aspiration-assisted bioprinter model, specifically in the area of time efficiency.
- The improved printer will help the lab with research involving fundamental biology, organ-on-a-chip devices, and regenerative medicine.

BACKGROUND [3]:

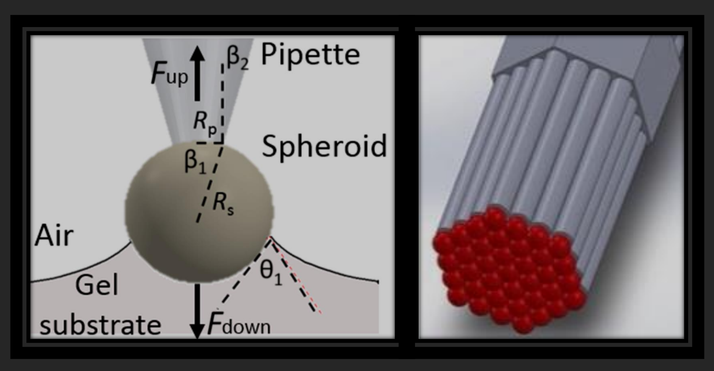
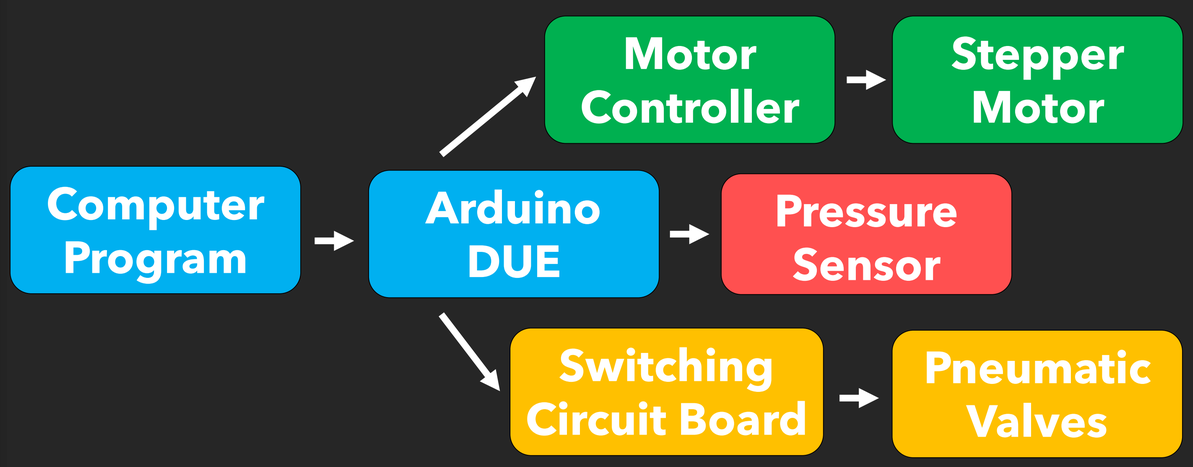


Fig. 1. (a) Free body diagram of aspiration forces present on spheroid (b) new 37 micro-needle printer head

- The aspiration-assisted bioprinter (AAB) is a category of bioprinter that relies on aspiration forces (fig. 1a) to precisely place a wide range of biologics
- The current AAB system requires each biologic to be placed individually, alternating between the supply and printing positions
- For larger scale prints, this additional time adds up, making it time inefficient
- The new AAB will instead print layer-by-layer, in a hexagonal configuration with 37 micro-needles (fig. 1b)

OVERVIEW OF SYSTEM:



- The system starts with a overarching control program which interacts with an Arduino Due microprocessor
- The Arduino then interacts with three systems: valve control, movement control and pressure readings

SOFTWARE:

- A control interface was coded using Processing (Fig 2)
- This interface allows for manual control over individual valves states and XYZ movement in varying intervals
- The system also displays pressure reading, while also keeping track within an excel spreadsheet.

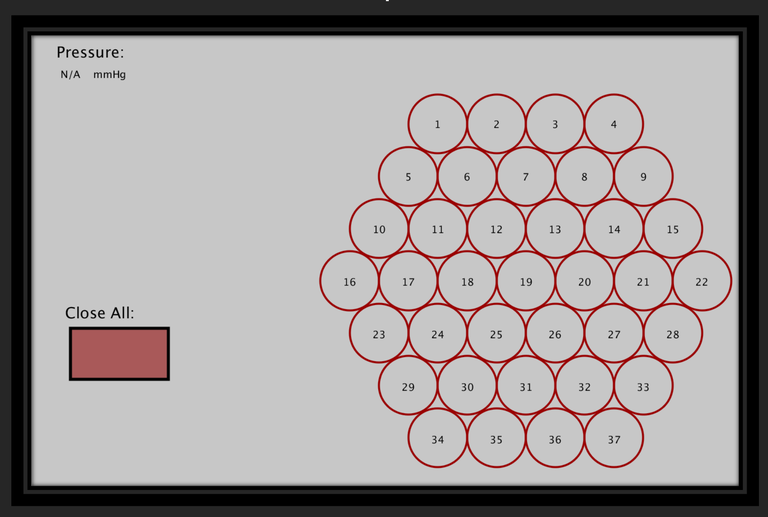


Fig. 2. Control interface *Large portion of display was cropped to display important interface features*

HARDWARE:

- A switching circuit board was created (fig 3) using MOSFETS allowing the Arduino to control the valves
- Overall movement of the system is controlled in a similar manner, with the Arduino connected first to a motor control board, then next to stepper motors
- A BME 280 Spark Fun atmospheric sensor is used to gather the necessary pressure readings

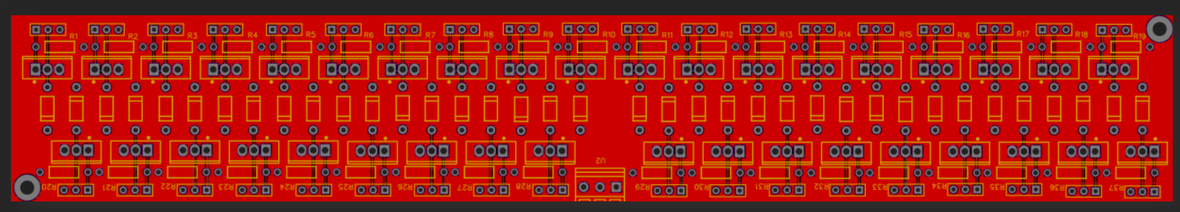


Fig. 3. Circuit board that allows for individual control of valves by the Arduino

FUTURE WORK:

- Due to the COVID 19, access to the lab has been blocked so construction and testing of the printer has been delayed
- The movement system still needs to be fully integrated into the main software as well
- Once both of these tasks are completed, the new printer should have drastically decreased print times

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