3D Printer Accessory That Prints Multiple Polymers While Being Able to Manipulate Their Concentration

Calvin Dulaney and Edward Davis

The new growth and development in 3D printing is grabbing the attention of many mechanical, chemical and material engineers who are fascinated with photo-polymerizing types of printing that are used in tissue engineering, surgeries and drug delivery. Being able to control the resin concentration of a print would allow for many new possibilities and avenues for 3D printing in the areas of medical, mechanical, and chemical engineering. New 3D printing developments bring forth the question: Is there a way to control the absolute concentration of the resins going into the printers? The purpose of this project was to coat and aid the transportation of drugs in the medical field.

Investigating this topic requires an understanding of Stereolithography (SLA) 3D printers and how they crystallized resin through a untraviolet laser to illuminate the surface of a material. From this information, I constructed a bread board circuit in which three individual pumps control the concentration of resin from a single Arduino program. The Arduino program is able to control the stepper motors (pumps) by assigning each pump its own voltage output. The voltage output is exponentially proportional to the output mass flow rate of resin. The pumps allow each individual resin to transport separately in their own respective tubes, where they will enter a mixing chamber and finally be transported to the SLA printer.

Results from this study showed that the different types of resins have different viscosities, which change the mass flow rate required to pump out the needed amount of resin. Thus, in future applications, each specific resin must be separately evaluated. In addition, the results indicate that Arduino Nano is able to control the voltage of the pump at a cheaper cost than an Arduino Uno but has the flaw of being slightly less reliable. To determine whether the Arduino Nano isable to complete the job at the same rate as an Arduino Uno, we tested each by running 24 volts through both circuit boards and found that neither malfunctioned. This study shows that both circuits have the ability to run the operation at full capacity; therefore, the deciding factor between the two is cost.

The crucial impact of this research is to offer a cheap and efficient way to control and manipulate the concentration of SLA printers. The findings from this experiment are that the ability to control resin concentration is possible with a very inexpensive system, and that separate studies need to be done on each resin based on their color and brand due to their difference in viscosity. The next step in this research will be to finalize a link between Arduino and MATLAB™ which will allow for easy transfer into MATLAB™ for use in controlling the pumps for concentration.

Statement of Research Advisor

Calvin has designed and developed a system to augment the capabilities of a commercial SLA printer designed to print one resin at a time. He has constructed a system capable of producing blends of two printing resins and varying the overall composition during the print. The system enables the printing of gradient structures. My research group is looking forward to utilizing the equipment to study how gradient systems can control degradation and controlled release behavior of additively manufactured bioimplants.
-Edward Davis, Mechanical Engineering and Materials Engineering

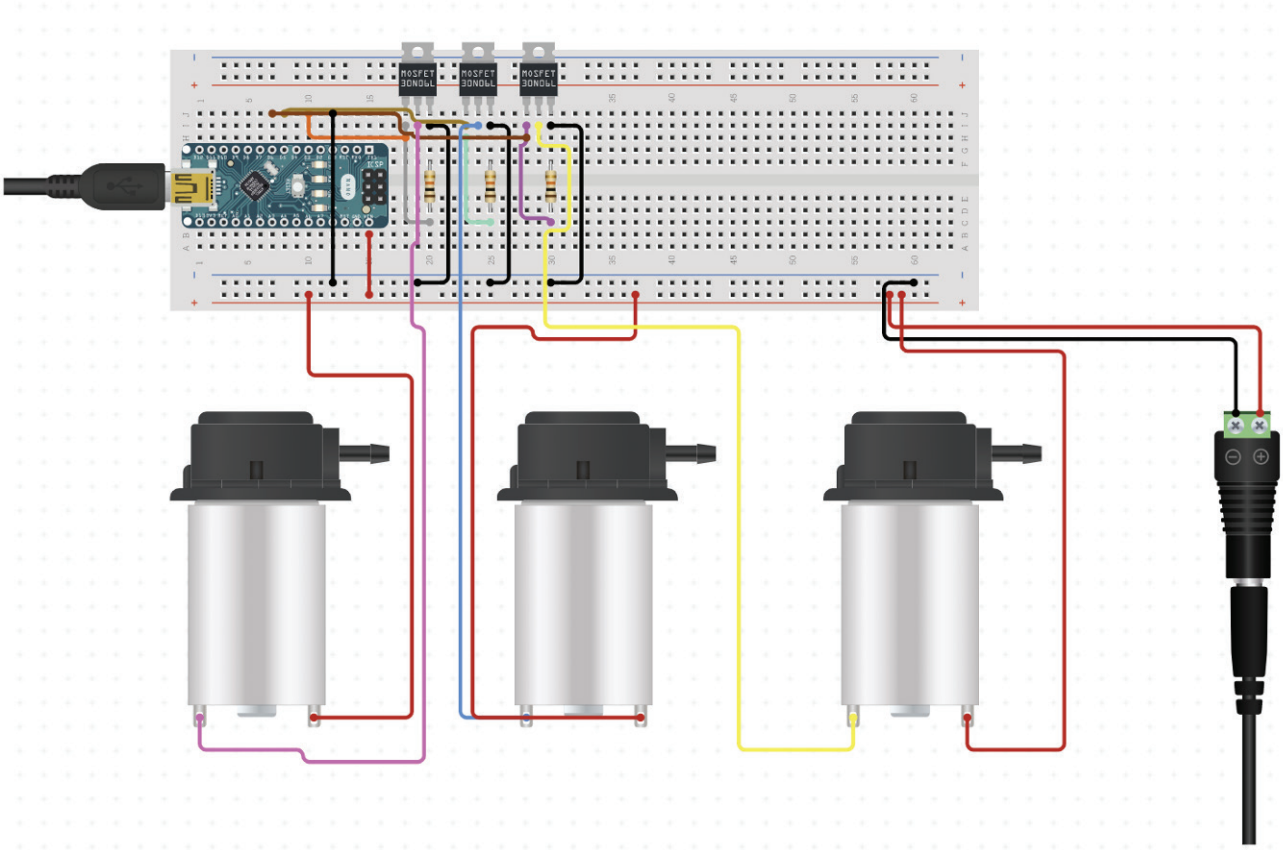

Figure 1. Final bread board circuit to control concentration of resin.