Retrofitting a Commercial 3D Printer for Bioprinting Capabilities

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Abstract

In order to create Lower Critical Solution Temperature (LCST) polymer frameworks with complicated 3D structures, we present a low-cost hardware and software adaptation for a commercial dual extrusion 3D printer. The modified printer uses the two existing thermoplastic extruders and adds a third pressure extruder with a blunt needle to extrude biocompatible materials. In addition, the software revises the conventional G-Code instructions for the triple-extrusion process. This allows for three separate materials (including one biomaterial) to be printed on the same layer.

Background

- 3D networks made from biocompatible materials are important for creating scaffolds for tissue engineering
- Dissolvable plastic support structures would allow for networks of greater complexity

3D Bioprinting Price Comparisons

- Multi-toolhead 3D Bioprinting is more affordable with our self-made solution [2]

Printer Design

- Conventional Extruders are used for printing support structures
- Air pressure is used to expel biocompatible materials through needle
- Solenoid air-valve is used to control airflow activation and deactivation
- Java code is used to control bio print head timing and coordinate translation

Triple Printing Process

- Create three separate print processes for each CAD file using a 3D slicer
- Export generated G-Code as a .gcode file and run firmware compatibility software
- Use Java source code to automatically translate G-Code for triple-extrusion process
- Print
- Set appropriate bio-extruding pressure in accordance with biomaterial’s viscosity
- Convert to .x3g binary

Results

- Ability to print three different materials on the same layer using a streamlined process

Conclusions and Future Work

- 3D printing with plastic and biocompatible materials in the same 3D print is viable at a low-cost level
- Future work will need to be done to determine optimal pressures for printing different LCST polymers
- Analysis will need to be done on quality of polymer structure after printing and support dissolution

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References