Retrofitting a Commercial 3D Printer for Bioprinting Capabilities

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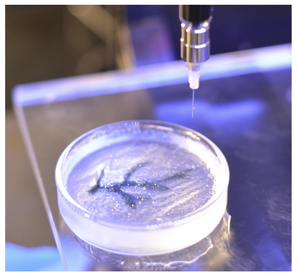
Abstract

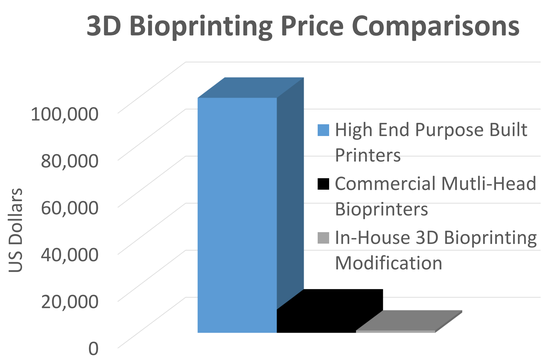
In order to create Lower Critical Solution Temperature (LCST) polymer frameworks with complicated 3D structures, we present a low-cost hardware and software adaptation for a commercial dual extrusion 3D printer. The modified printer uses the two existing thermoplastic extruders and adds a third pressure 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



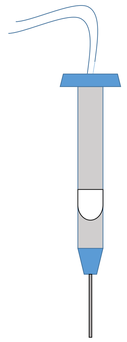
A bioprinted coronary artery [1]

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

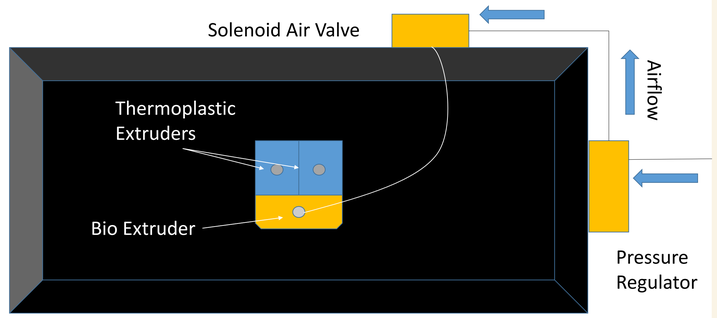


- Multi-toolhead 3D Bioprinting is more affordable with our self-made solution [2]

Printer Design



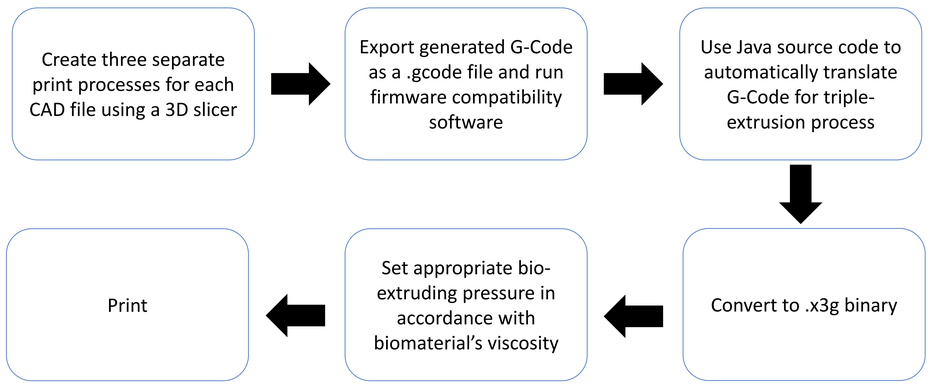
Schematic of needle used to extrude biocompatible polymers



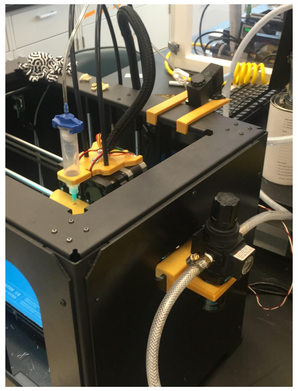
Schematic of Top Down View of Modified 3D printer

- 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

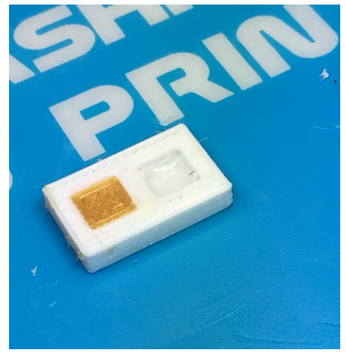
Triple Printing Process



Results



3D Dual Extrusion Printer with Air Pressure Attachments



Test Part comprised of two different PLA filaments as well as Methyl-Cellulose

- 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

Acknowledgements

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References

[1] https://nihdirectorsblog.files.wordpress.com/2015/10/3d_bioprinting_artery2.jpg
[2] https://3dprintingindustry.com/news/top-10-bioprinters-55699/