Improved Design and Evaluation of An Extrusion Based 3D Bioprinter

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Abstract

3D printing techniques have evolved to allow the printing of complex structures in a wide range of applications. In this work, we redesigned and fabricated a 3D bioprinter from literature. The goal is to improve the printability and understand the process-property-performance relationship. We demonstrated the feasibility of building a low-cost extrusion-based bioprinter modified from a Fused Deposition Modeling (FDM) desktop 3D printer and evaluated the printer's performance. With the printer, a variety of food ingredients, including cream/frosting and mayonnaise, was examined, The redesigned 3D bioprinter is capable to print geometrically defined structures.

1. Introduction

3D bioprinting is an emerging field in the bio-manufacturing industry. Progress in this field aims to enable the complete fabrication of artificial living cells, tissues, and organs. 3D bioprinting techniques permit the layer-by-layer deposition of biomaterials with high precision positioning of cells [1]. Three bioprinting techniques have been developed to this day: extrusion-based, inkjets and laser-based. In an extrusion-based bioprinter, an extrusion-based system can be operated by a piston, a pneumatic method or compressed air, or a mechanical screw [2]. Extrusion-based printers driven by a mechanical screw can perform a layer-by-layer deposition of biomaterials.

The purpose of the present research study is to redesign and test a prototype of an extrusion-based 3D printer, based on Ref. [3] (A.W. Feinberg et al, HardwareX, 3, 2018, 49-61). The printer can later be modified and optimized for 3D bioprinting. 3D printing tests were demonstrated with food pastes such as frosting and mayonnaise as biomaterial simulants with different viscosities.

2. Experimental method

2.1. Redesigned 3D bioprinter

In order to integrate the syringe-pump extruder, an AnyCubic Mega zero 2.0 was acquired, disassembled, and reconstructed with the extruder. The original design for the syringe pump extruder was obtained as STL files and further assembly instructions can be found from Ref. [3]. Originally, the axis of the syringe pump extruder was horizontal to accommodate for a Bowden tube attached to the end (increasing extrusion reach). However, difficulty in priming the tube led to the change