EML 4501 - Group 6 – Summer 2020

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BIOmedical Gadget Applying Three-dimensional Organization for Research

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Abstract

The BIOGATOR was designed to be a simple yet innovative Bio-printer focused on improving common weaknesses found in commercial designs. The goal of the BIOGATOR is to maximize profit per customer need while minimizing complexity per-part. Each of the four subsystems include unique features that distinguish it from its competitors. The cell delivery subsystem is comprised of two syringes for greater functionality allowing for deposition, extraction, or both.
The cell support structure utilizes two solenoids allowing each of the two needles of the cell-delivery to be controlled independently of each other and occupy the same working volume. The cell delivery and support mechanisms move in the X,Y,Z axes using 3 ball screws supported by vertical sliders attached to the framework. The microscope turret mount and printer framework were combined into a single nylon part to maintain overall simplicity.

Product Summary

The BIOGATOR achieves living cell deposition and extraction with control from the Smoothieboard combined with 3 stepper motors. The 3 stepper motors translate motion remotely using flexible cable attached to 3 ball screws on the printer assembly. Upon rotation of these ball screws, the attached cell delivery assembly can move in the X, Y, and Z directions. The dual extruder cell delivery system has the ability for both 28-gauge needles to fit in the same well. With the use of two solenoids, the needles can independently move up and down in the Z axis based on the user's preference. The cell delivery syringe pumps mounted externally, are actuated using a linear ball screw slider mechanism to push or pull on the syringe plunger. The syringe pumps push the LLS through two hoses connected to the cell delivery mount on the printer and through the two needles.

Product Cost

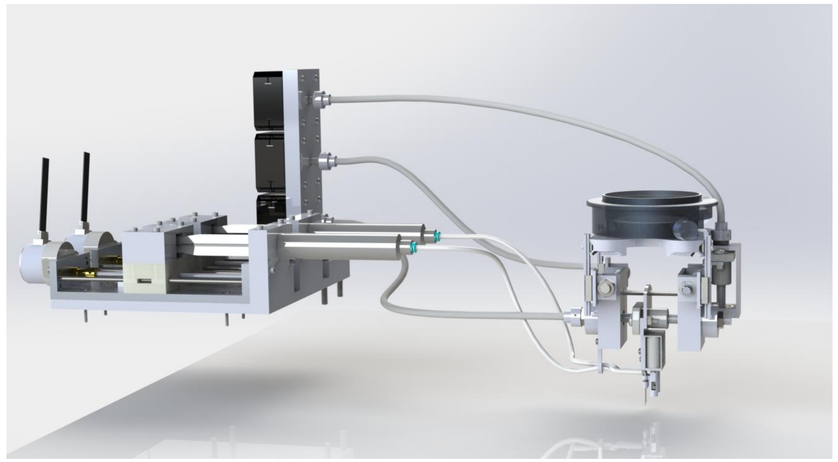
Cell Delivery Subsystem
Raw Material Costs: Nylon 12 $1.42
Manufacturing Costs: $42.94
OTS Costs: $101.44

Cell Delivery Support Subsystem
Raw Material Costs: Nylon 12 - $0.10
Manufacturing Costs: $36.24
OTS Costs: $57.50

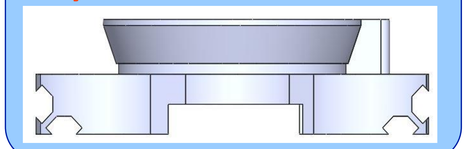
Linear Motion Subsystem
Raw Material Costs: Nylon 12 $10.21
Manufacturing Costs: $85.46
OTS costs: $1053.32

Framework/Turret Mount Subsystem
Raw Material Costs: Nylon 12 - $0.83
Manufacturing Costs: 3D printing manufacturing – $25.74
OTS costs: N/A

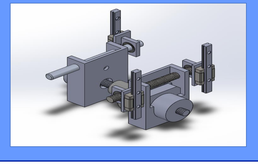
Overall System Cost: **$1415.20**



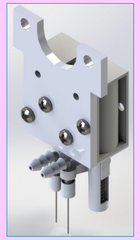
Easy-to-Assemble Framework

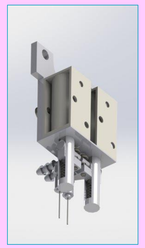


Lead Screw Motion

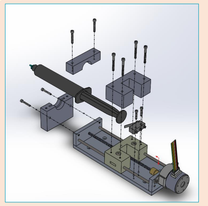


Dual-needle System



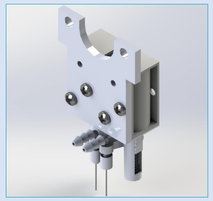


Cell Delivery Subsystem



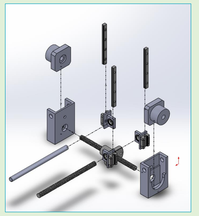
The cell delivery subsystem consists of two syringes, each mounted to a syringe pump. The syringe pump consists of an OTS ball screw stepper slider with custom 3D printed nylon syringe mounts. The syringe is mounted to the stepper slider with enclosed clamps. The first clamp holds the barrel to the stationary part of the syringe pump. The second clamp mounts the syringe plunger to the sliding mechanism to either deposit or extract cells. The syringes are fitted with an OTS Luer lock barb fitting that connects Tygon tubing to the microscope mounted printer assembly.

Cell Delivery Support Subsystem



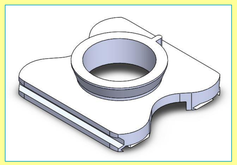
The cell delivery support subsystem consists of a mounting bracket that facilitates the attachment of the cell delivery subsystem to the linear motion subsystem. Mounted to the bracket are two linear solenoids that allow the user to actuate each of the two deposition tips independently. Attached to the solenoid push rod is the needle casing which allows the deposition tips to be placed such that both deposition tips can work in the same working volume simultaneously.

Linear Motion Subsystem



The linear motion subsystem consists of a set of ball screws connected to each other through different mechanisms. This system allows for the cell delivery support to be mounted and moved through the intended print area. This subsystem is mostly made up of OTS parts and some custom manufactured pieces. This system allows for the necessary linear accuracy to print at the user's discretion. This entire subassembly is intended to be mounted unto the framework/turret mount system.

Framework/ Turret Mount Subsystem



The framework incorporates the turret mount and the structure from which the other subsystems will mount. Similar to rapid-prototyping 80/20 beams, the framework has grooves on the sides and bottom to facilitate ease of assembly. The turret mount is made to align with the condenser mount easily and can withstand the compression forces needed to maintain alignment. The structure is made up of lightweight 3D-printed nylon which has a high durability and can be sterilized.

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Customer Need Mapping