Turbid-o-STAT: A Better Semi-Autonomous Microbioreactor

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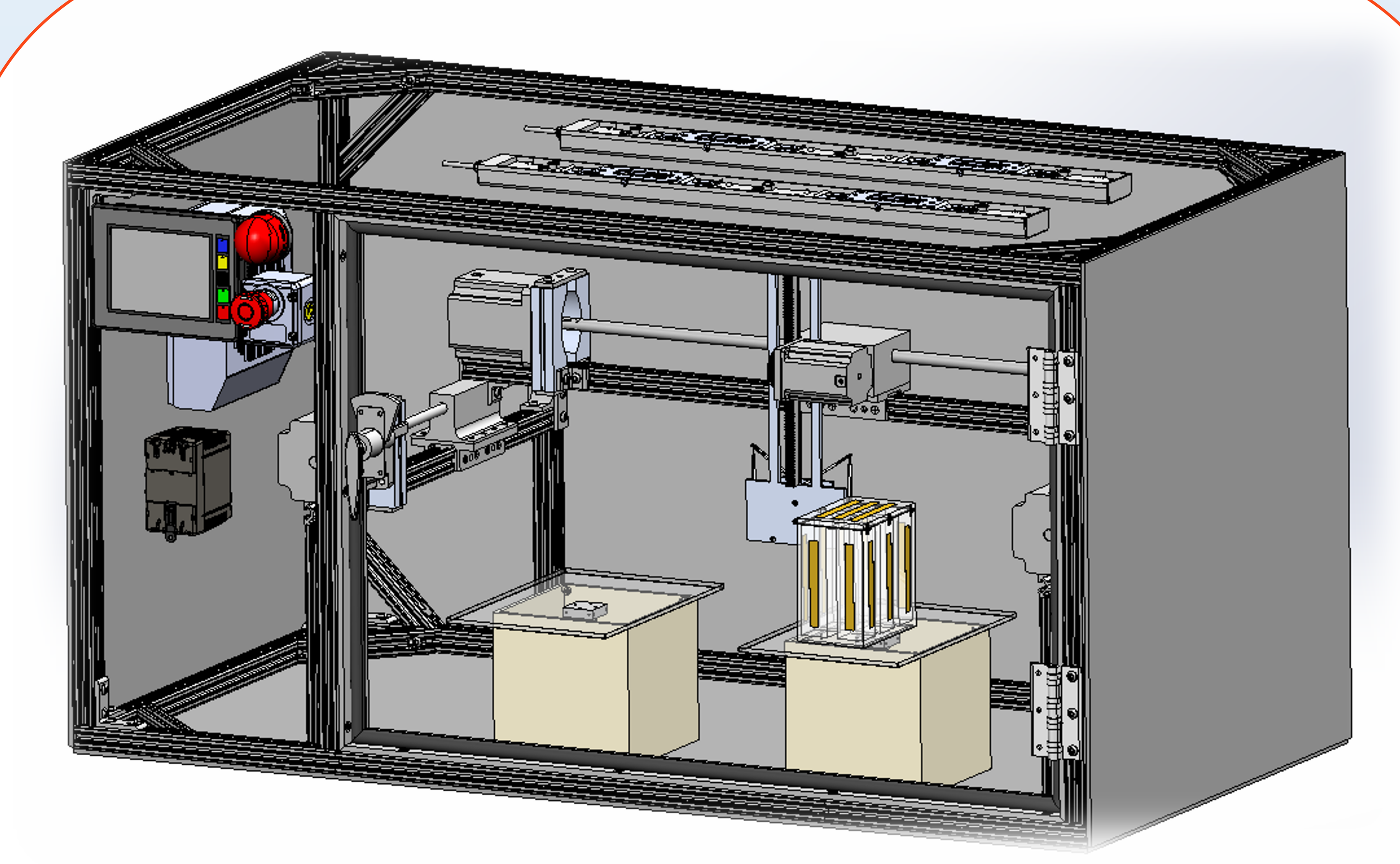

Figure 1. Final CAD model for the Turbid-o-STAT microbioreactor.

Abstract

Current microbioreactor systems are not sufficient in working with large volumes and lack automation. The main goal of the new microbioreactor is to increase design flexibility, further the creation of open-sourced microbiological data, and reduce costs. This will be accomplished through the design's autonomous culture monitoring and liquid handling systems. The new design features increased temperature control ranges, accommodation of existing culture vessels, detection of optical density within cultures, fluid addition and subtraction to culture vessels, gaseous injection and disposal, multiple shaking patterns, and an intuitive user interface. A unique feature of this design includes the use of a gantry style liquid handling system capable of autonomous multi-axis movement to interact with all cultures within the modular unit. Another unique feature is the double motor shaking system that can achieve linear, orbital, and double orbital shaking patterns for culture vessels.

Product Differentiation

To differentiate this product from others on the current market, the following novel experimental capability features will allow for success:

- Increase volume range for university research labs (20µL to 20mL).
- Ability to add and subtract liquid from each culture plate or test tube.
- Broader temperature range (4°C to 70 °C) for extremophile culture capability.
- White light addition for photobioreactor capabilities.
- Adjustable numbers and sizes of wells/tubes (a 384-microwell plate vs. a 15 mL conical tube).

Proposed Functions and Operations

- Accommodate existing culture carrying vessels for implementation in a variety of lab settings.
- Reuse existing culture vessels will enable the product to be used in pre-existing laboratories and reduce costs by not needing newly manufactured vessels.
- Direct fluid addition and subtraction in a cell well with an autonomous three-dimensional movement and handling system.
- Inject and regulate Nitrogen, Oxygen, Carbon Dioxide, Methane, and Hydrogen
- Control temperatures from 4°C to 70 °C for more culture variety than competing systems.
- Uniformly heat the culture vessels will be helpful in the prevention of condensation.
- Monitor culture data through optical density and fluorescent intensity readings under closed loop control.
- Produce white light that will be beneficial towards studying cultures such as cyanobacteria.
- Shake test samples with three patterns: linear, orbital, and double orbital.
- Modular design with minimal instructional input with an intuitive interface.

Product Subsystems

- Fluid Dispensing and Disposal - system capable of adding and removing of media in culture on a three-dimensional track system with nozzle lowering and raising technology (Fig. 2).

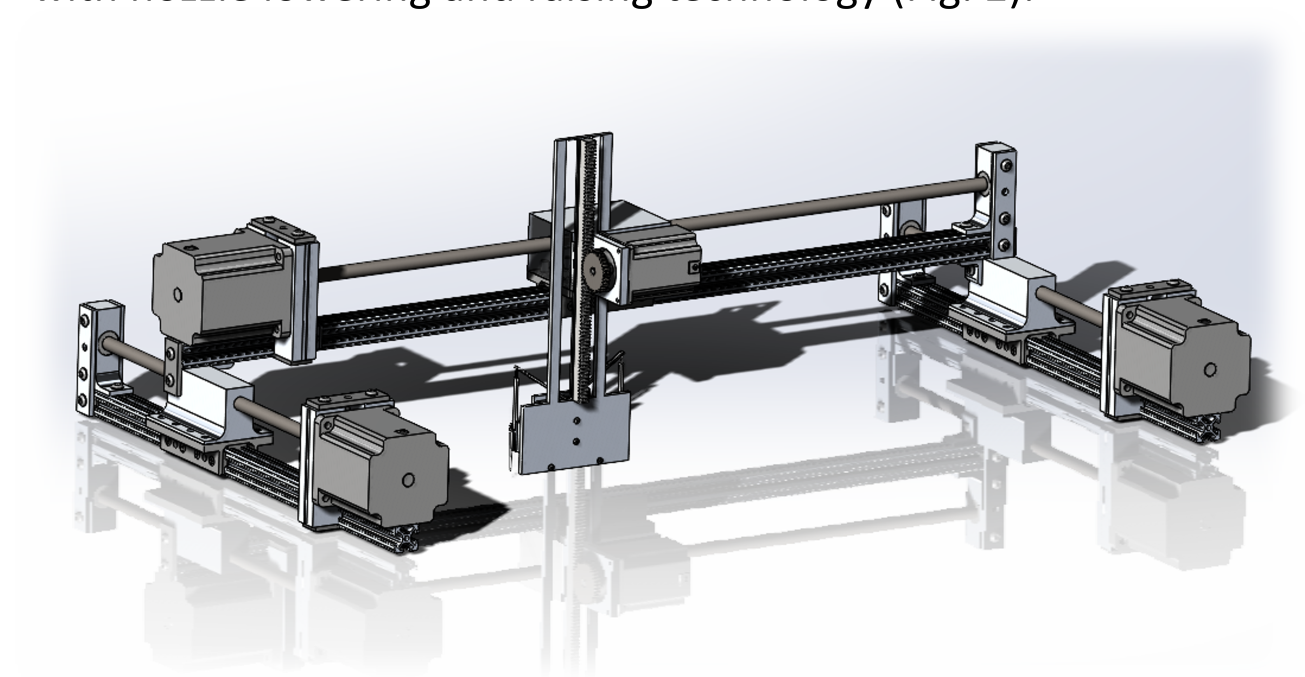

Figure 2. CAD model for the Turbid-o-STAT Microbioreactor fluid dispensing and disposal subsystem

- Gas Dispensing and Disposal - system capable of adding and removing gas to culture atmosphere through a solenoid valve system that would deliver gas into the incubation enclosure. This subsystem would also dispose of gas through a compressor and tubing into a laboratory supplied waste container.
- Optical and Temperature Control – the optical system would detect turbidity in the culture through LED light readings. The temperature control system would be comprised of heating strips and a thermoelectric cooling device (Fig. 3).

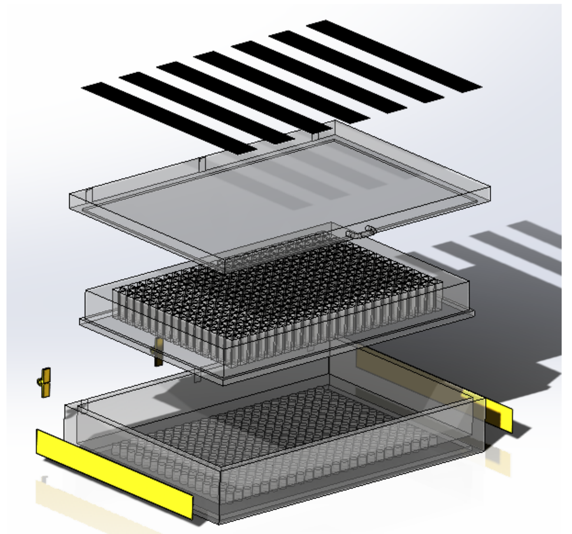

Figure 3. CAD model for the optical and temperature subsystem

- Shaking and trays– the shaking and trays subsystem would serve as the location for manipulating the test samples. The shaking mechanism is currently being filed through the university for Intellectual Property (Fig. 1).
- Controller Setup – system capable of monitoring and adjusting parameters of other systems such as temperature, shaking, liquid dispensing, and gas dispensing. This system would include all visual safety requirements defined in the customer needs (Fig. 4).

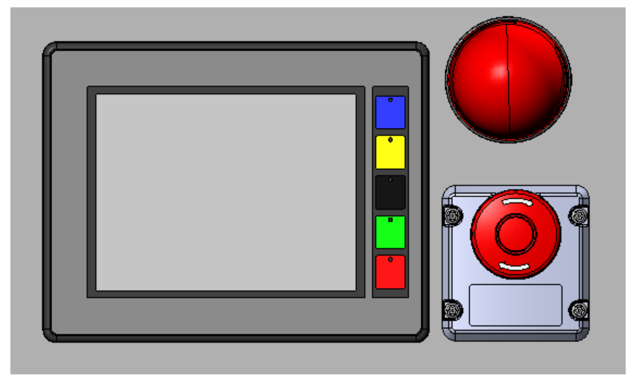

Figure 4. CAD model for the controller interface subsystem

- Housing – system to house culturing area, capable atop a workbench in a research facility. It will be constructed from extruded 80/20 aluminum and an appropriate panel thickness of HDPE to limit outer surface temperature (Fig. 1).

Overall Cost

The overall cost of the Turbid-o-STAT was determined by the summation of the OTS part cost, raw material part cost, manufacturing and MFG cost, assembly labor cost, and energy cost to develop the product (Table I.). The total cost was determined to be $6209.40.

OTS Cost	Raw Material Cost	Manufacturing and MFG Cost	Assembly Cost	Energy Cost	Total Cost
$5,877.81	$22.66	$103.10	$24.39	$181.44	$6209.40

Table I. Cost table for the Turbid-o-STAT microbioreactor based on varying production costs.

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