Accelerating Additive Manufacturing Using 3D Printers with Automatic Part Ejection

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Research Objective: To revolutionize additive manufacturing with 3D printers via implementation of automatic part ejection, thus drastically reducing the number of person-hours required for printing and allowing for 24/7 operation of print farms.

Background

Motivation

GatorKits Lab™ utilizes 3D printing to rapidly prototype and manufacture components for a variety of remote engineering course lab kits. One lab kit in particular — designed for the EGS1006 "Introduction to Engineering" course — consists of 17 unique 3D-printed parts. The Fall 2023 semester proved that production of these parts contributed significantly to the person-hours required in kit assembly. To reduce this contribution, an offshoot project was created to design and build a 3D printer capable of automatically ejecting finished parts and commencing subsequent prints. Such a printer could be operated 24/7 without human interaction, limited only by the amount of filament in its feed.

Project Requirements

The proposed design involves modification of the commercially available FLSUN Super Racer. To fulfill the needs of the GatorKits Lab™, the project must meet or exceed the following requirements:

1. Printing Facilitated by Execution of a Single File
2. Part Ejection is Not by Means of Impact
3. Modification Costs Must Not Exceed $200
4. Build Volume of 230mm x 110mm x 230 mm
5. No Compromises to Versatility or Consistency

Existing Designs

45° Belt Printers

A number of commercially available printers exist which boast an infinite z-axis made possible by a conveyor belt print bed; these include the Creality CR-30 (pictured), iFactory One Pro, Sainsmart Infi-20, and more.

This style of printer introduces two issues. The 45° nozzle, while convenient for infinite printing, requires compromises to part geometry and consistency. Additionally, such printers utilize movement of the printing surface, rather than the nozzle, to facilitate printing in the z-direction; this also compromises print consistency. For these reasons, 45° belt printers are ill-suited to the needs of the GatorKits Lab™.

Design Inspiration

One community-made printer shows promise: a design by Michael Laws (*Teaching Tech,* YouTube) involves modification of the FLSUN Super Racer, a delta-style printer, to automatically eject parts. Use of a delta printer avoids the issues presented by 45° belt printers and provides the basis for this project.

Current Design

Base Printer

The FLSUN Super Racer was selected as the base for this design. This printer utilizes three independent motors to control nozzle movement in three planar directions, allowing the print surface to remain stationary during printing.

Conveniently, the Super Racer comes equipped with an extra stepper motor port, which proves useful in powering the drive roller for the conveyor belt. The circuit board can readily be coupled with a Raspberry Pi to allow for external control of the printer and its motors.

Hardware and Software

A commercially-available conveyor belt will be installed using both machined and 3D-printed hardware. Conveyor belt motion will be facilitated by a stepper motor; control of this motor and printer functions will be managed by execution of an OctoPrint file through a Raspberry Pi unit connected to the printer's motherboard.

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