ILR05

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TEAM F: ADD_IN

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Individual Progress

Since our previous progress review I have focused on solving the issue of filament trails being created when the print bed moves to its insertion configuration. Previous tests with our last extruder were consistently producing a thin trail of 3D print material when the nozzle moved away from the part. This trail (shown in Figure 1) would limit the accuracy of the part and frequently create issues when printing at later layers.

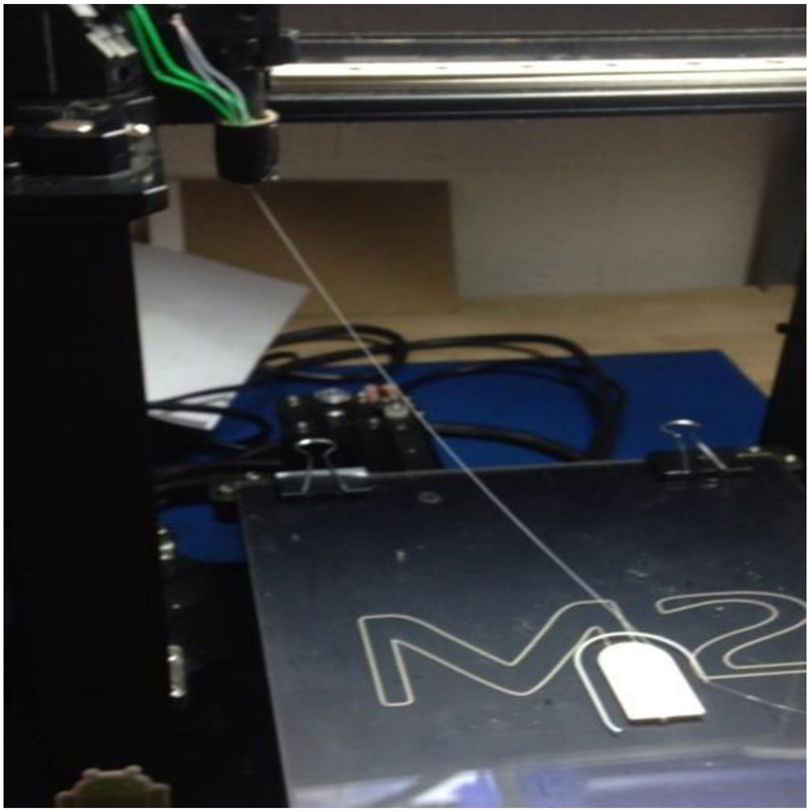

Figure 1: Filament trail created when the printer enters its insertion configuration

Astha and I theorized that the cause of this trail was likely a combination of temperature (the deposited filament being too molten) and the trajectory of the nozzle as it moves away from the printer. To verify this, we conducted a series of tests where we would create a 'blob' of filament on the print surface and then move the nozzle away and determine if a trail was created. We found that with a combination of lowering the temperature (210°C from 220°C) and adding a rapid x-axis movement before moving the z-axis to the insertion configuration would consistently prevent filament trails. We also experimented with adding a fan to the extruder, which seems to improve the overall print quality but didn't specifically solve the filament trail issue. A side effect of the fan is that it significantly increases the rate of heat loss from the heat block, and thus the heater was unable to maintain temperatures above ~200°C. We have been able to overcome this by increasing the voltage delivered to the heater (24v from 19v) and have ordered fiberglass insulation tape which we will apply to the outside of the heat block. In the coming weeks we plan to do more testing with the fan and minor temperature adjustments to try to improve the print quality.

Challenges

After our last progress review, we theorized that adding a cooling fan might solve the filament trail issue. When Astha and I went to implement this, we found that the we were unable to perform a reliable test since the fan was cooling the heat block faster than the heater could compensate. To overcome this, we first tried to adjust the PID constants controlling the heater temperature but still were unable to achieve the needed temperature. We then disconnected the printer's original 19V power supply and replaced it with our bench power supply enabling us to supply the heater with a higher voltage. The controller board is rated up to 24V, and we found that at voltages above ~23V, in combination with a large proportional gain, the heater was able to produce heat block temperatures ~210°C. However, it was noted that this temperature would occasionally fall during printing as filament cooled the heat block. Finally, we applied some fiberglass thermal insulation which came with the printer's original heat block which enabled us to reliably maintain temperatures up to ~215°C while printing. This enabled us to complete our testing and solve the filament trail problem.

The piece fiberglass insulation from the original heat block is small compared to our custom heat block and thus only marginally improves performance. We have ordered a roll of high temperature adhesive fiberglass insulation tape which will allow us to fully insulate the heat block and hopefully further reduce heat loss. If we find this to be insufficient it is also possible to purchase a higher-wattage heater.

Teamwork

Astha Prasad and I worked together to solve the filament trail issue. This work consisted almost entirely of lab tests where we would be modifying either the g-code commands for insertion layer entry or modifying the hardware of the printer. Astha worked primarily on the software modifications and I performed the hardware modifications.

Nikhil Baheti worked on further understanding the firmware and modifying it to rotate the R axis stepper motor from G-Code commands.

Ihsane Debbache spec'd and ordered the slip ring and custom hollow shaft stepper motor that we will be using. He also designed the 3D-printable mount which will support both the R axis stepper and the slip ring. A CAD model of the mount is shown in Figure 2.

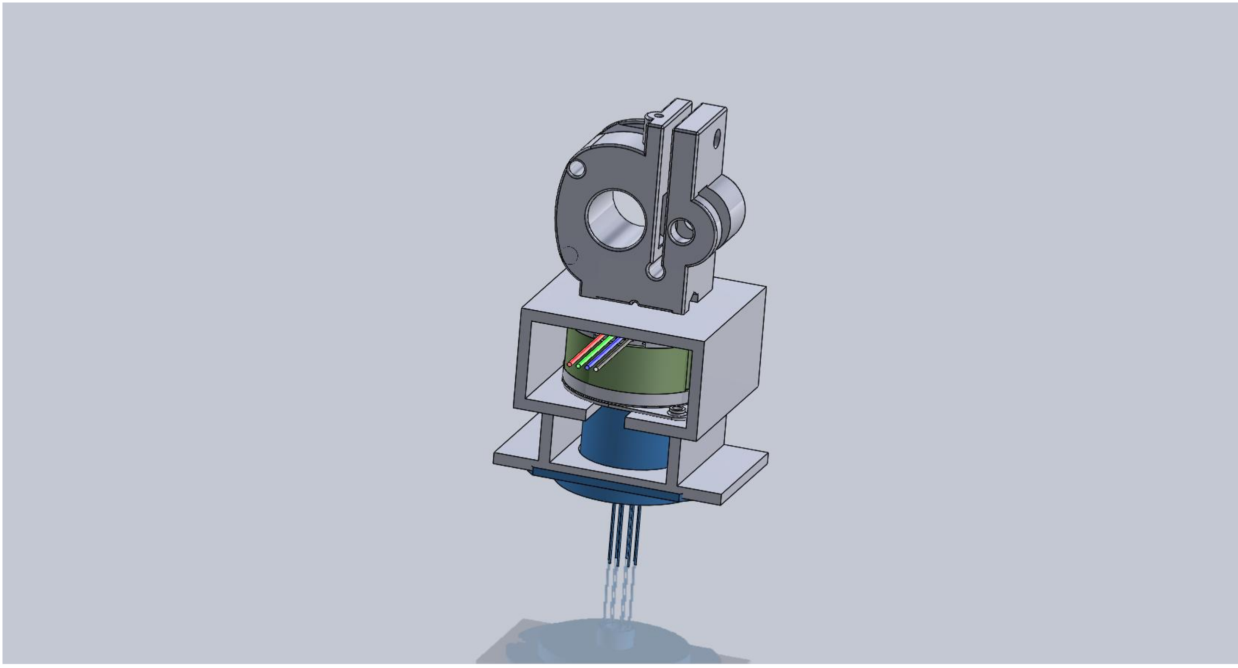

Figure 2: Mount for stepper motor and slip ring

Future Plans

From now until the FVE we plan to work on improving our print quality and consistency by tuning the printer's nozzle temperature, bed temperature, fan settings, speed settings, and endstop settings. We will also be designing our demo parts to be printed at the FVE. As suggested during our PR, we will try to find a way to highlight the capabilities of our custom nozzle, such as by printing along the side of a COTS item during our FVE.