ILR11

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TEAM F: ADD_IN

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Individual Progress

Since the last PR I've worked supporting the mechanical and software systems. For the mechanical systems my primary goal has been increasing nozzle reliability and print quality. To do this I've created two new nozzle variants and extensively tested both. The first version (Figures 1, 2) is a smaller version of the design that has been most reliable but was unacceptably large. By changing the orientation of the cartridge heater and sourcing a much smaller thermistor I was able to significantly reduce the nozzle's footprint so that there are no collisions when printing around the COTS items we will be using during our SVE.

I've also done two experiments to try to reduce nozzle jamming. Nozzle jamming appears to be caused by two sources. The first is when heat travels up to the top of the barrel and softens filament causing it to swell get caught in the interface between the nozzle and motor assembly. The second occurs when molten filament from within the heatblock's melt chamber seeps up the barrel, solidifies, and adheres to the inside of the barrel. Both issues were identified by extruding large amounts of filament until a jam occurred, and then carefully disassembling the printer and observing signs of deformation of the filament. Modifications were made to the nozzle design to address both situations.

To reduce the amount of heat traveling up the barrel two barrel variants were tried. One was a custom machined aluminum barrel with cooling fins, and lined with a thick PTFE liner. The cooling fins were inspired by aftermarket cooling fins which are available for some 3D printers, but which would interfere with the COTS components during printing. For convenience the barrel was machined from aluminum, which proved to make the design ineffective. The aluminum was too thermally conductive and thus even with the cooling fins it increased the frequency of nozzle jamming. As a second test a stainless steel barrel was machined to accommodate a thicker PTFE liner. Thus far this barrel has performed well and jamming has been nearly eliminated. If time permits a variant of this barrel will be manufactured to include cooling fins which should further reduce temperatures at the top of the barrel.

To address the issue of molten plastic traveling up the inside barrel I redesigned the interface between the barrel and heatblock. The original heat block design relied entirely on a threaded interface between the heat block and barrel to form a molten-plastic proof seal. This worked acceptably, but provided no additional sealing between the outer barrel and its PTFE liner. To address this, a constriction has been added at the end of the threads in the heat block. This constriction provides a flat surface which both the PTFE liner and barrel seals against. Using a liner which is slightly longer than the barrel causes the PTFE to compress during assembly and enhances this seal. Testing has shown this to work well, with the amount of plastic leaking from the barrel-nozzle interface significantly reduced and the instances of jamming nearly eliminated.

Figure 1: Custom heat block + barrel after manufacture prior to assembly. The constriction is visible through tapped hole on left of image.

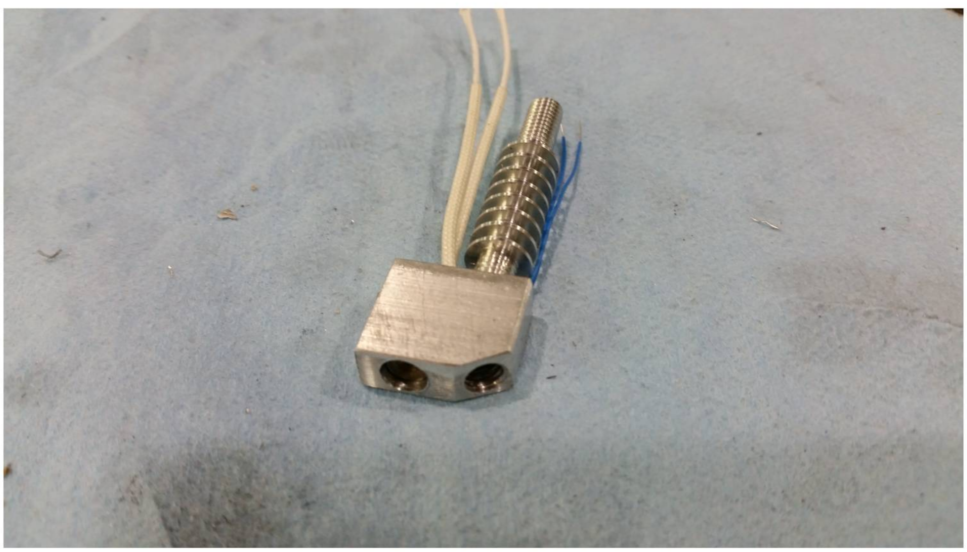

Figure 2: Assembled heatblock + barrel

Development on the other nozzle variant (Figures 3, 4, 5) also continued however it has been set aside since the first nozzle design is now working acceptably well. This design provides a smaller footprint, reduced melt zone, and significantly faster heat-up time although also requires significantly more time to manufacture. If the current nozzle design demonstrates signs of inadequacy this nozzle's development will be continued. It has been shown to successfully extrude large amounts of filament without jamming. Currently this nozzle's thermistor is damaged (due to rough handling) but spares are available and if needed can be repaired for further testing and use.

Figure 3: New nozzle design prior to winding of the heating coil. A used thermistor is installed which will eventually failed from handling.

Figure 4: New nozzle design with heating coil completed.

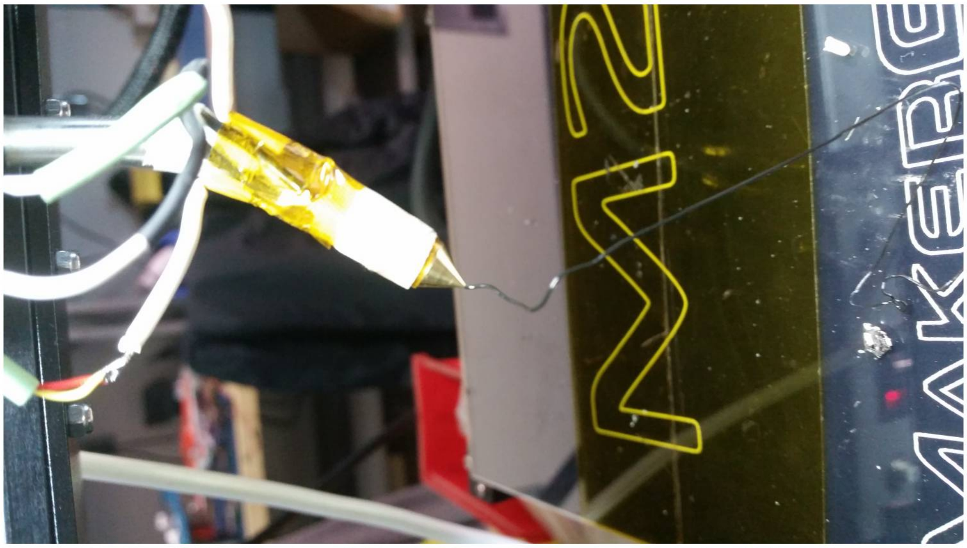

Figure 5: Nozzle successfully extruding while undergoing testing for jamming

I have also continued to support software development, making minor adjustments and bug fixes to the GUI-application. Furthermore, to help with firmware testing I have developed a MATLAB script to generate G-Code files for cylindrical objects, which offer more control of certain parameters than is afforded by Slic3r.

Challenges

With nozzle reliability significantly increased the primary challenge remains reducing drift in the print. The MATLAB script has been instrumental in determining the possible sources of the drift, and has demonstrated that for certain G-Codes the drift can be eliminated. This suggests that likely sources are decimal truncation errors in the parsing of serially-transmitted G-Codes, or math round off errors during the IK calculations. Many of these problems may be solvable via modifications in either software or firmware.

Teamwork

Astha Prasad – Has supported testing operations. She has also collaborated with Nikhil in trying to isolate possible sources of drift in firmware.

Ihsane Debbache – Has been designing and printing SVE parts. The parts designed are a part with enclosed threaded insert, part with an enclosed stiffener, and a part with an enclosed force sensor.

Nikhil Baheti – Has continued to work on firmware, trying to isolate possible sources of the drift. In doing so he has conducted numerous test prints which have also helped to greatly increase overall print quality.

Future Plans

With nozzle reliability greatly enhanced, my upcoming tasks will focus around preparing for the SVE. Specifically, I will be ensuring that we have access to the necessary facilities (Coordinating access to an Instron machine in the material science department), all the test parts and control parts are well designed and suited well suited for our printer, and ensuring that both the printer and software is reliable and in presentable condition.

The team as a whole will be working to solve the drift problem. Print quality has already been greatly developed through test prints, and the nozzle drift issue appears to be the final hurdle to cross before a successful SVE.