

ILR10

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TEAM F: ADD_IN

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Individual Progress

Since the last ILR I have worked on numerous aspects of the project, putting out fires as they flare up so that the entire team can continue working towards our goal of successfully printing around COTS items. In addition, I have made some preparations on our second printer which are likely to be necessary for improving print quality once all the other details are worked out.

Firmware:

On occasion I have worked with Nikhil to identify and correct software bugs in the firmware. As proposed in my last ILR, we replaced time intensive trig calls with a linear interpolation of a lookup table. The table was designed to match precision that our rotational joint can physically achieve (6400 steps per revolution) and minimized computation by performing all calculations in thirty-two bit integer format. Calculations were optimized by storing values as multiples of two and using bit shifting instead of multiply/divide to perform calculations. Nikhil did most of the work implementing the table and I helped him to solve a few bugs that cropped up.

Hardware:

For most of the period since our last ILR we did not experience any issues relating to nozzle clogging or filament jamming. During this time, I worked to develop a more robust mechanical assembly for the R-axis (Figure 1), which is likely to be necessary for producing high quality prints once all other issues are resolved. The new mount uses a bearing located near the nozzle to provide rigidity, whereas in the original design all forces were supported by a cantilevered shaft connected to the motor. A PEEK adapter (Figure 2) was machined to allow the wires to pass thru the bearing and to provide thermal insulation.

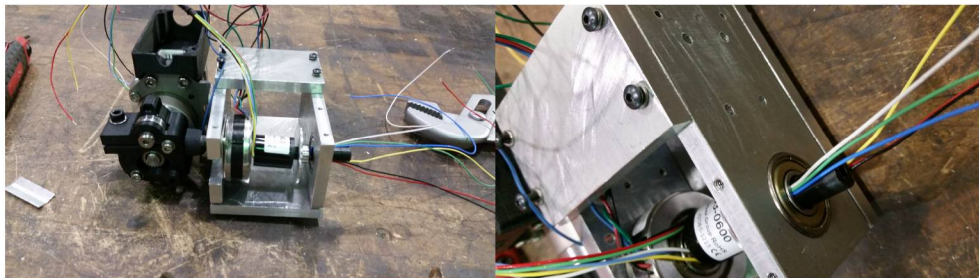


Figure 1,2: (Left) New mount design. (Right) Close up of PEEK adapter + wire passthru

With the new mount manufactured shifted my attention to refining the nozzle design. I first made the necessary couplings to attach the nozzle I designed at the end of last semester to our printer. The nozzle showed promise, but would fail at the pinned interface between the PEEK insulator and heated aluminum nozzle tip. To solve this, I iterated on the design and machined a new nozzle (Figures 3,4) that used a threaded connection and a single of Teflon that acts as both a barrel guide and nozzle mount. Again, the nozzle briefly showed promise before failing at the same interface. I remade the Teflon component with a larger OD to accommodate a heli-coil, and still the threads stripped out under the extrusion pressure of the filament. It is clear

that the Teflon is too pliable to support threaded connection without additional support. To solve this, I will be making another iteration which includes a metal sleeve pressed fit on the outside of the threaded section of the Teflon to prevent it from expanding under pressure. This has already been shown to work on a threaded connection on the other end of the Teflon component.



Figure 3,4: New nozzle design before (left) and after (right) winding heating element.

Challenges

Time has become the primary challenge. We are now behind schedule and thus losing valuable testing time because we are still in development. To address this, we have tried to develop other means to perform some of the testing. Locating feature and adhesion testing have been performed using the MRSD labs MakerBot 3D printers. Although these results will not be identical to our printer we have been gaining insights which we will be able to apply to our printer once it is up and running.

We have also faced some more unexpected challenges. One of the MOSFETS in our controller board failed preventing the bed heater from working. A cause was not able to be identified, but we were able to replace it with one from a spare board. We have also ordered a second spare board since the first one was used to source parts.

Teamwork

Due to the slipping schedule we have restructured our team to devote all resources towards solving immediate challenges. To do this, Astha has stepped back from software to work full time helping Nikhil with firmware development. Ihsane has been performing as much testing as possible using the MakerBots and addressing any immediate printer mechanical issues that impede firmware development (i.e. unjamming nozzles). I have been working on iterating the nozzle design and mechanical design to try to make all parts more reliable and capable of printing consistent parts.

To ensure progress and quickly identify any roadblocks the team is now meeting for at least 10 minutes daily, to sync and allocated resources towards the most pressing issues.

Future Plans

Our primary goal remains to get the printer successfully printing around COTS items. To facilitate this, I am working full time on developing a better nozzle to both solve the jamming issue and to deliver a better print quality than has been achievable with our current version. I am also available to quickly manufacture any needed parts to keep our current mechanical iteration functional. This will likely include making new insulators for the old nozzle design, which although produces low quality prints is useful for debugging firmware.