
PROGRESS REVIEW 12

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Team F: ADD_IN

ILR #11

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Teammates:

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Ihsane Debbache

Introduction

In PR 11, the team was focused on printing around COTS items weren't able to show the same due to the some firmware bugs that caused a heavy drift. Since then, all members of the team have worked tirelessly to get to the bottom of the issue.

Firmware Fix

As of last PR, the issue with the firmware was that it was causing the nozzle to drift gradually over layers. Nikhil and I worked on troubleshooting this further. The team agreed that it was probably some error that was accumulating over time. Typically, for each G-Code, the last run of the ISR always contains some remainder X and Y counts that turned out to be too low to evaluate to one complete step. Earlier, we were attempting to carry over these remaining counts to the next G-Code. On examining the original firmware that the RAMBO board ran, we noticed that the algorithm just carried over 0.5 times this remainder value to the next G-Code. On implementing this, we were instantly able to achieve much better print quality than we were in previous runs. This is exhibited below:

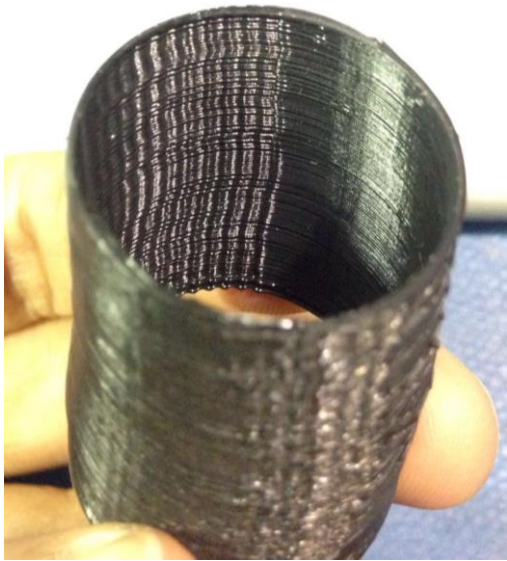


Before

After

Figure 1 Remainder XY count correction (Before and after)

After this was achieved, we noticed that the the cylindrical part had some irregularities over two quadrants. Rather than printing uniformly, the printer would print wavy lines along the perimeter in only two quadrants. This behaviour can be seen in Figure 2a. Nikhil observed that the G-Code contained R-Angles below 3 degrees over these parts of the perimeters. Dan then generated a G-Code that maintained the R-Angles above 5 degrees. On testing this G-Code, we found that it eliminated all drift and we were able to print excellent cylinders without the waves or drift. This is shown in Figure 2b.



(a) Waves observed along perimeter



(b) Uniform print with R-Angles > 5 degrees

Figure 2 : Improvement in print quality

The G-Code for the print in Figure 2(b) was generated manually by setting the locating the COTS item in the center and incrementing the R-Angles uniformly by 5 degrees in each G-code. On attempting to generate the same using the software by adding a condition to accumulate R-Angles if they were less than 3 degrees, we found that alternate G-Codes would skip the C angles altogether, causing the print to be non-uniform throughout the perimeter. This is shown in Figure 3.



Figure 3 : Uniform irregularity

This behaviour makes sense since the G-Code is only changing the R value in every alternate line. Hence, what remains to be debugged is why the firmware causes a drift when handling angles that are less than about 3 degrees.

We also noticed that the stepper motor did not produce enough holding torque to keep the nozzle in place. It would often hit a printer part and move, causing the rest of the print to go wrong. To tackle this issue, the current to the motor was increased. This largely solved the issue.

The remaining time was spent testing the quality of prints by replicating the print exhibited in Figure 2b.

Challenges

This week, the team saw a lot of progress in terms of print quality and drift correction. A major challenge was the time that testing takes. It meant spending long hours in the lab waiting to see gradual results. The entire team tackled this by dividing up the print requirements and spending nearly equal time testing the printer.

The second printer was purchased to speed up the testing. However, due to the mount not being sturdy and the nozzle clogging often, we were not able to make much use of it. We plan to have the printer set up with the same mount as the working printer by this week, so as to be able to test more prints quickly.

Teamwork

This week, we all put in a lot of effort as a team. The dynamics were as follows:

Nikhil Baheti

Since Nikhil is most familiar with the firmware, he was in charge of modifying it. The entire team helped him come up with ideas to change and test the firmware so as to narrow down the underlying cause for the drift.

Dan Berman

Dan machined two new heat blocks that are slimmer and less bulky. This was necessary since the older, more bulky heat block was likely to come in the way of any COTS item we would insert. He also helped out with debugging by writing a script to generate G-Code with uniform R-Angles.

Ihsane Debbache

Ihsane largely worked on testing the printer for repeatability. He designed the STL parts that we will be printing in the SVE.

Future Goals

The goals that remain for the team and for me as an individual team member are as follows:

- Work with Nikhil to get down to the bottom of the drift issue.

- Test print all the SVE parts several times.

With the SVE only a week or so away, we are all working towards performing the experiment again and again leading up to the big day.