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Team F: ADD_IN

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ILR03

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I - Individual progress

My goals this week were to machine and test the heat block and research appropriate slip ring and rotary stage. I also worked on the PDR and studied some ways to improve our system.

1.1 - Heat block:

The heat block was actually machined by Dan, who is a professional machinist and managed to do a great work really fast. I then ran some tests prints with it. The results were very promising, as the printed filament consistent, even though some leaking can be observed, which is not totally surprising for this first design. Figure 1.1 shows the implemented nozzle during a print, and the leakage can be observed. We will of course have to iterate on the heat block, but this first experiment made us confident that we will be able to implement the bend in the heat block, where the filament is melted, thus solving any kinking problem and keeping our offset relatively small. It is 10 mm in our current implementation.

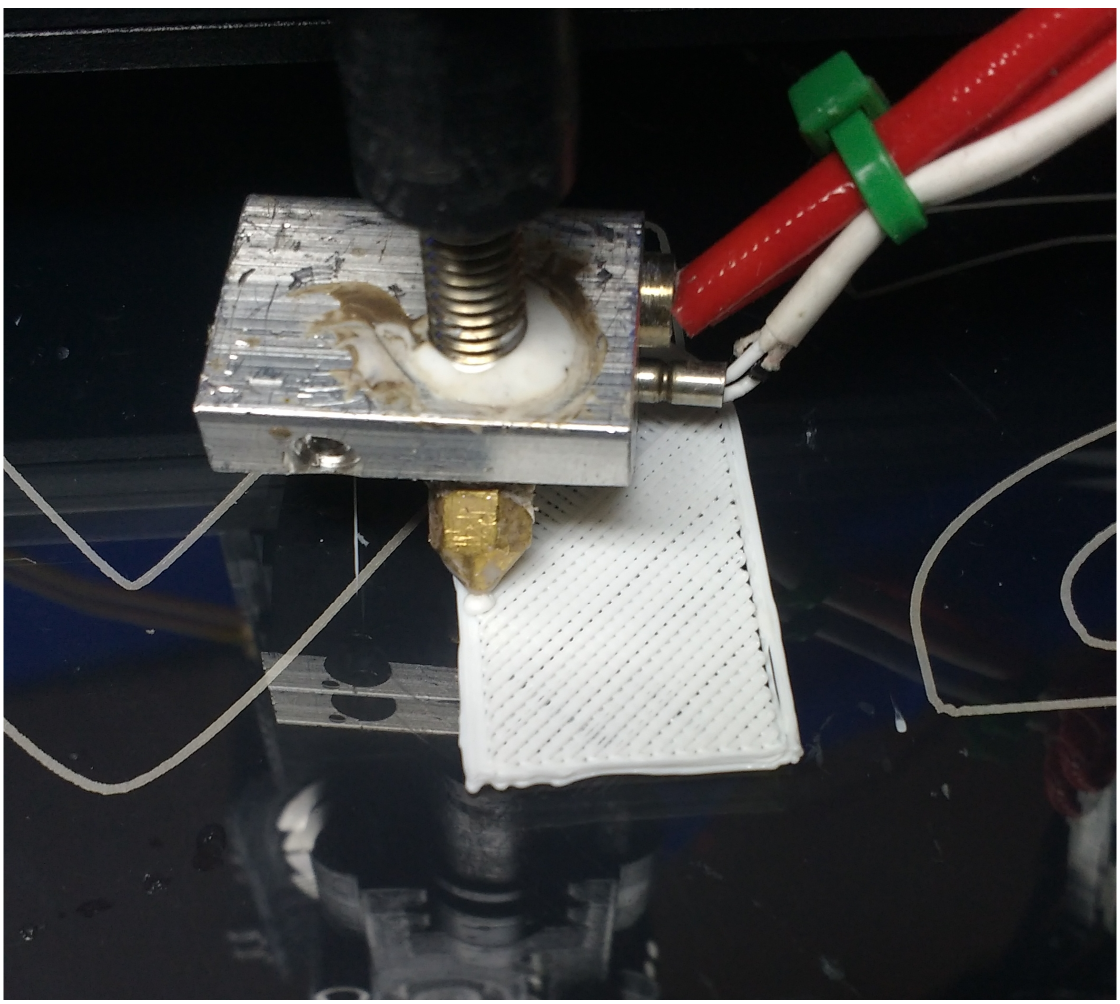


Figure 1.1 ADD_IN Hot end V0.1

1.2 Selecting R joint actuator

After doing a lot of research on rotary stages, the most compact one available was the DT-34 by PI-Micos, shown in figure 1.2 a. It largely satisfies our repeatability and speed requirements, and weights 150 grams.

But taking many parameters into account, I realized having a rotary stage on our extruder is not the best design, so I started looking at hollow shaft stepper motors. The reason is that a rotary stage would too bulky and the mounting complexity might create problems, while hollow shaft steppers, even though they offer much smaller positioning resolution, come close to rotary stages in repeatability, which is what's important in our project. Also our required hollow shaft diameter can be reduced to as little as 4 mm, the minimum to let the filament through. Those facts motivated us to look for a hollow shaft stepper motor instead of a rotary stage. One interesting model is shown in figure 1.2 b.

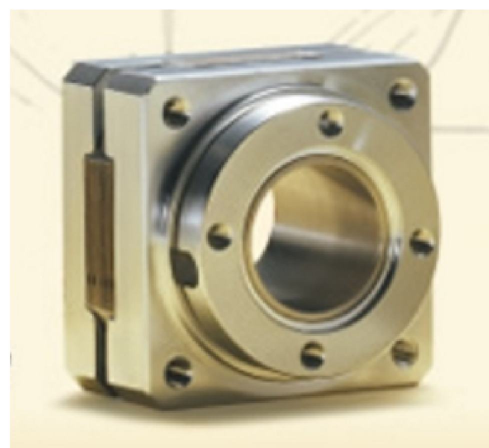


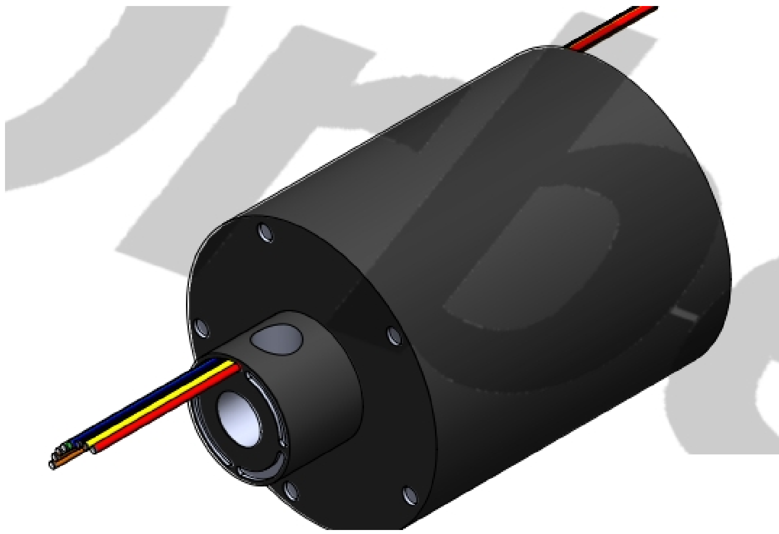
Figure 1.2 a) DT-34 rotary stage b) Asahi HSM-3604 hollow shaft stepper motor

The repeatability of standard stepper motors is 3 to % of a step. With most models having 200 steps per revolution, that gives us a 0.09° repeatability in the worst case. Even though higher end steppers can do much better. Since we now know that our offset can be limited to the order of 10 mm or less, a standard stepper satisfies our requirements, and greatly simplifies our control and our mount design.

We placed an order on a cheap stepper motor at first, to quickly implement and test it. We can then invest on higher end products when we validate it is what we need.

1.3 Slip Ring

The slip ring we selected is the 504-0600 hollow shaft slip ring by orbex, and is shown in figure 1.3. It offers a compact design and a 4.5 mm through hole, which is just enough to let the filament through inside of a 4 mm PTFE tubing. The quote we got was 140$, and the slip ring has very good specifications.



1.4 Improving the system

I have also been thinking on ways to improve our system, and one method to do that is to bend the barrel backwards near the junction with the stepper, so that the the heat block will have an offset and the nozzle tip will be closer to the axis. A bend of about 10° would make the nozzle tip on the axis, completely removing the offset. If we manage to precisely achieve that, it would mean the R axis could be rotated without the tip changing position. And that would tremendously simplify and improve our system. First in precision, the precision of the original 3D printer would stay still. Second the speed and precision requirement on the stepper would be dropped, since rotating by say 10 ° or 20 ° wouldn't change much as long as the COTS item is still avoided, third the path planning would be simplified because then we can keep the exact same XYZ generated by slicer, and generate a 4th R position that is robust to errors and does not interfere with the XYZ, and finally the firmware would also be simplified greatly, since the synchronization requirement of the R axis with the XY profile is less important, and thus the R axis can be controlled as if it was a second extruder motor, which is a capability that is already implemented in the firmware. All these tremendous advantages motivate us to try and achieve that in the future, even though having the nozzle tip not move at all while the R axis is rotated is going to be hard to achieve, it is worth pursuing.

II - Challenges

The challenges that were faced this week where mostly related to printing with the new heat block. First of all the recently machined block started leaking after printing for a few minutes. The leaking can be greatly reduced using teflon tape, but not totally eliminated. This problem will be addressed in the next iteration of the heat block.

The second challenge was that the hot end started jamming at the groove mount level, due to a well documented issue that happens when using a different barrel than Makergear's. Dan fixed it by machining the barrel, but some jamming was still happening due to filament being still stuck in the gap. We ordered new barrels and groove mounts to avoid having to deal with any more of these issues.

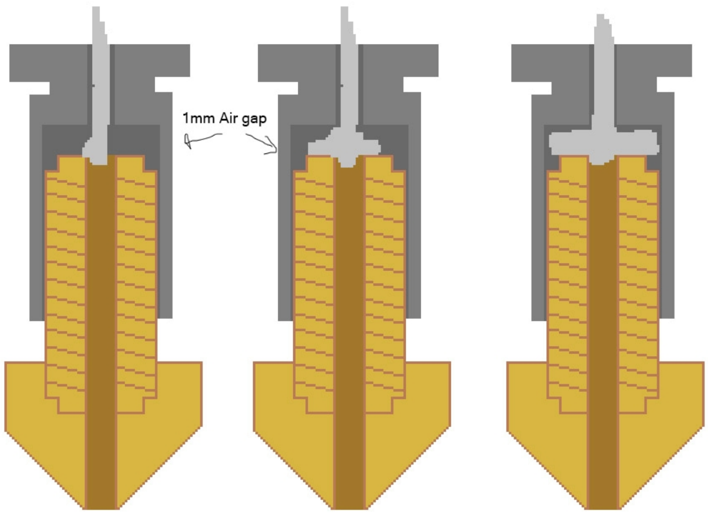


Figure 2.1 a) Air gap causing the jam b) Makergear barrel above vs standard barrel below

III - Teamwork

During last week, Astha managed to show STL files and the insertion layer in matlab. Dan made good progress on the path planning, and is now able to show it in matlab, and he also machined the heat block. And Nikhil started working on the firmware, understands now the various parts and is able to move a 4th stepper. Also all the team worked a lot on the PDR.

IV - Future Plans

The future plans for the next two weeks are to work on designing the mount in cad, and 3D printing it, then order a stepper and slip ring. I will also work on fixing the leaking in the heat block and designing the bent barrel mentioned in 1.4.