Progress Review 4

Nikhil Baheti

Team F: ADD_IN

Teammates: Ihsane Debbache, Dan Berman and Astha Prasad

ILR05

November 25th, 2015

1 Individual Progress

This week I had to work on the firmware and control the R-axis stepper motor given a relative position to extrude. This is independent and not in synchronization with the other axes of the printer. However, the team's priority was to ensure the nozzle prints filament uniformly. Thus, I helped Ihsane whenever needed. Also, since the heat block was modified, its heat transfer properties changed which affected the PID constants heating. I also worked on the project website and made modifications to it.

1.1 Stepper Motor R_axis Control

I had to modify the firmware to ensure that the R-axis stepper motor can be controlled by a user-defined angle. This can be used by the firmware in future, to run the R-axis stepper motor by degrees defined by the Gcode. The modifications in the firmware are as follows:

1. **Configuration.h**: Added ADD_IN as a parameter to keep track of changes made in the firmware for this project. Also, modified the PID constants, which will be defined for the ADD_IN heat block. Code snippet in Figure 1.1 shows the format that will be followed for all further modifications to the firmware.
2. **Pins.h:** Defined the R-axis stepper motor control pins.
3. **Marlin_main.cpp:** The R_AXIS variable was defined and the Gcode G5 was defined to invoke the R_axis control code.
4. **Marlin.h:** Modified variable like NUM_AXIS, destination, feeder rate, etc which define the axis variables.

```
//ADD_IN
#ifdef ADD_IN
    #define  DEFAULT_Kp 28.81
    #define  DEFAULT_Ki 1.61
    #define  DEFAULT_Kd 128.77
#endif
```

Figure 1.1: Code snippet showing format for ADD_IN Firmware changes

Also, with the above modifications, I now have a better understanding of the motion profile function and the planner function. While modifying these file the lcd interface files also had to be modified to accommodate for the R_AXIS changes.

1.2 Tuning the PID Constants for Temperature Control of Heat Block

The newly machined heat block was not settling to the desired temperature quickly. This was because of its change in the heat transfer properties; as a result it changed the heating curve. Therefore, the PID constants for the nozzle temperature control must be modified. To tune the PID constants, concepts from the MMC controls class were used. However, in the process of tuning I found an auto tune library for 3D printers. It can be invoked using the command "M303 E0 S220 CX." Here X represents the number of cycles for tuning. This returns the PID values which were then modified in the firmware.

1.3 Extruder Testing

During the testing of the heat block Ihsane needed help in reinserting the barrel into the extruder. I helped him with the same.

1.4 Website Changes

I was assigned the work to upload the project progress to the website and thus, I updated all the pages of the website.

2 Challenges

The challenges faced during the term of this progress review are as follows:

1. **Firmware:** There was a bug in the modified firmware which turned off the PID control when the temperature reached the desired temperature. This bug could not be debugged and thus the original firmware was modified again to get the stepper motor running independently.
2. **Log Changes:** The changes made in the firmware must be logged to avoid future errors. Current I am updating it in the Visio file which I am using as reference, but I will have to implement a logger function for this.
3. **PID tuning:** Tuning PID constants for temperature control is time consuming as we have to wait for the temperature to reach 220 and then again wait for it to cool down.
4. **Writing to EPROM:** The printer always initializes the variables from EPROM and thus changing the PID constant in the firmware did not change its implementation. To solve this we have written the variables onto EPROM.

3 Teamwork

- **Astha:** She worked on eliminating the filament trail that was being produced during the pause insertion layer sequence. She also helped me with the modifications that I made to the website.
- **Dan:** He also worked on eliminating the filament trail that was being produced during the pause insertion layer sequence. Apart from this he also worked with Ihsane on testing the heat block print quality.
- **Ihsane:** He was responsible for testing the machined heat block. He also worked on the CAD file designing for the joint assembly. He has filtered a hollow stepper motor which we will use for the project. He has also ordered the slip ring. He also helped me select the stepper motor connector and order it.

4 Plan

For the FVE, I plan to work on ensuring the nozzle prints uniformly for a minimum of two orientations. This means it can print uniform lines and arcs. The FVE experiment will be rigorously tested to minimize the failure chances. Also, Dan and I will work on soldering the PCB and testing it to make sure it works.