Pour-over-and-over

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Electrical and Computer Engineering Department
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Product Pitch

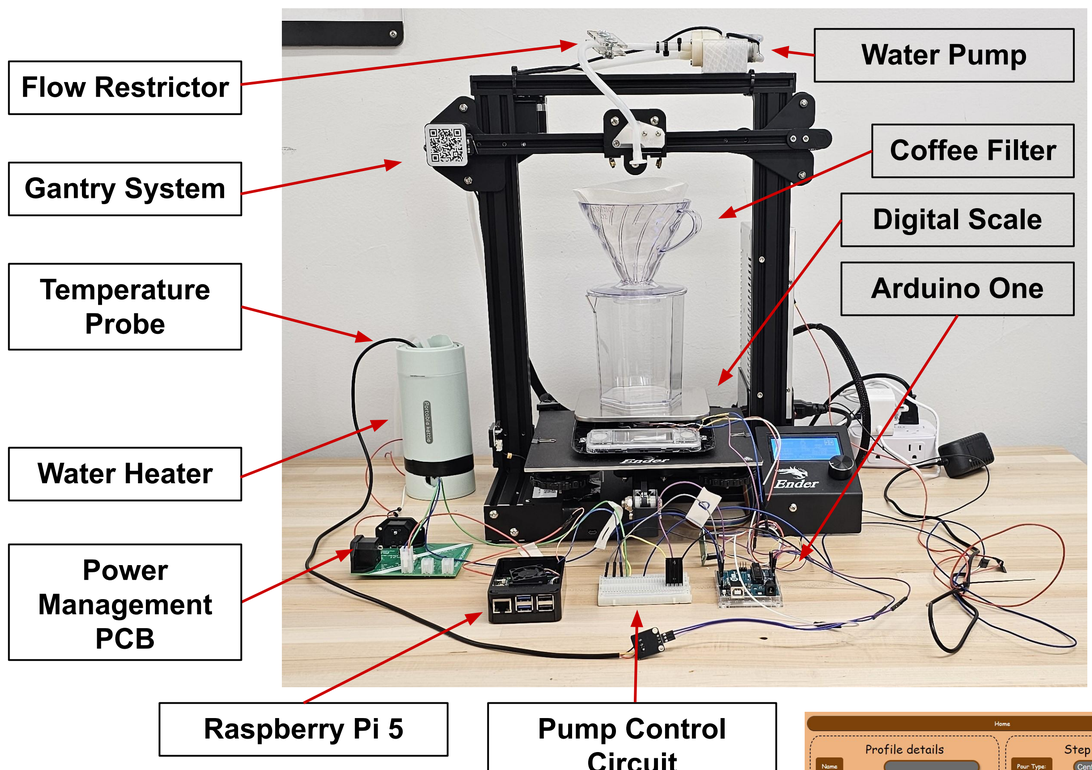
The world of coffee brewing is diverse and complex. When evaluating different brewing options, one must often choose between convenience and quality.

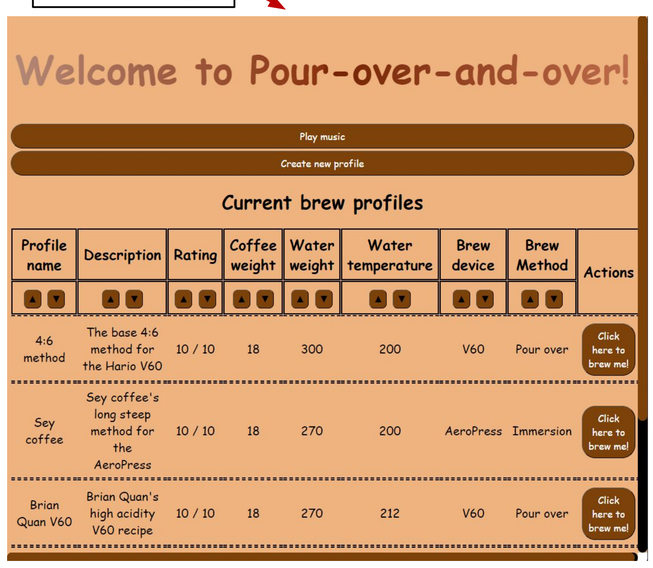
Our project, the Pour-over-and-over automatic coffee machine, aims to bridge this gap between a convenient and quality cup of coffee!

We approached this project with two types of users in mind. Firstly, we wanted a coffee machine that is simple and easy-to-use for those prioritizing a quick cup of coffee. We did this by creating 5 different brewing presets the user can select. After pouring in room-temperature water into the machine, pouring coffee grounds into the filter, and selecting the brewing option they desire, the user will not have to perform any further actions. However, we also wanted to create a machine capable of delivering an in-depth, customizable pour-over brewing experience for the coffee nerds (like us!). To do so, we wanted to enable the user to create and edit their own brewing profiles, with the following variables available to the user to change:

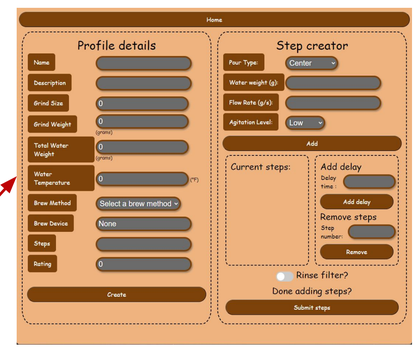
- **Water temperature:** Our machine is currently capable of heating water from **180℉ - 212℉, with an accuracy of ±5℉**
- **Flow rate:** tested flow rates available to user range from **2 - 7 g/s**
- **Pour Pattern:** the user can build their own pour pattern sequence

System Description

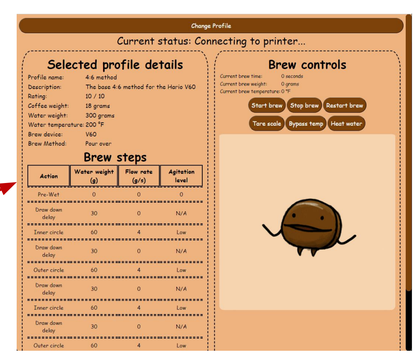




Profile creation page



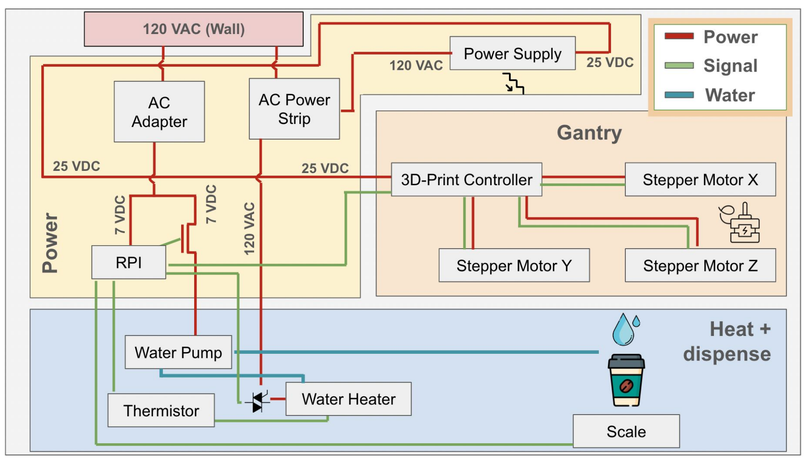
Brew page



System Architecture

Hardware Subsystem Block Diagram

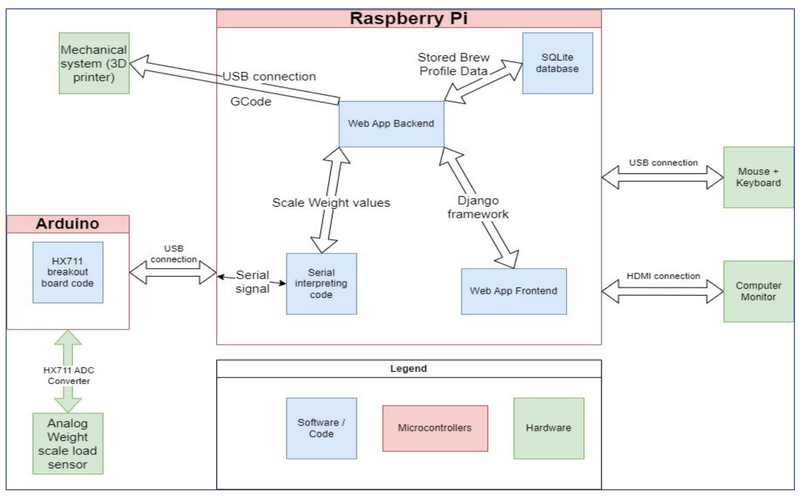
We have a power management PCB which switches the heater @ 120VAC using a TRIAC, connected through an optocoupler to the arduino. The scale is connected to the RPi through an ADC.



The pump system is controlled by a power MOSFET, which is switched by a 9V power supply through a small signal MOSFET. This allows us to regulate the flow rate by varying the PWM signal from the arduino. Lastly, the gantry's stepper motors are connected to the 3D-Printer Controller, and we communicate to it through the RPi.

Software Subsystem Block Diagram

We are hosting our Django-based web application on a Raspberry Pi, which is connected via USB to our other devices such as Arduino, Mechanical system, and interface devices.



The Arduino is running code to interpret signals from the Raspberry Pi and turn them into analog signals for our hardware to interpret. The Arduino is also sending sensor data over serial to the Raspberry Pi. The web application is sending GCode directly to the mechanical system over USB, allowing for quick and easy interpretation by the mechanical system.

System Evaluation

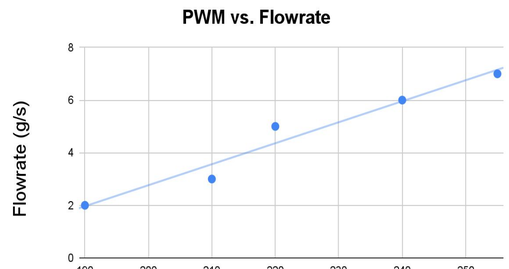
Temperature

Ran **4 trials** at different target temperatures to ensure we are **within 5 degrees F** from the target. This ensures the user will get **consistent extraction** levels based on their temperature profile.

Temperature **Target** (℉)	Temperature **Min** (℉)	Temperature **Max** (℉)
180	177	183
195	190	200
205	203	207
212	212	212

Flow Rate

Characterized the pump + flow restrictor circuit by pouring water at different PWM levels, and **measuring flow rate with digital scale**. To the user, this ensures consistent **grounds turbulence** as well as **filling up a full cup of coffee**.



User Experience

We **surveyed** students with questions regarding the user interface to determine **ease of navigation** and **functionality**. To our use-case goals, this ensures our product is **accessible** to beginners and experts alike!

Question Asked	Result
How useful were the features (tare, profile creation, sorting)?	**4.8**
Was it easy to navigate?	**5**
How satisfied are you with the functionality?	**4.3**
Do you see yourself using this at home?	**4**

Conclusions & Additional Information

Scan this to explore our design website that's filled with behind-the-scene goodies!

https://course.ece.cmu.edu/~ece500/projects/s24-teama1/

Summary - Overall, the team had an absolute blast creating the Pour-Over-and-Over coffee machine. Being pour-over coffee lovers ourselves, it was a project near and dear to us.

Lessons Learned - Perhaps one of the biggest lessons we learned during this project was to read the data sheets of *all* of the components we integrated into our project. There were several times in which we could have saved ourselves *many* hours of troubleshooting if we took the time to read the datasheets - even the parts that did not seem pertinent at the time.

Final Thoughts - We hope that someone will find this project compelling enough to implement for themselves! If interested, scan the QR code on the left to get started!

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