# SFSU

## Electric Kettle – Intro to Microcontrollers

**Title:** Electrifying a Kettle – Creating an Electric Kettle Attachment

**Date:** Friday, December 20th, 2024

**Lecturer:** Prof. Jonathan Song

**Subject:** ENGR 294-01: Intro to Microcontrollers

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**Abstract:**
The project presented here is an attachment for stovetop kettles designed to mimic the advantages of an electric kettle without the need for one, by creating an attachment that replaces the kettle lid with a device that can let the user know when their water is ready, with an ability to set the temperature depending on the drink desired. The electric kettle attachment has a DS18B20 temperature probe that detects the water temperature, a series of buttons to set what temperature the user would like the water at, and a RGB LED alerting the user when the water is ready. These parts were connected together using a breadboard and controlled by an Elegoo UNO R3, all of which were housed inside a custom-designed case printed using PLA plastic on an Ultimaker 2+ Connector 3D printer, made with the help of the dimensions of the old top for the kettle for a perfect fit.

**Background and Schematics:**
The main reason why I had chosen this project was due to circumstance, since originally I was prepared to design and create a coffee machine. I had prepared all the material and had even drawn a schematic, but unfortunately too many of the components involved failed to function. More specifically, the water level sensor failed to work despite numerous attempts so there wasn't a feasible way to detect the water available in the reservoir, and the heating element wasn't working as intended, which convinced me to prevent using it out of fear of creating a fire hazard in my home. Due to these unprecedented hardware issues, I pivoted to designing this project, which was an attachment that essentially turned a stovetop kettle into an electric one. Below I have attached the schematic I drew up prior to beginning the design and building of the electric kettle attachment, where you see where I included the DS18B20 temperature sensor, the RGB LED, the buttons for the different temperature thresholds, and the microcontroller controlling it all. I have also included the simulated schematic that I used for testing code prior to real-life tests, which has all the same components except for the temperature sensor, which I simulated using a potentiometer as a test for the varying temperatures from the kettle.

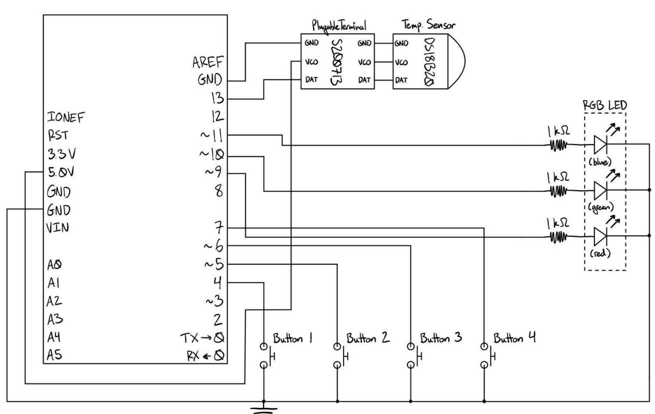


**Figure 1:** Hypothetical Schematic of the Electric Kettle Attachment (drawn using Goodnotes)

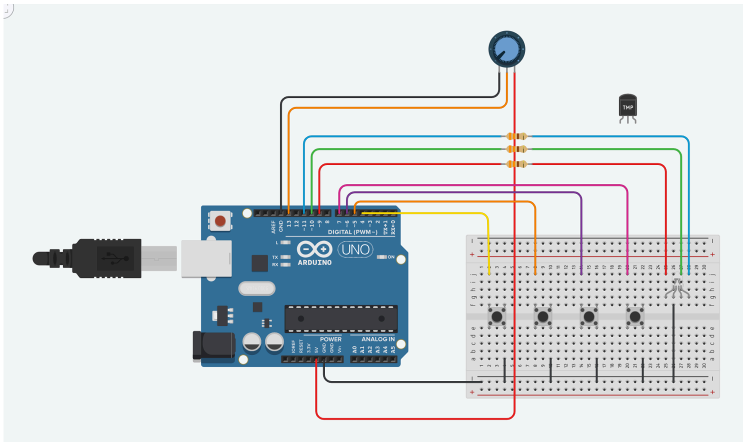

**Figure 2:** Simulated Schematic of the Electric Kettle Attachment (created using TinkerCAD)

**Testing:**

As previously stated, I first began testing the electric kettle attachment via the simulated schematic I designed in TinkerCAD, where I began to write the code before commencing the building of the hardware. After writing and troubleshooting the code for the attachment, I tested the electric components to ensure the temperature sensor, the LED, and all of the buttons involved were working as intended, particularly concerned after the issues I ran into previously with the water level sensor and the heating element. After conducting a hardware and software test, I put them together using the Arduino IDE and made sure both worked together before designing and building the enclosure for the electronics. Due to time constraints I didn't have time to test the integrity and fit of the PLA enclosure, but fortunately the plastic attachment fit perfectly as a replacement for the kettle lid and had enough space between the electronics and the heat exuded from the kettle to prevent a hardware malfunction. Finally, I conducted a final test with all of the components of the project combined and recorded a video of the final product functioning (visible in the in-person presentation of the project).

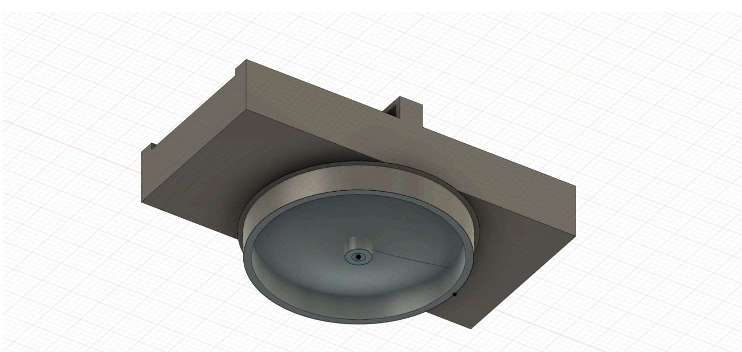

**Figure 3:** CAD model of the kettle lid attachment (designed in Fusion360)

**Recommendations:**

Naturally, if I had more time I am positive I could have found alternative pieces for the water level sensor and the heating element so to execute my initial idea for this assignment, since having to present prior to Thanksgiving break as well as waiting for shipping times meant that I had no feasible way to find replacement components for each. However, for the electric kettle attachment specifically, I would make a couple of minor changes, specifically making the product more user-friendly by using a visible display of the temperature selected, as well as a device that emits sounds to alert the user that the water is ready. Additionally, although PLA plastic is food-safe, the high temperatures from the boiling water introduce the possibility of plastic contamination of the water, so finding an alternative material that can withstand higher temperature and remain both food-safe and relatively inexpensive would been the next improvement.

**Main Takeaways:**

One of my main takeaways from this project was the importance of providing ample time in a project's schedule for unforeseen hurdles, such as my issue of faulty/unsafe components forcing me to pivot to a different project. In the future, I will always keep in mind the possibility of unwanted issues when scheduling out a timeline for any future projects. I also learned how extensive it was to create an enclosure with the right tolerances to fit as a kettle lid, making me realize the importance of creating the right presentation for the attachment, since for the looks for any product is essential to its ability to be presented and commercialized. Nonetheless, I am proud of still presenting a project with sufficient technical difficulty, learning both from the development of the project and from the planning of the project itself, to hopefully become a better prepared engineer in the future.

**Bill of Materials:**

| Part/Component | Quantity | Price |
| --- | --- | --- |
| ELEGOO UNO Project Super Starter Kit | 1 | $44.99 |
| DS18B20 Temperature Sensor | 1 | $9.99 |
| PLA Kettle Lid Attachment | 1 | $0 (used free resources at SFSU machine shop) |
| | Total (+ SF local tax): | $59.72 |