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ECE 110 Honor Section

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Honor Project Report

Introduction

Problem Description

During this honors section, we attempted to create a heating system for drinks that could heat up a drink and then keep it at a constant temperature for as long as one pleases. To do this, we used a heating pad that would heat up based on temperature of the liquid, and we could control the heating pad having a temperature sensor to detect the temperature and output a variant voltage into Arduino, which will take that voltage and decide whether to turn on or off the heating pad.

Design Concept

Our design uses a heating sensor, heating unit, and an Arduino. At first, we tried to use a comparator chip, but found that this would be significantly harder because we would have to convert an analog to a digital signal. So to simplify, we decided to use an Arduino which already has a lot of functionality that we can easily use. By doing this, we had a constant source of power to the heating pad. We used a battery to power the Arduino circuit, which then output current into the heating pad.The next step was to find a way to control that output from the Arduino so that the heating pad turns off when it gets to a certain temperature. To do this, we used a temperature sensor which was attached to the heating pad and connected to the Arduino. Once we had this temperature reading, we wrote code that stopped the output of current to the heating pad. To keep the heating pad at a provided temperature, we had the code run every 10 seconds so that it can adjust quickly. When we began to test, we realized that the heating pad was only getting about 300 mA, when it is rated for 600 mA. To fix this, we used a BJT as an amplifier so that we could obtain more current. Once we put the BJT into this circuit, we started to obtain around 550 mA.

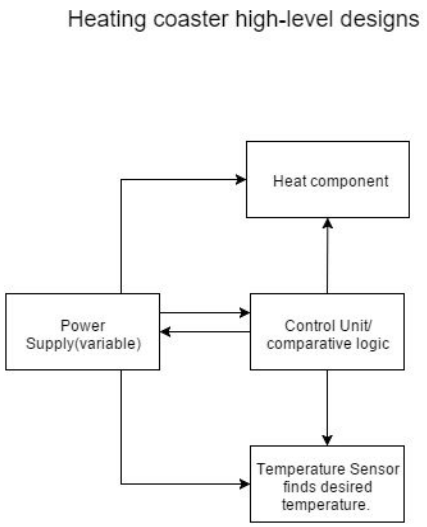
Design

Components

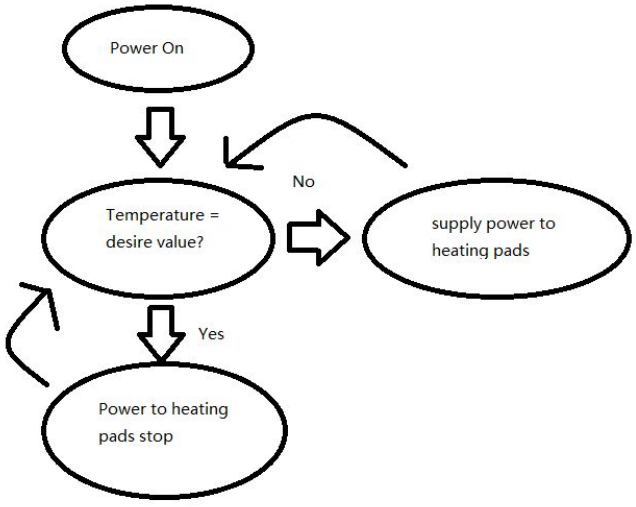
- SparkFun RedBoard with Arduino
- LEDs
- Breadboard
- Heating Pad - 5x15cm

- TMP36 Temperature sensor
- 2N5192G Transistor
- 330 ohm resistor
- 7.2 V battery
- Bunch of wires!

Block Diagram



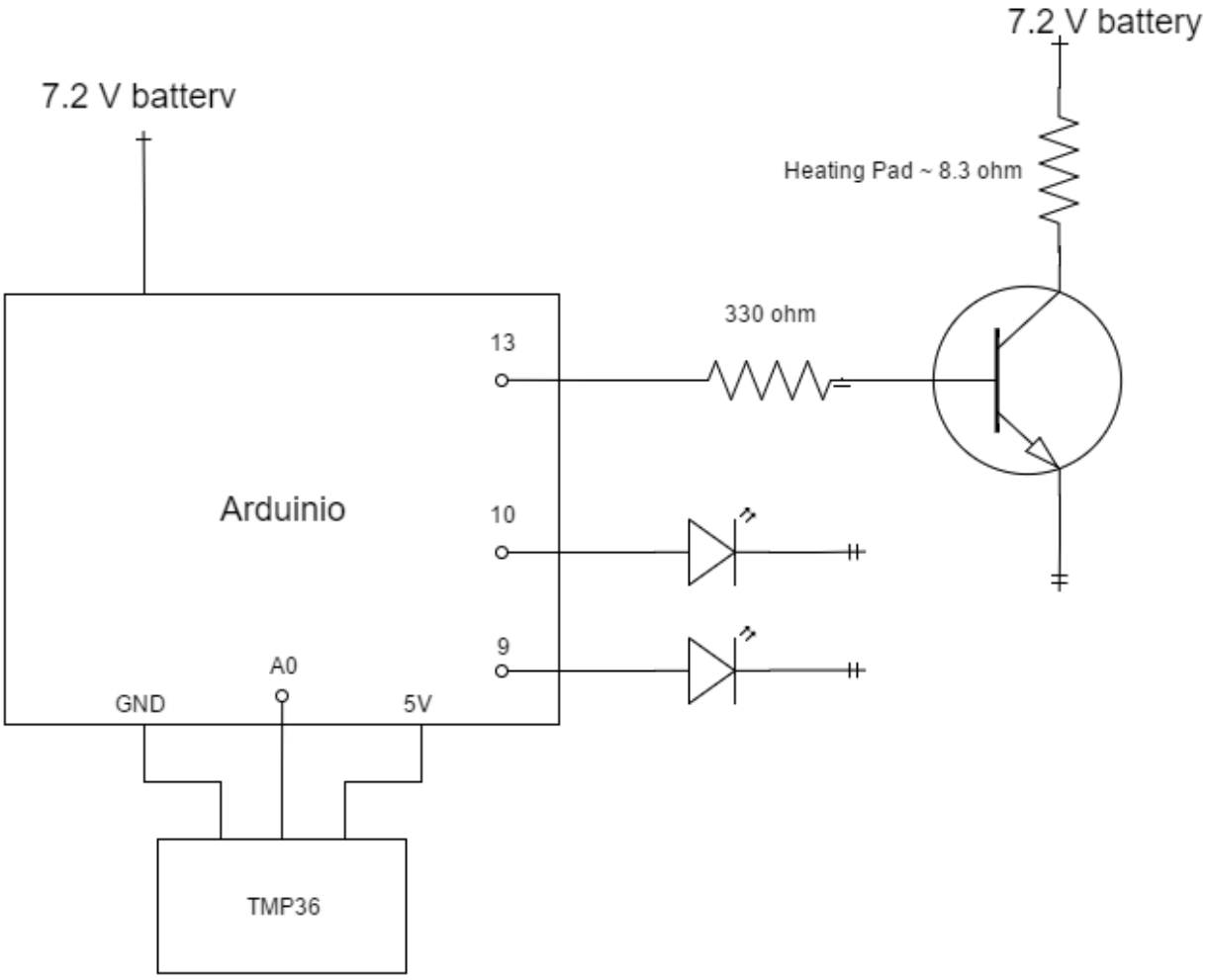
State diagram:



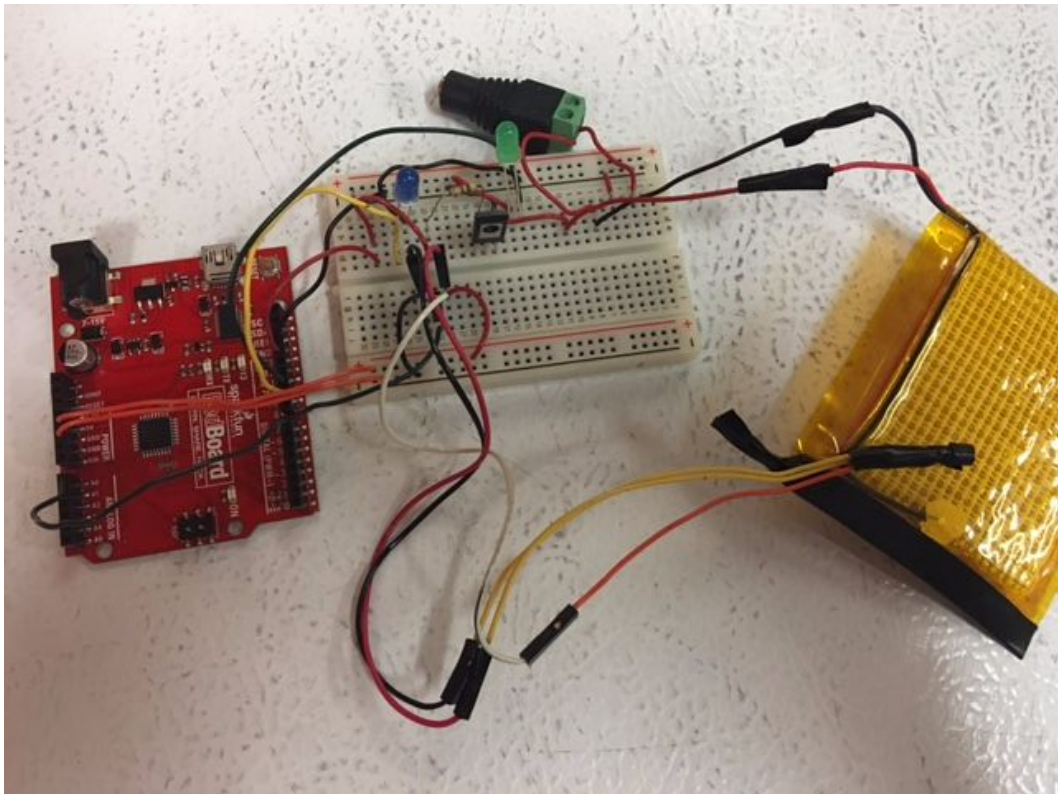
Written Description of Blocks

The first diagram explains that we will have a power supply controlling the heat component and a temperature sensor. This just explains how they will be powered. Then we have a control unit, which in our case is the Arduino that is based in the power supply, but directly controls the heat element and uses the temperature sensor. This control unit basically provides all the functionality that is used for our project. The next diagram is the basis for our Arduino logic. The code runs a loop every 10 seconds, and when it does, it checks if the temperature from the temperature sensor is at the desired temperature. If it is lower than the desired temperature, then we continue to supply power to the heating pad. If it is higher than or equal to the desired temperature, then we cut off power to the heating pad.

Circuit Diagram



Pictures



Code Used

```
void setup() {
  Serial.begin(9600);
  const int heating = 13;
  const int sensor = A0;
  pinMode( heating, OUTPUT);  // outputting to heating
}
void loop() {
  float voltage =  analogRead(sensor)*0.004882814;
  float currentTemp = (voltage-.5)*100.00;
```

```
  float targetTemp = 30;
  if ( currentTemp > targetTemp){
    digitalWrite(heating,LOW); //cut off current to the heating
    Serial.print("Off");
    Serial.print(currentTemp);
    Serial.print("\n");
    digitalWrite(9,HIGH); // turn on LED
    digitalWrite(10,LOW);


  }
  else{
    digitalWrite(heating,HIGH); // continue;
    Serial.print("on");
    Serial.print(currentTemp);
    Serial.print("\n");
    digitalWrite(10,HIGH); // turn on LED
    digitalWrite(9,LOW);
  }
  delay(5000);// check every 5 sec
}
```

Results

In the end, our project worked, although maybe not to the full extent. We wanted to actually heat a drink, but our materials were not capable of this. The heating pad with more like a hand warming device than water heater. The finished project successfully maintains a given temperature, and we can demonstrate this by using the arduino serial monitor. We added additional code that alerts us of the temperature and if the heating pad is receiving current or not. We also had a blue LED to signal that it was heating, and a green one that would go on and off every 10 seconds or so because of the adjustment from the Arduino. We got about 550 mA to the

heating pad, which is pretty close to the 600 mA limit. Even if we got to this point, the increase in heat would not be very significant. Probably the biggest problem was not getting a heating element that is capable of getting up to 100℃.

Future Work

If we were to continue this project, I think that the main thing would be to adapt it so that it can actually heat a drink. To do this, we would have to get a new heating source. We looked into this and saw cartridge heaters, which can be inserted in directly into the drink. These also get very hot, so it would be a better heat source. Since it will draw larger amount of power, we will need to be looking for a larger power supply, maybe directly from an outlet. Then to get the temperature, we could put the temperatures sensor either inside the drink or on the side, but we would have to test for materials in order to get accurate temperature for inside water. To go even farther, we could create a wireless system that allows one to turn on the system with a phone or app and monitor the statues of the system.

Conclusion

Overall, the project worked, the heating element will stop heating when the temperature reaches the desired value and turn back on when the temperature falls back below the value. Though the mechanism does work, but it is not practical, for instance since this is supposed to heat some sort of liquid, our current methods of heating does not provide enough power to heat the liquid. Also, because it does not heat up the liquid, we have to place our sensor such that it will detect the temperature of the heating pad and not the liquid, it just needed a better heating source and maybe we could have hid the circuit so that it would be more practical for a person. In conclusion, we learned how to use transistor so that it can provide power from a larger powering source. We also learned how to characterize our sensor so that we are able to match translate its voltage input to temperature. More importantly, we need to be more careful on deciding our powering source, so we can avoid our mistake for lack of power.