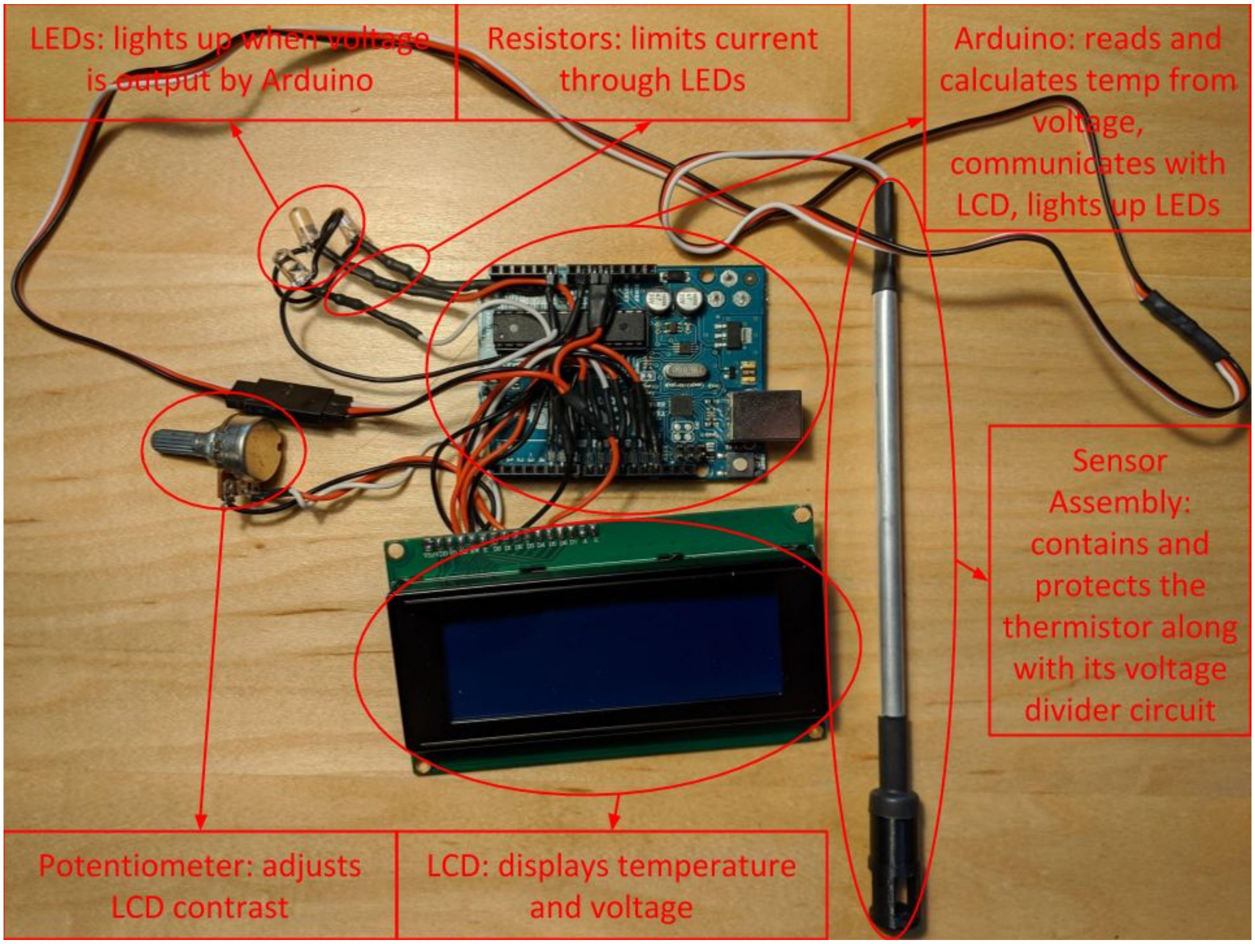
The Arduino Consolometer

Built, programmed and written by Nikolai Nekrutenko

Top-Down Annotated Photograph of Device



Device Construction and Calibration

The device was built around an Arduino Uno microcontroller which uses the ATmega328 chip. A LCD2004 LCD display with a 20x4 resolution was used to display the temperature and voltage. A potentiometer was used to control the display's contrast so that the information could easily be seen. Each 5mm LED was soldered with an appropriate resistor to prevent them from burning out. For the red LED, a 150Ω resistor was used so that the voltage coming into the LED would be within the 1.6V-2.0V range. For the green and blue LEDs, two 200Ω resistors were soldered in parallel for an equivalent resistance of 100Ω for each LED (Fig 1). This was so that the green LED would be within its voltage range of 1.9-4.0V and the blue LED would be within its voltage range of 2.5V-3.7V. A current draw of 15mA was assumed for all LEDs. A female Futaba J connector was soldered onto the +5V, ground, and the analog input port of the Arduino. All the exposed wires were insulated with heat shrink tubing. An enclosure was designed in Fusion 360 and 3D printed for the electronics to be securely held in place and protected (Fig 6).

The device was calibrated against another digital thermometer. The voltage values were measured every 0.5 degree celsius increment, as is shown in *Table 1* and graphically in *Graph 1*. A formula based on the Steinhart-Hart relation was used to come up with coefficients for a prediction curve based on this calibration data (*Graph 2*). Then, a program was written to display values such as temperature, resistance and voltage on the LCD display, and to different LED's light up in relation to the temperature.

A button assembly was also constructed and a program modified to make the device transform into a gaming console (*Fig 7*), thus it was given the name "Arduino Consolometer."

Sensor Waterproofing and Construction

The sensor was constructed with a voltage divider circuit using a 10kΩ resistor and a 10kΩ negative temperature coefficient thermistor. The standard resistor was connected to ground, while the thermistor was connected to +5V. The analog input port was connected in between the standard resistor and the thermistor (Fig 2).

To waterproof the sensor, a combination of liquid electrical tape with heat shrink tubing was used as shown in the image above (Fig 3). Then, the assembly was put into an aluminium tube and the thermistor was further waterproofed with even more heat shrink tubing and liquid electrical tape. The aluminium tube was waterproofed on both sides with heat shrink tubing and liquid electrical tape (Fig 4). A guard was designed in

Fusion 360 and 3-D printed to protect the sensor from damage and to make sure that it was actually measuring the temperature of the liquid, instead of the temperature of the container (Fig 5). A male Futaba J connector was soldered with the ground, analog input, and +5V for ease of use, portability and redundancy.

Tables

Table 1: Sensor Voltage reading versus Temperature.

Voltage	Temperature
1.207	0
1.222	0.5
1.241	1
1.261	1.5
1.281	2
1.305	2.5
1.325	3
1.354	3.5
1.378	4
1.408	4.5
1.422	5
1.452	5.5
1.481	6
1.510	6.5
1.530	7
1.559	7.5
1.579	8
1.603	8.5
1.628	9
1.652	9.5
1.686	10
1.711	10.5
1.735	11
1.760	11.5
1.784	12
1.818	12.5
1.843	13
1.872	13.5
1.891	14
1.921	14.5
1.945	15
1.984	15.5
1.994	16
2.033	16.5
2.058	17
2.092	17.5
2.116	18
2.146	18.5
2.170	19
2.195	19.5
2.229	20
2.248	20.5
2.278	21
2.307	21.5
2.331	22
2.366	22.5
2.385	23
2.419	23.5
2.444	24
2.468	24.5
2.493	25
2.522	25.5
2.546	26
2.571	26.5
2.590	27
2.630	27.5
2.654	28
2.678	28.5
2.713	29
2.732	29.5
2.761	30
2.781	30.5
2.810	31
2.840	31.5
2.869	32
2.893	32.5
2.918	33
2.947	33.5
2.967	34
2.991	34.5
3.021	35
3.045	35.5
3.069	36
3.094	36.5
3.118	37
3.143	37.5
3.162	38
3.187	38.5
3.211	39
3.231	39.5
3.255	40
3.280	40.5
3.299	41
3.324	41.5
3.348	42
3.368	42.5
3.387	43
3.407	43.5
3.431	44
3.451	44.5
3.475	45

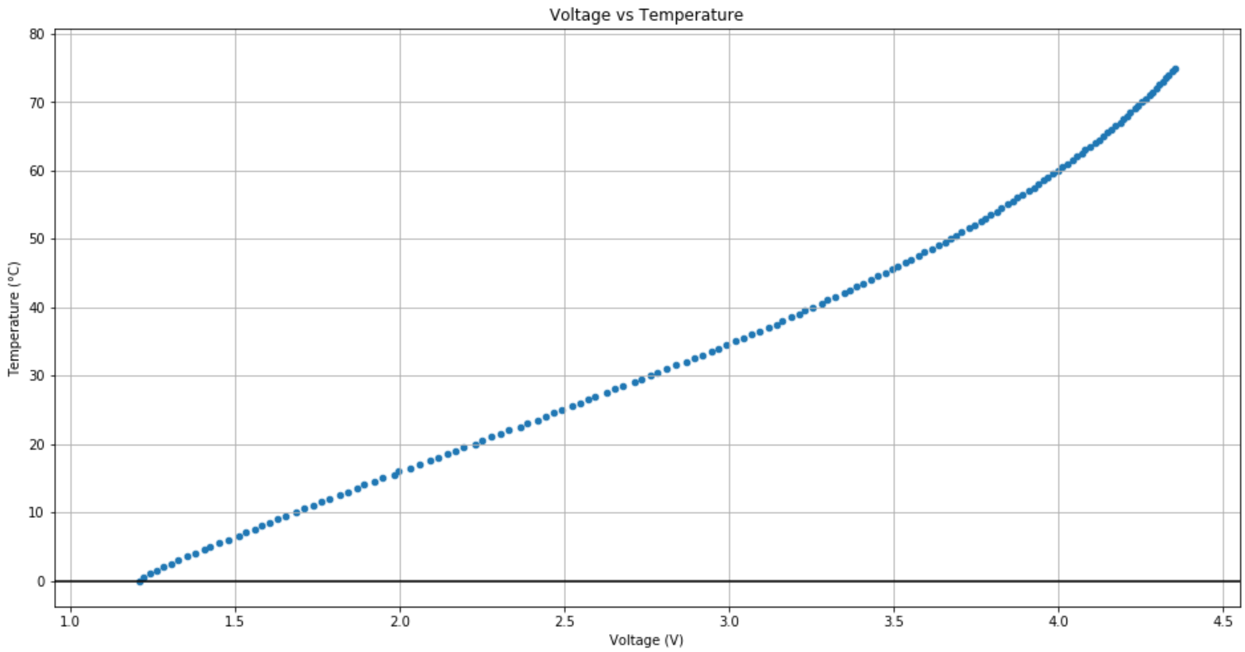
3.495	45.5
3.509	46
3.534	46.5
3.553	47
3.578	47.5
3.592	48
3.617	48.5
3.636	49
3.656	49.5
3.671	50
3.690	50.5
3.705	51
3.729	51.5
3.744	52
3.763	52.5
3.778	53
3.793	53.5
3.812	54
3.827	54.5
3.847	55
3.861	55.5

3.876	56
3.891	56.5
3.910	57
3.925	57.5
3.939	58
3.954	58.5
3.969	59
3.983	59.5
3.998	60
4.013	60.5
4.027	61
4.042	61.5
4.057	62
4.071	62.5
4.081	63
4.096	63.5
4.110	64
4.125	64.5
4.135	65
4.150	65.5
4.159	66

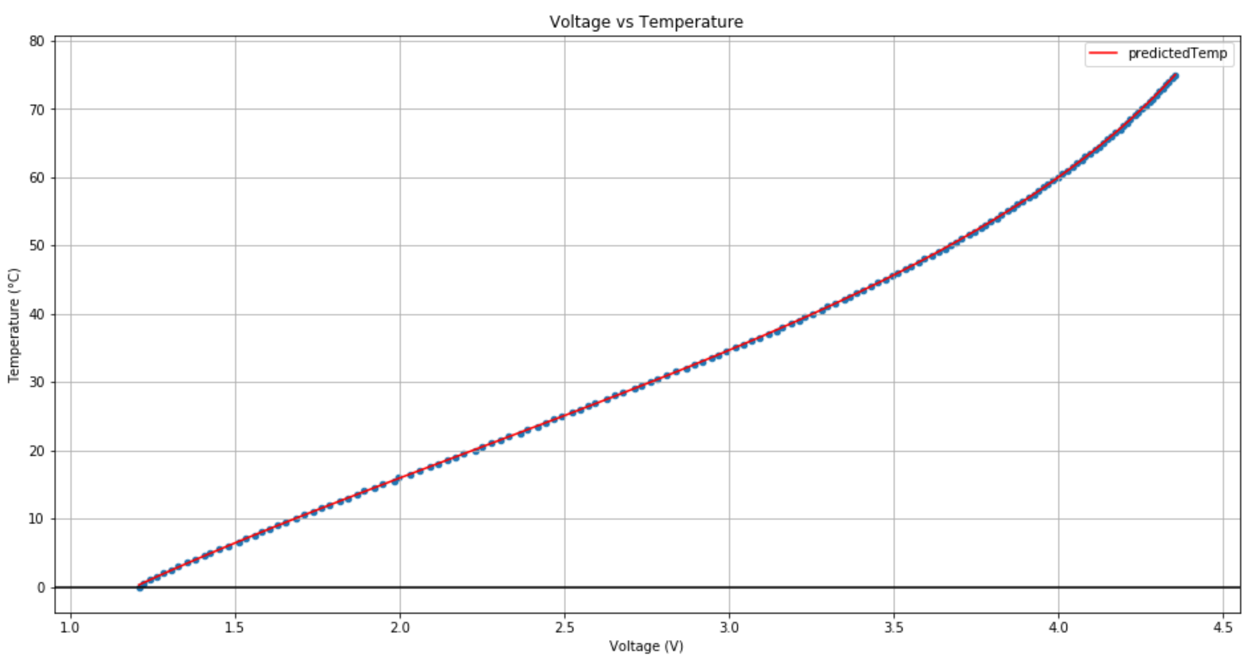
4.174	66.5
4.189	67
4.198	67.5
4.208	68
4.218	68.5
4.233	69
4.242	69.5
4.252	70
4.267	70.5
4.277	71
4.286	71.5
4.296	72
4.306	72.5
4.316	73
4.326	73.5
4.335	74
4.345	74.5
4.355	75

Graphs

Graph 1: Sensor reading voltage vs temperature.



Graph 2: Sensor reading voltage vs temperature (prediction equation overlaid).



Figures

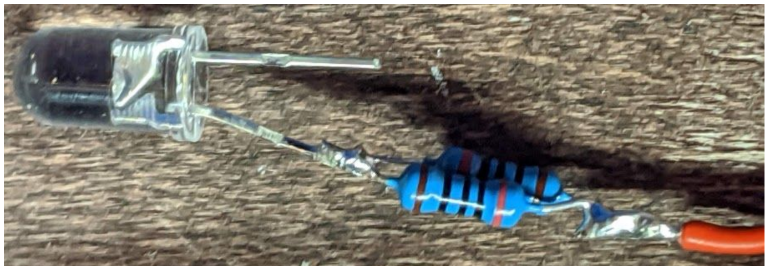


Fig 1: 2 200Ω resistors soldered in parallel, which are in series with the LED.

Fig 2: Voltage divider assembly with black wire representing ground, white wire representing the analog port and the red wire representing +5V. The red electrical tape is covering the 10 kΩ resistor. The 10kΩ thermistor is clearly shown.

Fig 3: Waterproofing of the voltage divider assembly with heat shrink tubing and liquid electrical tape. Once again, the 10kΩ thermistor is peeking out to the right.

Fig 4: Fully assembled and waterproofed sensor assembly. It utilizes a Futaba J connector to connect to the Arduino.

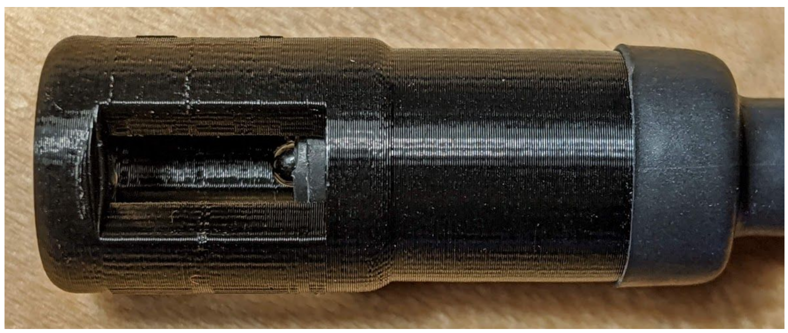


Fig 5: Close-up of the front tip of the sensor assembly. The 10kΩ thermistor is peeking out to the left.

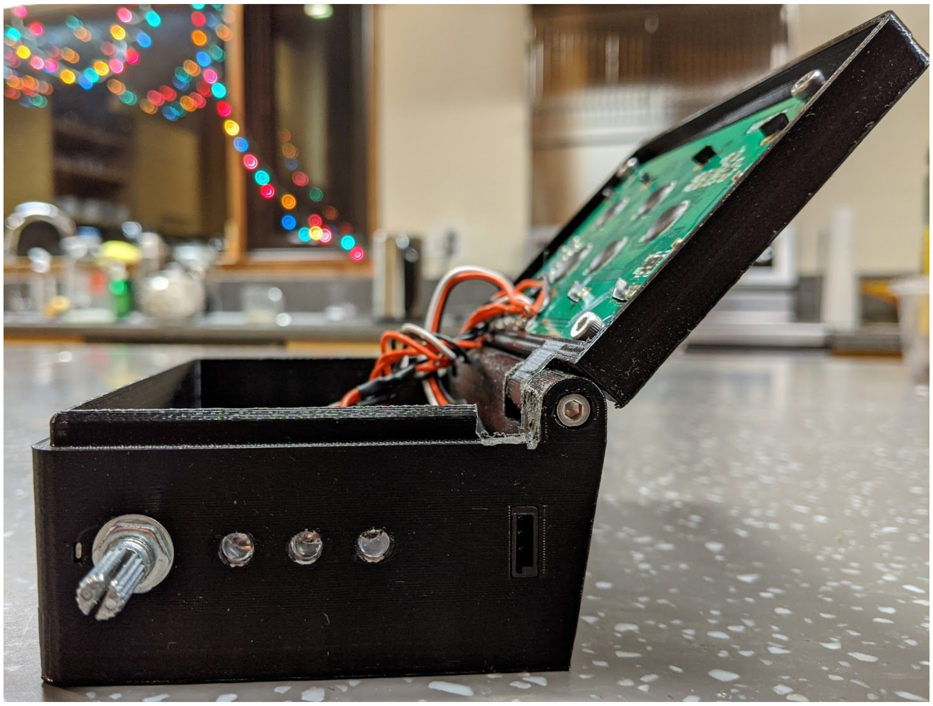


Fig 6: 3D printed enclosure for the device.

Fig 7: Button assembly.