AUTONOMOUS THERMAL DATA COLLECTION. C. M. Peterson[1], Z. T. Zebley[1], Z. Z. Vinegar[1], and V. G. Garcia-Carroll[2], [1] Durham Academy: 3601 Ridge Road, Durham, NC, 27705, [2] Durham School of the Arts: 400 North Duke Street Durham, NC 27701

Introduction: The Mars Outreach for North Carolina Students (MONS program allows Durham area high school students the opportunity to work as true scientists discovering the geologic history of the rocks and soil on Mars, as well as conducting experiments designed by the students themselves. The results of these experiments contribute to a NASA-funded research project led by Dr. Jeff Moersch, at the University of Tennessee, and will help characterize the thermal behavior of Martian bedrock and sediments. In previous years, students spent hours using manual temperature sensors to collect thermal data sufficient for analysis. These probes are designed to be buried in wet and dry sediments. This allows temperature measurements to be taken from below the surface of the sediments being tested. The MONS robotics team automated this process to make it easier and more efficient. First, we determined that the most cost effective sensing device that could be used to convert temperature data to an analog signal, which was a thermistor, a resistor that varies its resistance in proportion to the ambient temperature. We then used an Arduino microprocessor to convert the analog voltage to a digital temperature reading. A user-friendly Java program was also written, which the other MONS students used during their experiments to record and analyze data obtained from the new probes. These probes were so reliable and easy to use that the MONS team completely redesigned their research to incorporate them. During this portion of the program, we gained experience working as tech support, helping to set up the thermistor data collectors for the other groups and troubleshooting any problem that arose..

Construction: Thermisters were used in conjunction with Arduinos to create an autonomous thermal data collection setup.

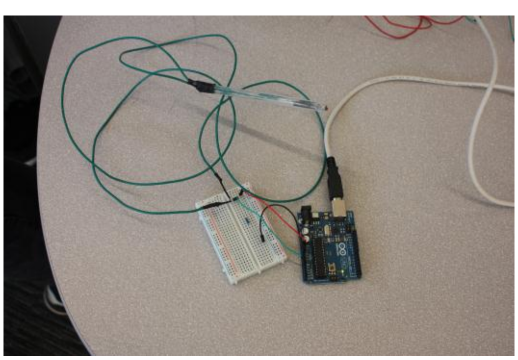

Figure 1

Figure 1 shows the basic setup for one thermistor. The Arduino is used as a power source as well as to interpret the electrical signals and turn them into temperature data. This setup can be condensed into a smaller amount of space on the breadboard allowing for more thermistors to be added to this setup.

The basic setup consists of an Arduino, a breadboard, some wire, a 10 kilo-Ohm resistor, and a thermistor probe. The thermistor probe is a thermistor with a wire soldered to each lead. These joints are covered with electrical tape to prevent a short circuit. The thermistor is then pushed into an empty pen tube so that the thermister is sticking out. This protects the joints when buried in sediment. This can be seen in figure 2.

Figure 2

A wire is connected from the 5 volt port on the arduino to the breadboard. The thermistor is then added to the circuit, from the row with the connection from the 5 volt wire to another row. A wire is then placed in the same row as the second lead to the thermistor to the A0 port (or another anolog port) on the Arduino. The 10 kilo-Ohm resistor is added between the row with the thermistor lead and the analog port wire, to another row. A ground wire is then added from the row with the other lead of the thermistor to a GND port on the Arduino. The circuit can be seen in better detail in Figure 3.

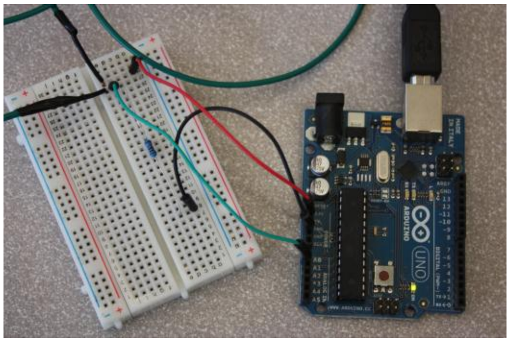

Figure 3

Figure 4 shows the circuit diagram that was used to construct the thermistor circuits.

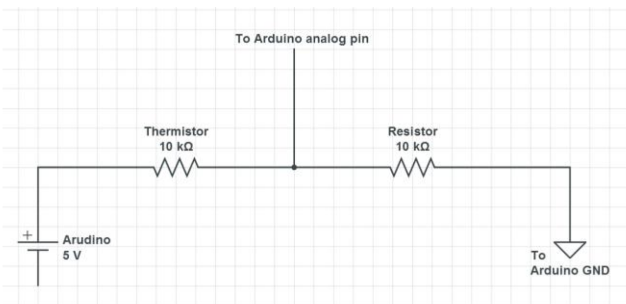

Figure 4

Using Thermistors: A website was used to figure out the calculations needed to take the voltage data into useful temperature data in either Celsius and Farenheit. (Hacktronics, n.d.) Celsius was used for all experimentation. A user interface was made for easier usability as can be seen in Figure 5. There are many features to this program including duration of the testing, and how often data is collected as well as the number of thermistors plugged into the arduino. All data is displayed here, but also saved in a text file.

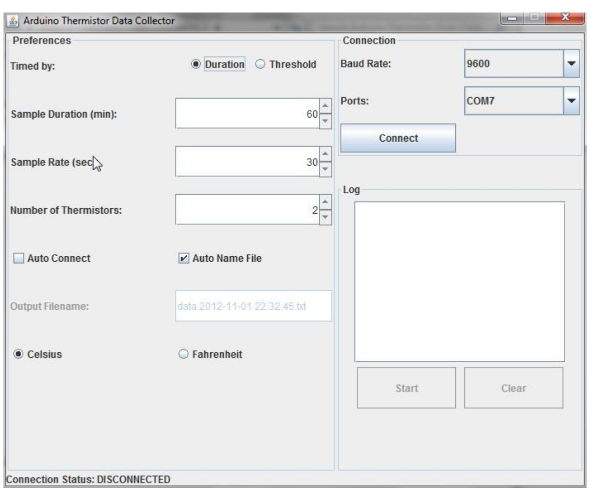

Figure 5

Future Work: Future Work: We plan to continue our work with autonomous data collection in the future. Our long-term goal is to construct a robot capable of taking thermal data using a thermal imaging camera autonomously to allow for outdoors testing for an extended period of time. We plan on using this robot in conjunction with the thermal probes we constructed and tested this past summer.

Refrences:

Arduino thermistor tutorial. DOI: www.hacktronics.com/Tutorials/arduino-thermistor-tutorial.html

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