TerraRover 2 Engineered to Detect and Record Potential Atmospheric Implications of the 2024 Solar Eclipse

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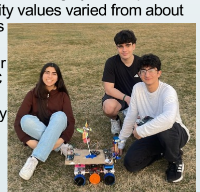
Abstract

In this research, student researchers engineered a suite of microsensors designed to detect and record atmospheric parameters potentially useful for sensing weather variations during the upcoming 2024 Solar Eclipse taking place on April 8th, 2024. These sensors were attached to a NASA TerraRover 2 originally designed to take surface temperature measurements. The researchers specifically utilized a TerraRover 2 to ensure a consistent measure of data and ensure that potential human error was not a limitation. The parameters sensed by the TerraRover 2 include air pressure, air temperature, humidity, light intensity, sound, and a proximity sensor. To detect wind, the researchers used an Arduino proximity sensor connected to a handheld pinwheel. This allowed the researchers to calculate wind speed based on the amount of spins counted while testing. Each sensor was independently programmed using the Arduino programming language and wired onto Arduino Uno Boards. The researcher's goal for this research was to develop protocols that will ultimately be utilized in comparing data the week before, during, and the week after the Total Solar Eclipse. Understanding the variations between each testing period would allow the researchers to make conclusions about the microclimate effects of a solar eclipse. In the future, the suite of sensors on the TerraRover 2 can be expanded to measure different protocols. The microsensors on the TerraRover 2 can be a significant and novel way to monitor changes during a solar eclipse wirelessly.

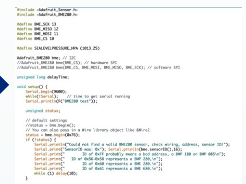
Discussion

Air pressure, air temperature, humidity, light intensity, sound, and wind speed (based on outputs of a proximity sensor) measurements were taken on March 4th. This data was taken to represent the data we will be collecting the week before, during, and the week after the April 8th Solar Eclipse. The location where data was measured was our Band Practice Field, an open, grassy, field directly in front of Crestwood High School. This location is near a busy road, Beech Daly, where passing cars and pedestrians walking by can impact sound levels. On March 4th, light intensity values varied from about 290 lm to about 440 lm; proximity values varied from 2190 µa to 2220 µa; sound values varied from 50 dBA to 90 dBA, air temperature values varied from 18.07°C to 18.14°C; air pressure values varied from 992.74 hPa to 992.83; and humidity values varied from 59.7% to 60.05%. A possible source of error in our research is the accuracy of the microsensors. To verify the sensors' results and data collection, the researchers could compare their data with professional grade sensors; however, these professional grade sensors are often outside of the researchers' budget range. The researchers were able to reject their first null hypothesis. The TerraRover 2 was modified to record air pressure, air temperature, humidity, light intensity, sound, and wind speed measurements. The researchers also rejected their second null hypothesis since they were able to find sensors that captured the data they wanted while simultaneously being cost effective. The researchers are unable to reject or fail to reject their third null hypothesis due to insufficient evidence. The researchers will be able to conclude this decision by April 15th, 2024 once all data is collected.

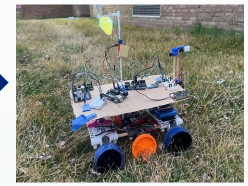


Methodology

Satellite image of data collection site, Crestwood High School



Using the Arduino IDE to code each sensor using the Arduino Programming language



All Arduinos and corresponding sensors mounted onto TerraRover 2

Driving the TerraRover 2 on the open field

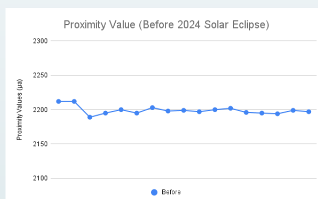
```
18:22:42.248 -> Ambient: 2832
18:22:42.329 -> Proximity: 2219
18:22:43.333 -> Ambient: 2812
18:22:43.473 -> Proximity: 2217
18:22:44.464 -> Ambient: 2819
18:22:44.583 -> Proximity: 2218
18:22:45.550 -> Ambient: 2719
18:22:45.670 -> Proximity: 2225
18:22:46.676 -> Ambient: 2435
18:22:46.797 -> Proximity: 2219
18:22:47.765 -> Ambient: 2270
18:22:47.886 -> Proximity: 2210
18:22:48.893 -> Ambient: 1961
18:22:49.015 -> Proximity: 2207
18:22:50.021 -> Ambient: 2346
18:22:50.144 -> Proximity: 2228
18:22:51.111 -> Ambient: 2419
18:22:51.233 -> Proximity: 2210
18:22:52.242 -> Ambient: 2446
18:22:52.362 -> Proximity: 2220
18:22:53.336 -> Ambient: 2329
```

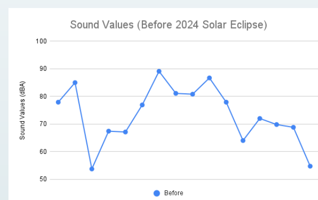
Sensor values get printed onto a Serial Monitor

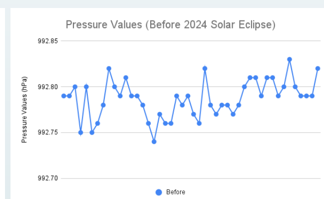
Proximity Sensor microampere (µa)	Sound (dBA)	Light Intensity (lm)	Temperature:
2212	77.9	437	18.12 °C
2212	85	406	18.12 °C
2189	53.7	378	18.12 °C
2195	67.4	371	18.10 °C
2200	67.1	360	18.12 °C
2195	76.9	363	18.12 °C
2203	89.1	352	18.12 °C
2198	81.1	363	18.13 °C
2199	80.8	363	18.13 °C
2197	86.7	360	18.12 °C
2200	77.9	357	18.12 °C
2202	64	352	18.11 °C
2196	72	349	18.12 °C
2195	69.8	356	18.12 °C
2194	68.8	354	18.10 °C

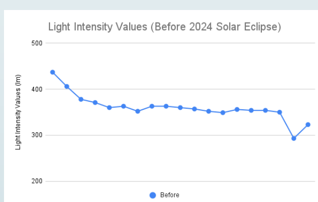
Data collected gets exported into a spreadsheet and visualized

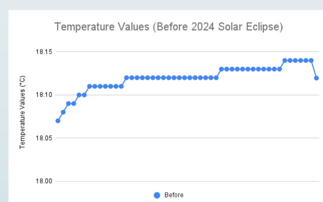
Results

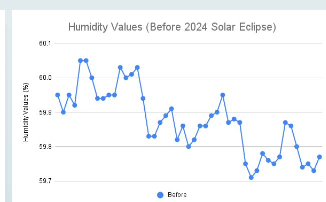












Conclusion

The August 21, 2017 Solar Eclipse marked the first total solar eclipse visible from coast to coast in the United States in nearly a century. Given this rarity, scientists seize the chance to study the various effects they produce. The researchers employed a wide array of Arduino sensors to capture data to compare atmospheric parameters before, during, and after the upcoming solar eclipse on April 8th, 2024. The parameters measured include air pressure, air temperature, humidity, light intensity, sound, and wind speed. The April 8th, 2024 solar eclipse can affect human lifestyle. This collection of wind speed data through the proximity sensor before the solar eclipse can help scientists further understand Atmospheric Boundary Layer Behavior and Local Wind Patterns. Atmospheric Boundary Layer Behavior is changes in the lower atmosphere's temperature distribution due to the decrease in solar radiation, and studying wind systems can help the researchers understand how the Atmospheric Boundary Layer responds to sudden changes in solar heating. The researchers' collection of sound data during the solar eclipse can help them understand the possible change in animal behavior and mating patterns as some of these animals are dependent on certain sound patterns. Collection of light intensity data can help the researchers understand how solar radiation is affected during the solar eclipse. The researchers' data collection of humidity levels can help them understand the change in humidity, aiding for a better understanding of possible cloud formation. The solar eclipse can also allow the researchers to understand dynamics of atmospheric temperature dynamics. Changes in solar radiation levels can create temperature variations in the atmosphere. The changes in solar radiation causes a temporary cooling effect, decreasing the temperature. Monitoring the temperature of the Earth before, during, and after the eclipse can allow us to understand the effect of a solar eclipse on the Earth's surface temperature. Finally, pressure data collection can allow the researchers to understand short term weather data and patterns as well as climate studies. The change in solar radiation can also allow the researchers to understand its effects on the climate by analyzing pressure variations.

Acknowledgements

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Citations

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