LightSound: A Sonification Device for Eclipses

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1 Background

On August 21, 2017, millions of people across North America turned their (protected) eyes to the Sun to witness a total solar eclipse. At the same time, in Jackson Hole, Wyoming and at several locations in Kentucky, LightSound 1.0, an Arduino device developed at Harvard University, streamed the event online for the blind and visually impaired (BVI) around the world (plot [c]). LightSound 1.0 was covered by several major media outlets, including *The Atlantic* [1] and BBC [2], in anticipation of the 2017 eclipse.

2 The Device

The LightSound 2.0 is an Arduino device with a sensor that measures the ambient light and converts it to sound using an Adafruit Flora board and a MIDI synthesizer board. The Flora microcontroller board has a micro-USB port that is used to upload the Arduino code and record data during observations.

In a process called "sonification," the device uses a light sensor that measures the light intensity (in the IR band, visual band, or both) and converts it to a pitch so that the listener can experience the real-time darkening during an eclipse.

The documentation and code for LightSound, which costs about $70 to build, are available online. See "More Information" section at bottom of poster for links.

3 Improvements and Future Work

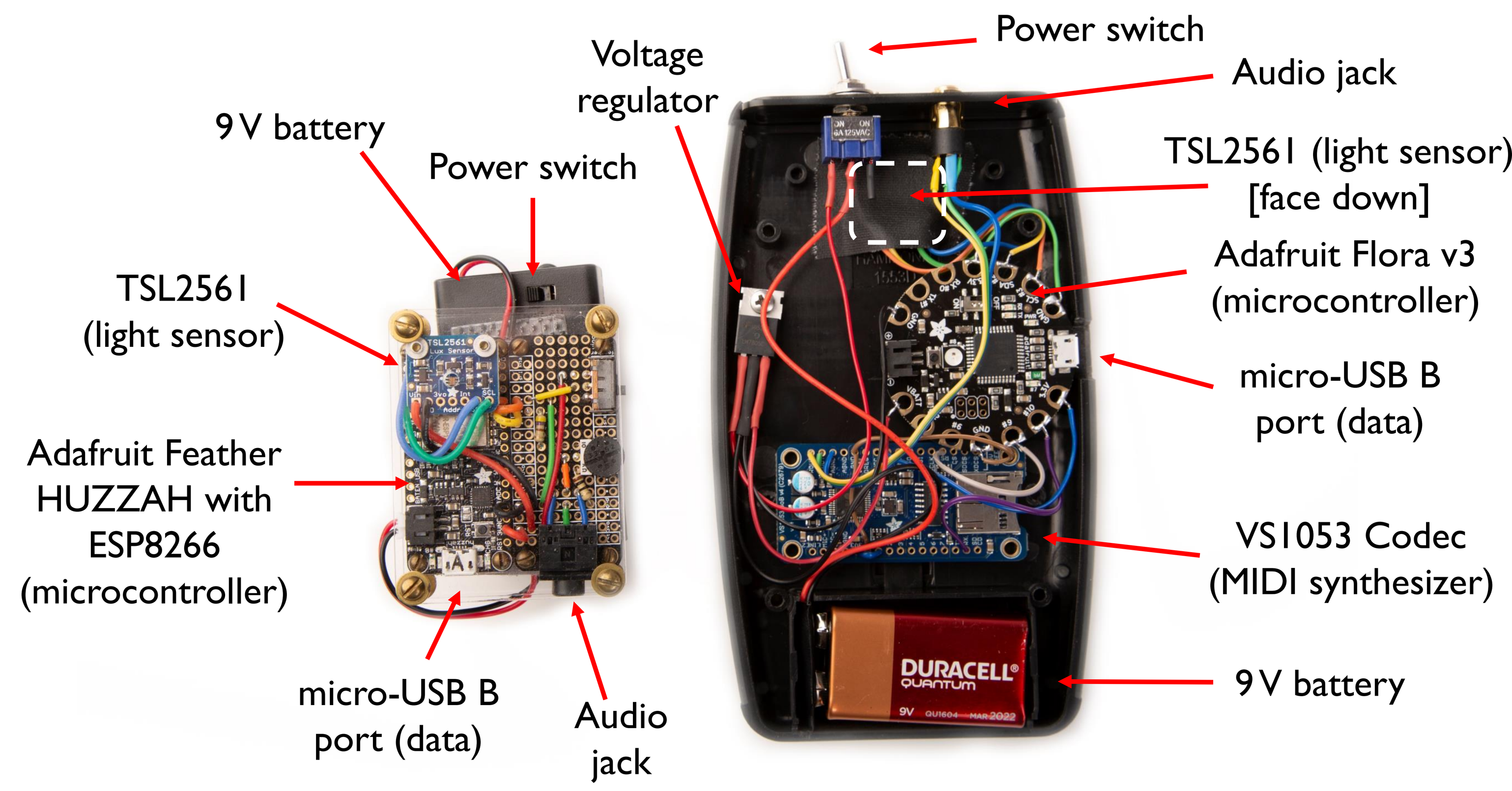
In preparation for the July 2019 and December 2020 eclipses across Chile and Argentina, the device has been redesigned as LightSound 2.0 with the following improvements:

- MIDI synthesizer board to allow the user to choose a variety of sound outputs
- More rugged and telescope-adaptable interface

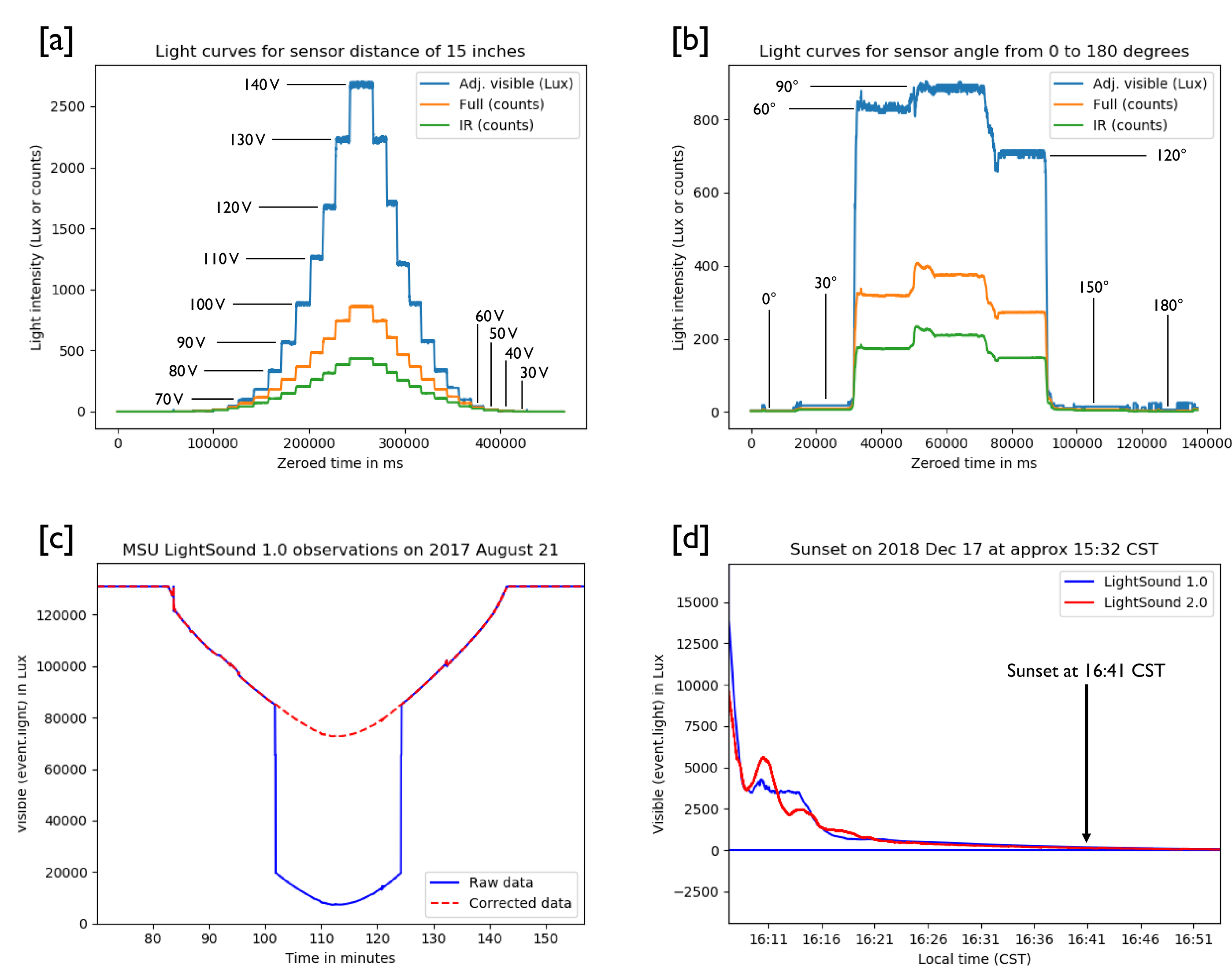
Work is also underway to increase sensitivity and to add haptic (vibrational) feedback for deaf-blind individuals. The LightSound 2.0 can be connected to a computer to record the data during observations.

A similar Arduino device called the Orchestar is being developed to sonify colored light, for use as a teaching tool in both a classroom setting and on a telescope eyepiece. The documentation and code are available for download.

LightSound 1.0 vs LightSound 2.0

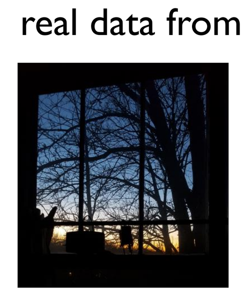


LightSound 2.0 Testing



Testing on the LightSound 2.0 has been done in both a laboratory setting to look at the stability of the readings for changing light intensity [a] and angle to sensor [b].

Comparison tests [d] are being conducted to see how the two LightSound versions perform during sunset conditions, to simulate eclipse-like conditions. Plot [c] shows real data from the 2017 eclipse taken by Morehead State University in Kentucky.



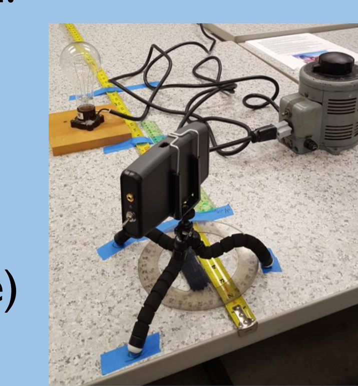
Left: Image of data collection setup in St. Louis, MO not long after sunset.

Right: LightSound devices during testing.

4 Testing

Since the LightSound device is designed for an eclipse, it is difficult to know exactly how it will behave until the actual event, so it is necessary to simulate different aspects of an eclipse for testing. The testing focused on:

- Stability of readings
- Sensor response at different…
  - distances
  - light intensities
  - angles (with respect to light source)
- Readings during sunset



Reading stability and sensor responses tests were conducted using a 200 W lightbulb connected to a variable voltage regulator with a 140 V/10 A output changing the lightbulb distances and intensities, as well as the angle of the sensor with respect to the light source. Sunset testing was done by aiming the LightSound 1.0 and 2.0 devices at the sunset horizon starting at least a half hour before sunset and connecting them to a computer, where their serial output was logged. The data analysis code will be available for download.

Overall, the stability of the sensor readings over time appear to be very good (plot [a]), although it is fairly sensitive to its angle toward a light source (plot [b]). Sensitivity is somewhat problematic during the sunset conditions (plot [d]), as the readings bottom out before true darkness. Additional testing is in progress to improve sensitivity.

5 Outreach for upcoming eclipses

The LightSound project has recently received funding from IAU100 to build 20 LightSound 2.0 devices and distribute them to schools in Chile and Argentina in the path of the 2019 and 2020 solar eclipses so that blind and visually impaired students may experience the event [3].

6 References

[1] Koren, M. 2017, *The Atlantic* (Atlantic Media Company), https://www.theatlantic.com/science/archive/2017/08/experiencing-eclipses-without-seeing/535551/
[2] Kumutat, L. 2017, In Touch (BBC), https://www.bbc.co.uk/programmes/b090vd7y
[3] IAU100 Special Projects announcement. 2018, IAU100: Under One Sky (International Astronomical Union), https://www.iau-100.org/iau100-special-project-announcement

Funding:

100 Years: Under One Sky

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More Information:

Visit the Harvard Astronomy Lab's Accessibility page for the instructions and code to build your own LightSound 2.0 or Orchestar at:

http://astrolab.fas.harvard.edu/accessibility.html

or scan the QR code to the left.

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