EPO and a Changing World
ASP Conference Series, Vol. 389, © 2008
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Learning about the Dynamic Sun through Sounds

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Abstract. Can we hear the Sun or its solar wind? Not in the sense that they make sound. But we can take the particle, magnetic field, electric field, and image data and turn it into sound to demonstrate what the data tells us. We present work on turning data from the two-satellite NASA mission called STEREO (Solar TErrestrial RElations Observatory) into sounds and music (sonification). STEREO has two satellites orbiting the Sun near Earth's orbit to study the coronal mass ejections (CMEs) from the Corona. One sonification project aims to inspire musicians, museum patrons, and the public to learn more about CMEs by downloading STEREO data and using it to make music. We demonstrate the software and discuss the way in which it was developed. A second project aims to produce a museum exhibit using STEREO imagery and sounds from STEREO data. We demonstrate a "walk across the Sun" created for this exhibit so people can hear the features on solar images. We show how pixel intensity translates into pitches from selectable scales with selectable musical scale size and octave locations. We also share our successes and lessons learned.

1. Mapping STEREO Data to Sounds, Sonification

The STEREO Mission has multiple instruments; so many that four suites of instruments each have a principal investigator in charge of each suite. In simple terms the data can be broken down into five data concepts: images, magnetic fields, positively charged particles, electrons, and waves in the electric fields. We are working to sonify all of these types of data. At this time we sonify all the data except the waves in the electric fields.

We are developing a program for the public and science centers that sonifies the STEREO beacon data (e.g. the fundamental aspects of the data useful for real-time space weather forecasting). The software is designed to allow a user to download the data products mentioned above for both STEREO satellites. The user can then both see and listen to the data. We have combined particle data from different instruments to make it easier to view, listen, and explain to non-scientists. A day of extreme ultraviolet images is made into a movie, which can be played back at varying speeds. When a user moves their mouse over a data display, it is explained in a separate text box with an accompanying image.

We are also creating a science center exhibit where visitors can listen to the images of the Sun by interacting with the image while also hearing the solar wind particles and magnetic fields measured by the STEREO satellites. We have developed a number of methods to perceive the Sun through musical sonification. For example, a radar display uses an audio line that spins around the image to listen to a part of the Sun. Spread out along the line are up to 60 audio needles, each of which play the pixel data under them, similar to the way a record needle would play a record. We have found that using the hue, saturation, and brightness color model of the pixel information is much more effective than using the red-green-blue color model. The hue of the color selects one of 18 instruments. The saturation selects one of 30 volume levels from moderate to moderately loud. The brightness selects one of 36 notes spanning 5 octaves of the 7-note per octave Spanish Gypsy scale - the brighter the pixel, the higher the note in the scale.

2. Conclusions and Lessons Learned

Our major successes can be summarized as follows:

- Creating new image sonification techniques.
- Generalizing the application of solar image sonification to any image.
- Creating and developing new infrastructure and working elements of software programs for displaying and listening to the data.
- Developing new collaborations amongst scientists and musicians and educating the instrument groups about applied sonification.
- Invited image sonification demonstrations at conferences (e.g., the Soundscapes panel of the 2007 Art Education for the Blind Conference sponsored the Metropolitan Museum of Fine Art (Met) and Art Beyond Sight).

We have learned many lessons along the way. Working with data, creating software, and designing sonifications takes longer than one often expects. Sonification results may be subjectively viewed as "beautiful" or "interesting", just like various graphic displays may be considered appealing to some. Thus, appealing to all with a particular sonification is impossible. Evaluations should be developed to ensure that the resulting audio meets scientific and data presentation goals set for the project. Evaluations should include feedback from both sighted and limited-sight people. The lack of access to STEREO instrument suite data in textual formats has slowed development of the particle sonifications. Our work seems to indicate that image sonification may make art work more accessible to those who are blind or visually impaired.

These projects stem from the STEREO-IMPACT (In-situ Measurements of Particles and CME Transients) EPO program and a grant from the IDEAS (The Initiative to Develop Education through Astronomy and Space Science (IDEAS) Grant Program.