spectrogram

Jessica Li, Benjamin Scharf, Nathaniel Wong

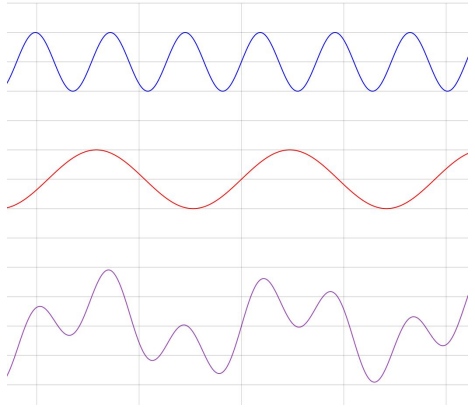
Introduction

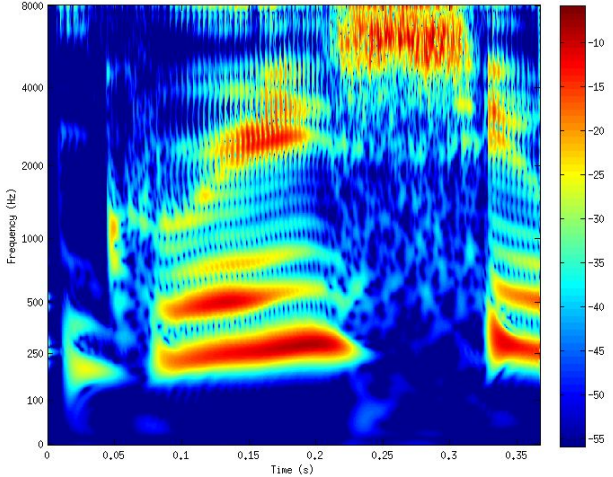
Introduce the concepts of Fourier Transform with:

- Tangible exhibit with exploratory, hands-on learning
- Collaboration and co-participation
- Audio and visual environment for multimodal interaction and understanding

Motivation

- An audio spectrogram enables a basic understanding of frequency and amplitude for people without physics backgrounds
- Experimentation with a live spectrogram allows learners to see how components of sound change in conjunction with their own actions





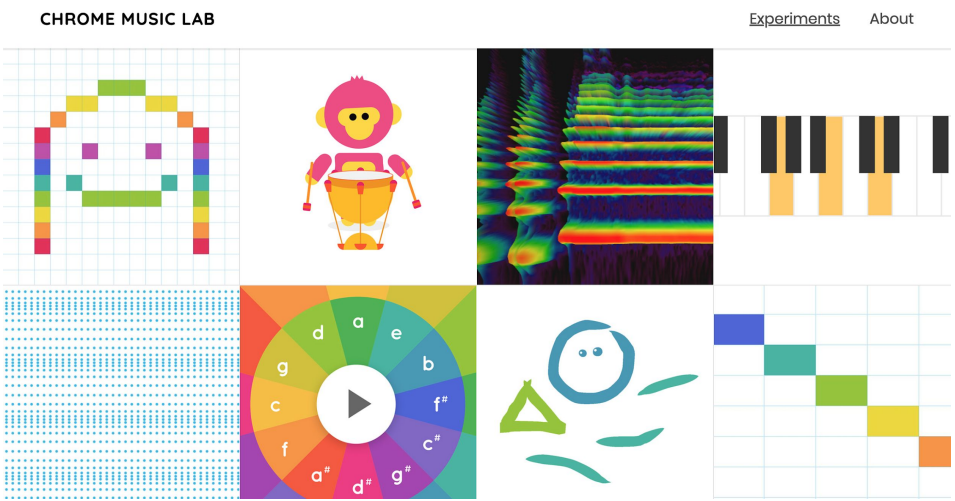
Related Work

Understanding Sound

- Chrome Music Lab: purely visual/digital spectrogram[1]

Making Sound Tangible

- Medieval instruments: audio feedback with real instruments[2]
- Haptic Wave: physical feedback for visual and auditory impairments[3]



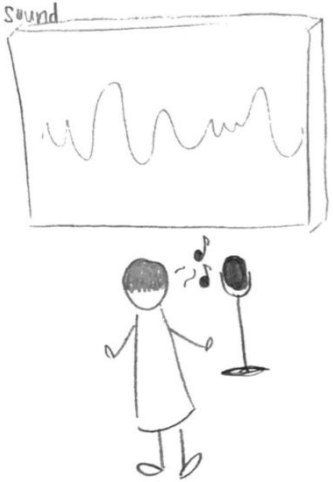
1. Music Lab. Chrome Experiments. https://musiclab.chromeexperiments.com/
2. Wolf, M., Lee, E. and Borchers, J., 2007, April. Education, entertainment and authenticity: Lessons learned from designing an interactive exhibit about medieval music. In CHI'07 Extended Abstracts on Human Factors in Computing Systems.
3. Tanaka, A. and Parkinson, A., 2016, May. Haptic Wave: a cross-modal interface for visually impaired audio producers. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems.

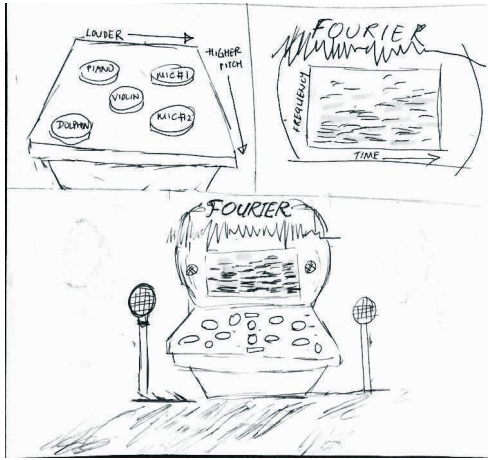
Theoretical Background

- “Teaching without a significant component of explicit conceptual exploration would seem to result in students’ approaching their tutorial exercises as sets of exercises in mathematics rather than a means of coming to understand physics”[1]
- A study on fifth grade students’ understanding of ideas about sound revealed that students had significantly better understanding when using an exploratory, hands-on, and application-based learning process than when using a traditional textbook and demonstration approach[2]

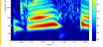
1. Linder, Cedric J. "Understanding sound: so what is the problem?." *Physics Education* 27.5 (1992): 258.
2. Barman, C.R., Barman, N.S. and Miller, J.A., 1996. Two teaching methods and students' understanding of sound. *School Science and Mathematics*, *96*(2), pp.63-67.

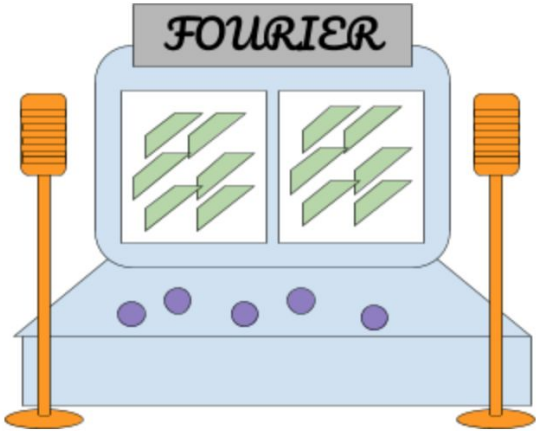
Design Sketches





explanation

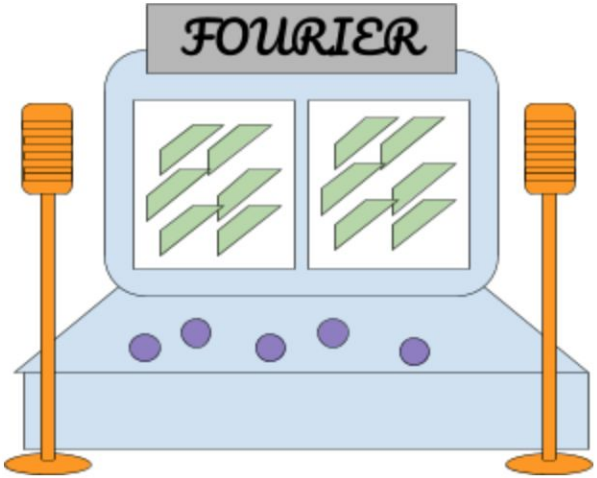




Current Prototype

- physical microphone
- different instruments
- sound-making-objects for users to try
- a screen that will display the spectrogram from the microphone input

Live demo!



demo

Future Work

Possible next steps:

- Physical manifestation of waves (like inFORM)
- Decomposition of a voice's fundamental frequencies into a playable instrument
- Both microphone inputs and spectrograms on-screen, side by side

Conclusion

We introduce an interactive audio-visual exhibit that allows visitors to

- Learn about **spectrograms**,
- Interact with **musical phenomena** like harmonics through instruments, and
- Explore the decomposition of waves using the **Fourier transform**.