Where did that come from?

Visualizing the direction of arrival in large acoustic datasets

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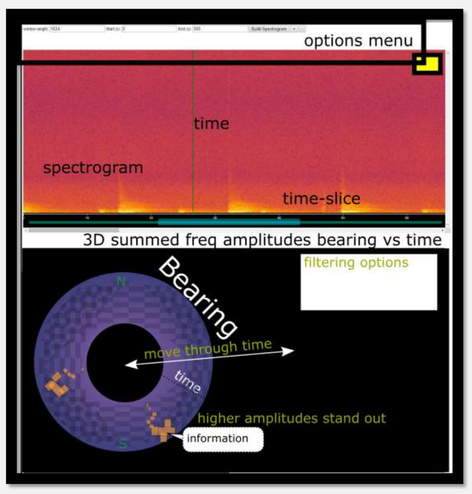
1 INTRODUCTION

Man-made noise is affecting the hearing, communication and behavior of marine life. Researchers need to understand the effects of sound in order to advise regulators on conservation strategies. MERIDIAN and JASCO Applied Sciences are working together to design a tool for visualizing new types of soundscape data that include the direction of arrival of sounds. While underwater acoustic data is normally presented in the form of 2D Time versus Frequency spectrograms which use color to indicate intensity, a new approach is needed to incorporate the direction.

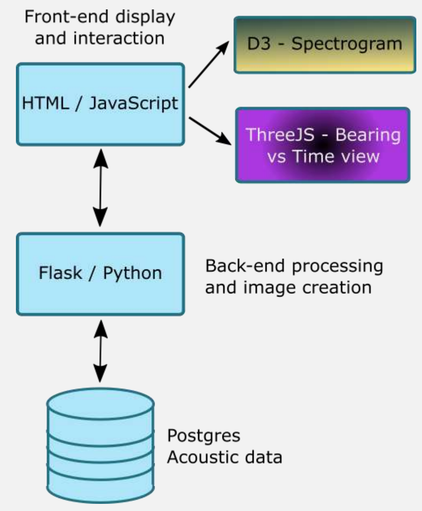
A tool for visualizing underwater acoustic data with a directional component

2 DESIGN

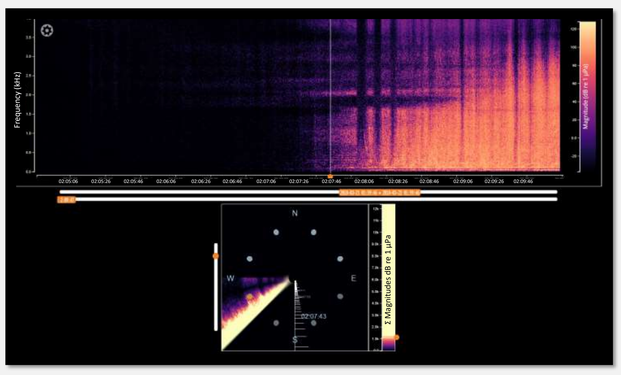


A 2D Time vs Frequency spectrogram connected to a 3D "Time Tunnel" Bearing vs Time view. Time runs along the z-axis. Amplitudes associated with each frequency in a bearing angle are summed, indicating where sounds are coming from and how they move through time.

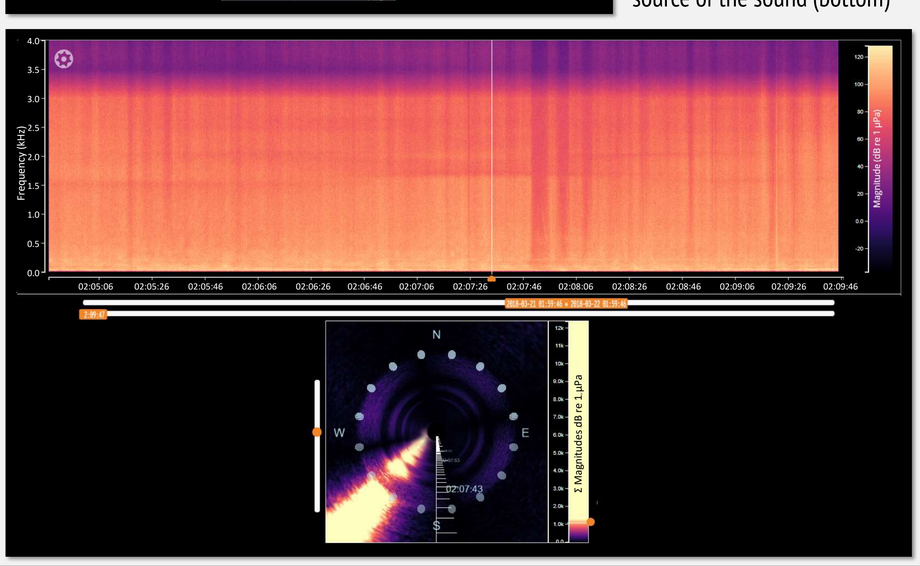
The application structure: a web-based front-end using open source D3.js and ThreeJS libraries with a Flask/Python back-end.



3 IMPLEMENTATION



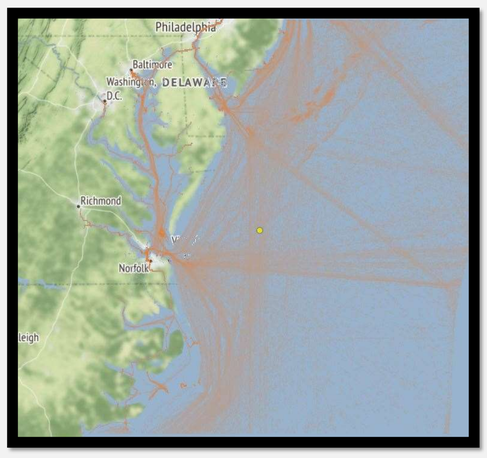
The spectrogram above with 3D bearing vs time plot with bearing angle-based filtering (right)
The full spectrogram showing the direction of the source of the sound (bottom)



4 FUTURE WORK

AIS tracking of vessels (orange) between December 2017 and May 2018 around the hydrophone (yellow) near Virginia, USA

Map tiles by Stamen Design http://stamen.com, under CC 3.0. & OpenStreetMap http://www.openstreetmap.org/ copyright



The machine learning portion of this project will investigate if directional acoustic data alone can be used to estimate the accurate position (range and bearing) of a sound source using Automatic Identification System (AIS) satellite data to generate the training data set for a fixed mooring. Research between 2017 and 2019 suggests that sound source localization using acoustic data alone is possible using neural networks [1][2][3].

[1] H. Niu, E. Ozanich, P. Gerstoft, "Ship localization in Santa Barbara Channel using machine learning classifiers", *The Journal of the Acoustical Society of America 142, EL455*, 2017, https://doi.org/10.1121/1.5010064
[2] Wang, Y. Peng, H. "Underwater acoustic source localization using generalized regression neural network", *The Journal of the Acoustical Society of America 143*, 2018, https://doi.org/ 10.1121/1.5032311
[3] Niu, H. Zaixiao, G. Ozanich, E. Gerstoft, P. Haibin, W. Zhenglin, L. "Deep learning for ocean acoustic source localization using one sensor", *Journal of the Acoustical Society of America*, 2019,[Online]. Available: https://arxiv.org/abs/1903.12319, [Accessed: April 7, 2019]

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