

Designing and Controlling Virtual Sonic Environments Using a Browser-based 3DUI

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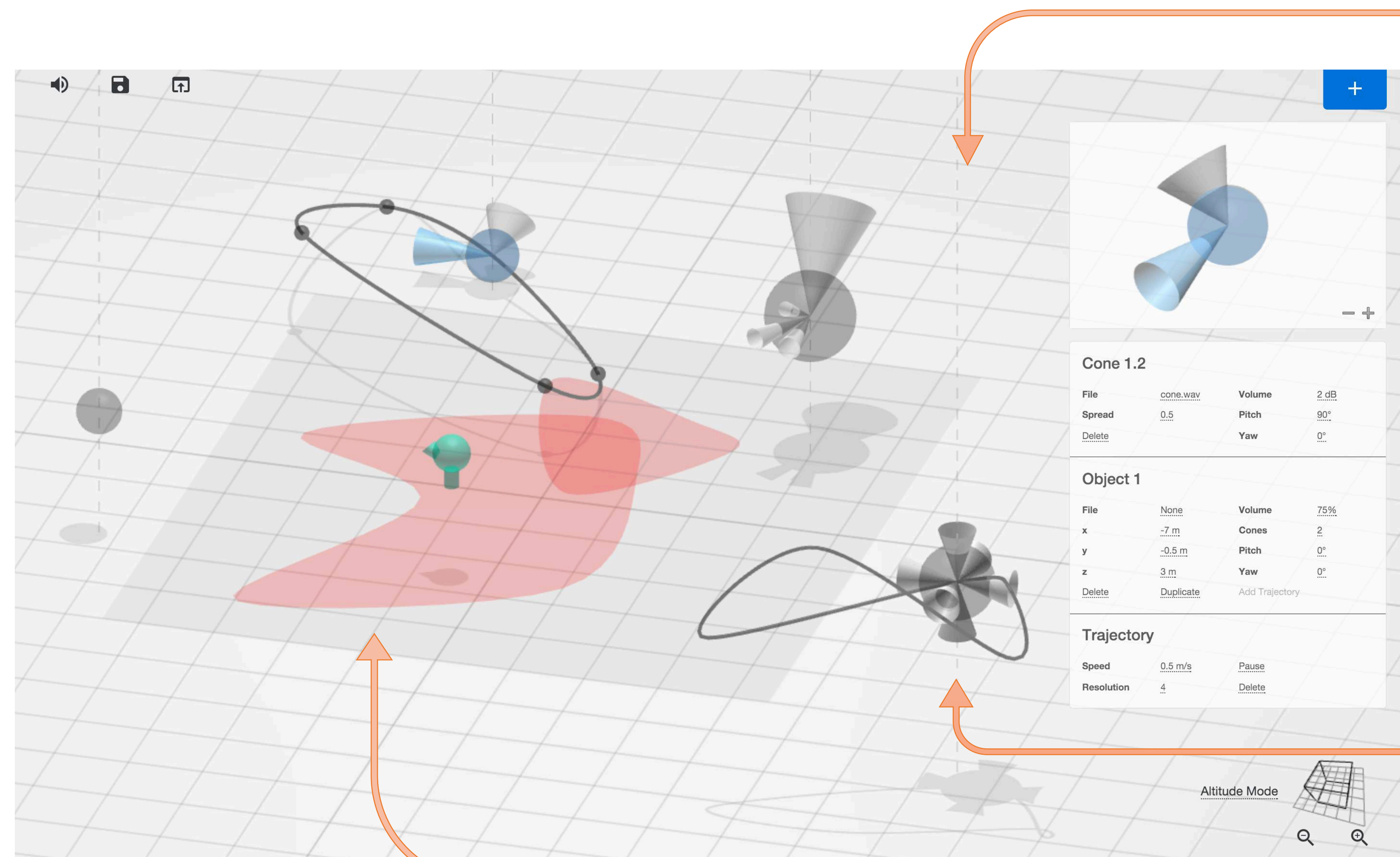
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A screenshot of our user interface on a desktop computer displaying an object with two cones and a motion trajectory being edited. On the top right region, a close-up window displays the object with the cone that is currently being interacted with highlighted in blue. The windows below this close-up allow the user to control various attributes of the cone, the parent object, and its trajectory. Two overlapping sound zones are visualized with red polygons. A gray square represents the room overlay. The user is represented with a green dummy head.

INTRODUCTION

A range of platforms facilitate the design of virtual environments. Most commonly, game engines, such as Unity and Unreal, are used for developing and simulating virtual realities. However, such platforms are primarily oriented towards visual design and provide only limited audio functionality. Furthermore, these platforms utilize separate editing and rendering modes, and operate on desktop platforms. Making use of existing research into the development of interactive virtual soundscapes [1], we introduce a novel user interface that enables the rapid design of both virtual sonic environments, and the assets (i.e. sound objects and sound zones) contained within them.

Specifically, our UI offers the following contributions:

- provides a 3D design environment specific to sonic virtual realities, with specialized components such as sound objects and sound zones;
- offers both interactive and parametric control over the attributes of such components, enabling a precise authoring of highly-detailed environments;
- introduces a multi-cone model for creating 3D sound objects with complex propagation characteristics;
- enables adding dynamism to objects via hand drawn motion trajectories that can be edited in 3D;
- makes it possible to design virtual sound fields at various scales using multiple view and attribute windows;
- offers a unified interface for the design and the simulation of such realities, allowing the user to modify a sound field in real-time;
- operates on the web-browser so that it supports mobile devices, which therefore makes it possible for the user to simultaneously explore and edit augmented sonic realities.

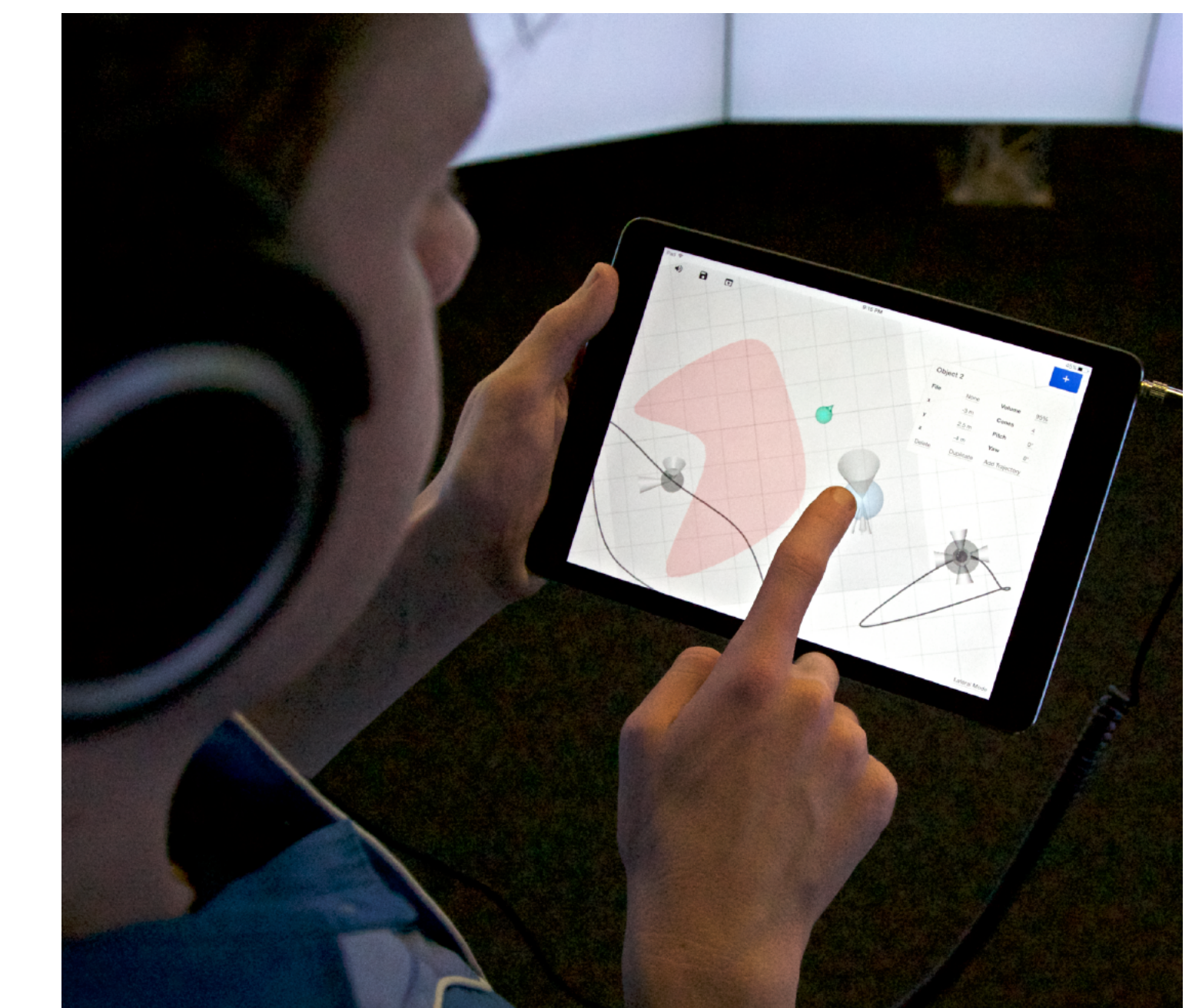
SOUND FIELD: The sound field is the **sonic canvas** onto which the user can place a variety of components, such as sound objects and sound zones. In the default state, the sound field is represented by a 2D overhead-view of an **infinite plane**. With a *click-drag* action, the user can pan the visible area of the sound field. Zoom icons found on the bottom right corner allows the user to zoom in and out of the sound field. A UI element on the bottom right corner of the screen allows the user to tilt and rotate the view of the sound field. A global mute button on the top left corner allows the user to turn off the entire audio output. This feature makes it possible to make offline editions to the sound field. Furthermore, with dedicated icons found adjacent to the mute button, the user can save and load UI states to restore a previously designed sound field.

SOUND OBJECT: Directionality in game audio can be achieved using **sound cones**. A common implementation for this consists of two cones. However, sound producing events in nature are much more complex. Parts of a single resonating body can produce sounds with different directionality, spread, and throw characteristics. We have implemented a **multi-cone sound object** that allows the user to easily attach an arbitrary number of right circular cones to a single object, and manipulate them.

After pressing the "plus" icon on the top right corner of the UI, the user can *click* a point in the sound field to place a new sound object. The default object is an ear-level omnidirectional point source represented by a translucent sphere on the sound field. Creating a new object, or interacting with an existing object, brings up an attributes window on the top right region of the screen. Right above the attributes window, a close-up view of the sound object allows the user to add or remove sound cones and position them at different pitch and yaw values. The latter is achieved by *click-dragging* a cone using an arcball interface. Interacting with a cone brings up a secondary attributes window for local parameters, where the user can attach a sound file to a cone, as well as control the cone's base radius and lateral height values. The base radius controls the projective spread of a sound file within the sound field, while the height of a cone determines its volume. These attributes effectively determine the **spatial reach** of a particular sound cone. The secondary attributes window also provides parametric control over pitch and yaw values.

TRAJECTORIES: After clicking the *Add Trajectory* button in the object attributes window, the user can *click-drag* the said object to draw a motion trajectory. Once the action is completed the object will begin to loop this trajectory using either back-and-forth or circular motion depending on whether the trajectory is closed or not. Once a trajectory has been defined, a trajectory attributes window allow the user to pause, play, change motion speed in either direction or delete the trajectory. A resolution attribute allows the user the change the number of control points that define the polynomial segments of a trajectory curve. Once the user clicks on an object or its trajectory, the control points become visible and **can be repositioned in 3D**.

SOUND ZONES: For **ambient or internal** (i.e. self-produced) sounds, we have implemented the sound zones, which demarcate areas of non-directional and omnipresent sounds. Once the user walks into a sound zone, he or she will hear the source file attached to the zone **without distance or localization cues**. After clicking the plus icon on the top right corner, the user can draw a zone of arbitrary size and shape within the sound field with a *click-drag* action. Once the action is completed, the UI generates a closed spline curve by interpolating between action start and stop positions. When a new zone is drawn, or after an existing zone is *clicked*, a window appears on the top right region of the screen to display zone attributes, which include audio source, volume, scale, rotation and resolution.



A user exploring the augmented reality in CAVE system, while using a mobile device to edit the 3D sonic virtual reality he is hearing through headphones. The user is controlling the position of an object in lateral-view mode.

NAVIGATING THE VIRTUAL SONIC ENVIRONMENT

The user can explore the virtual sonic environment in via one of two modalities (or a combination of both of them). In **virtual navigation**, a stationary user is equipped with a headphone connected to the device running the UI. Depending on the input device, the user can either use physical or virtual arrow keys to travel within the sound field. In **augmented navigation**, the user moves physically within a room that is equipped with a motion-tracking system. User's gaze direction is broadcasted to the UI via OSC to update the position and the orientation of the Web Audio's *Listener Node* [2], which effectively controls the binaural rendering of the auditory scene based on the user's movements.

FUTURE WORK AND CONCLUSIONS

A next step for our UI is to include a new 3D object that enables sound occlusion. This will allow the designer to draw non-sounding objects in arbitrary shapes that affect the propagation of sounds around them. We also plan to augment the sound zones with gradient volume characteristics. Similar to radial and linear gradient fill tools found in graphics editors, this feature will allow the user to create sound zones with gradually evolving amplitude characteristics. Additionally, we plan to facilitate rich mixed reality applications. For instance, the incorporating a video stream from the tablet camera will allow the user to superimpose a visual representation of the sound field onto a live video of the room they are exploring with a tablet.

In this poster, we introduced a novel user interface to control the **3D projection of sonic virtual realities**. Our UI provides an easy-to-use environment to construct highly-detailed scenes with components that are specialized for audio. It offers such features as unified editing and navigation capabilities, web-based cross-platform operation on mobile and desktop devices, ability to design complex sound objects and sound zones with dynamic attributes that can be controlled parametrically using secondary attribute windows, and multiple viewports to simplify 3D navigation. As a result, our UI provides new practical and creative possibilities for designing and experiencing sonic virtual environments.

REFERENCES

- [1] A. Çamcı, Z. Özcan, and D. Pehlevan. Interactive virtual soundscapes: a research report. In Proceedings of the 41st International Computer Music Conference, pages 163–169, 2015.
- [2] Adenot and C. Wilson. Web Audio API, 2015. [Online]. Available: <http://webaudio.github.io/web-audio-api/>.