Resonance Choir: The Renaissance madrigal meets spatial audio

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ABSTRACT

Resonance Choir is an interactive, immersive, audio experience that allows the user to hear a personalised rendition of "Weep, o mine eyes" by John Bennet (c. 1575–1614), in a recording by the British vocal ensemble I Fagiolini.[1] [2]

Resonance Choir is a web app that uses the Resonance Audio SDK[3] to offer an interactive, binaural rendering of a 16th-century piece for four voices. It was envisioned as both an artistic endeavour and an exploration of the capabilities and limits of the Resonance Audio SDK.

On the landing page, the user is prompted to choose a "listening environment" – that is, an auditory context for which the resonance and reverb properties are emulated by the Resonance Audio SDK. These settings are determined by the properties of the room, such as the room size and the materials of the floor, walls and ceiling. For instance, our "Cathedral" setting corresponds to a 158 x 75 x 111 m marble room, in reference to the dimensions of St. Paul's Cathedral. Once the user has chosen their preferred listening location (other defaults are "Ice cave", "Small studio", and "open-air theatre"), they are redirected towards the main page, as seen in Figure 1. Label A in Figure 1 provides a reminder of the chosen setting. Other labels in Figure 1 indicate further interface components via which the user can interact with different aspects of the rendering of the performance:

1. **The singers' positions:** The listener is situated at the centre of the room, indicated by the headphones and time display. Each singer is represented by a different-colour rectangle in the canvas E in Figure 1. These rectangles can be clicked and dragged (while the music is playing or stopped) to alter a singer's x- and z-location, while the sliders shown in D in Figure 1 can be moved to alter the y-location. The singers' initial positions are selected randomly from a list of possible configurations when the main page loads. The singers can also be toggled off or muted (C in Figure 1), if the listener wishes to focus on particular melodies or harmonies occurring in a subset of the four voices;

2. **The room's properties:** although the room size and surfaces are preset, the user can choose from a wider range of room sizes and wall/ceiling/floor materials (F in Figure 1).

3. **The recording function:** when the recording button (H in Figure 1) is on, any relocation or muting of the singers by the user is recorded. This recording can be replayed, as well as shared by pressing the "share" button (B in Figure 1). This generates a URL that contains an encoding of the movements, muting, and room properties of the audio experience. As such, one user's Resonance Choir experience is a shareable with and repeatable by another user.

Resonance Choir is based on HTML, CSS and JavaScript. Beyond the Resonance Audio SDK package, it makes use of p5.js for the graphical interface,[4] Tone.js to help with the time-sensitive recording of voice movement/muting,[5] and the Web Audio API to complement the Resonance Audio SDK's functionalities.[6]

Resonance Choir would not have been possible without the collaboration of Robert Hollingworth and his ensemble I Fagiolini, who provided the vocal stems used in the app. Madrigals are particularly well suited for this type spatial audio demonstration, as each voice carries a different melody, but the harmonies created through the piece's polyphony bring meaning to the lyrics. "Weep, o mine eyes" is one of the most recognisable madrigals of the Renaissance period, being written as an homage to an even more famous piece, "Flow, my tears" by John Dowland (c. 1563–1626).

The artistic experience emerging from the Resonance Audio SDK package should be seen as a first step towards other potential uses. Indeed, a similar interface could produce interesting results when applied to projects within the musical realm, involing different genres, epochs, styles, etc., or for educational purposes, not only to learn about spatial audio, but also to analyse music. Beyond music, a similar interface could be used in audio storytelling, where different tracks could be moved around a stationary listener, as a way to maximise immersion through interactivity.

[1]https://resonance-choir.glitch.me/
[2]https://www.ifagiolini.com/
[3]https://resonance-audio.github.io/resonance-audio/
[4]https://p5js.org/
[5]https://tonejs.github.io/
[6]https://www.w3.org/TR/webaudio/

Web Audio Conference WAC-2022, July 6–8, 2022, Cannes, France.

Figure 1: Screen shot of the Resonance Choir app with explanatory tags: (A) Listening location as chosen by the user; (B) Share button, which creates a URL comprising information about room property and recorded movements/muting of the singers; (C) Toggle buttons to mute/unmute the different singers; (D) Sliders to change the vertical position of the singers; (E) Interactive canvas where the four singers can be moved relative to a stationary listener (represented by the pair of headphones) by dragging the four rectangles; (F) Popover bubbles to change the room's preset properties (size of room and material of surfaces); (G) Information and how-to guide; (H) Record button which enables repeating and share the audio experience.

Biographies

Jemily Rime

Jemily Rime is a PhD student in the Music Department at University of York, working with XR Stories and BBC Research & Development. Her research focuses on the production of personalised and immersive audio using AI-driven tools for podcasts. Jemily is a musician and composer, and studied Physics at King's College London (2018).

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Dr. Tom Collins is a Lecturer (Assistant Professor) in Music Technology in the Music Department at the University of York, UK, and co-founder of Music Artificial Intelligence Algorithms, Inc. Tom has undergraduate degrees in Music from Cambridge University (2005) and Mathematics and Statistics from Oxford University (2008). He obtained his doctorate from The Open University, UK in 2011, working on improved methods for pattern discovery in music, with applications in automated stylistic composition. Postdoctoral work included time spent working on computational models of music perception and generation at University of California, Davis, USA and Johannes Kepler University Linz, Austria. He leads the Music Computing and Psychology Lab at University of York, which is concerned with the application of AI to music and audio, as well as with the development of web-based music systems.