

Docket #: S18-504

Real-time Auralization System for virtual spaces and on-line meetings

Stanford researchers have patented a real-time auralization-reverberation system for providing immersive and interactive audio environments. From living rooms to concert halls, this technology can be used in a variety of settings, and for a range of situations including music making, theatrical performances, gaming, conferences etc., at a single location or across multiple networked locations. The system synthesizes its virtual acoustic environments using standard audio speakers and microphones combined with a type of feedback cancellation, and provides real-time acoustics simulation, virtually transporting audience members and performers to another acoustic space.

The team has produced auralizations allowing musicians to virtually perform in the Hagia Sophia, Stanford's Memorial Church, and the Chiesa di Sant'Aniceto. This led to the production of the first ensemble album recorded live virtual acoustics, "Lost Voices of Hagia Sophia" in our collaboration with the Portland-based vocal group Cappella Romana. The album was No. 1 on Billboard's Traditional Classical Album Chart for three weeks in February and March, 2020.

Since March of 2020, in the wake of Covid-19, the technology has been adapted to networked systems with nodes such as virtual meetings, performances, or other streaming situations with individual participants logging in from separate locations. A common acoustic space or set of spaces can be shared among the participants to create a unified acoustic experience. Each participant can experience and control their own acoustics. Applications for this variant of the technology include online meetings and classrooms, networked gaming, and multiple musicians/actors performing as a single ensemble at multiple remote local sites.

Stage of Research:

- **Multiple Prototypes**
- **Demonstrated system and method** at Department of Music and the Center for Computer Research in Music and Acoustics (**CCRMA**) Open House, Stanford University in March 2019.

- **Used system and method** to study musician interactions with acoustic spaces at CCRMA, May 2019.

[Icons of Sound: Cappella Romana in a virtual Hagia Sophia - Cherubic Hymn in Mode 1](#)

[Documentary Film: The Voice of Hagia Sophia](#)

[Blu-ray Album: Lost Voices of Hagia Sophia](#)

[Speed and Space: Recent\(-ish\) Developments in Internet Music and Sound](#)

Applications

- **Dynamic acoustic environment** for music, theater, gaming, and augmented/virtual reality
- **On-line meetings and performances** – meetings and performances with multiple participants can share the same acoustics to create a more seamless environment – almost as if everyone is in the same space.

Advantages

- **Real-time, adjustable acoustic environment** in which users can be immersed into time-varying audio simulations
- **Immersive experience**
- **Flexible** – can transport audio to any acoustic environment
- **Less expensive and cumbersome** than current systems
- **Uses standard audio equipment**
- **Can be integrated into any existing speaker combination/array** for both professional and home use
- **Can be implemented as a stand-alone application or on a computer or device**

Publications

- Abel, Jonathan S., Eoin F. Callery, and Elliot K. Canfield-Dafilou. "[A Feedback Canceling Reverberator.](#)" In *Proceedings of the Digital Audio Effects Conference* . 2018.
- Canfield-Dafilou, Elliot K., Eoin F. Callery, Jonathan S. Abel, and Jonathan Berger. "[A Method for Studying Interactions between Music Performance and Rooms with Real-Time Virtual Acoustics.](#)" In *Audio Engineering Society Convention 146*. Audio Engineering Society, 2019.
- [How a Historian Stuffed Hagia Sophia's Sound Into a Studio](#) New York Times July 30, 2020.

Patents

- Issued: [10,812,902 \(USA\)](#)

Innovators

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