USC UNIVERSITY OF SOUTHERN CALIFORNIA | IMSC Integrated Media Systems Center

INTEGRATED MEDIA SYSTEMS CENTER
A National Science Foundation
Engineering Research Center at the
UNIVERSITY OF SOUTHERN CALIFORNIA

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Immersive Audio Lab Mission Statement

While DVD and high definition television deliver 5.1 channels of sound to consumers today, in the future these systems will seem as antiquated as the monophonic recordings of Caruso, which were created in the early 1900's. Certainly better than 2 channel stereo, 5.1 channel audio is not completely convincing-it is easily distinguished from the real thing.

Research in the IMSC Immersive Audio Laboratory is focused on algorithms for capturing and rendering sound so that it is indistinguishable from reality. Our goal is to provide an immersive experience through greater imaging and envelopment capabilities than ever before. The unique component to our work is a comprehensive synergy in the understanding of acoustics, psychoacoustics, recording technique, and adaptive audio signal processing. Our hope is that this kind of immersive experience can become practical for various playback environments including movie theaters, home theaters, headphones, and even the desktop computer.

Since we have already reached the limits of human perception for frequency range and dynamic range, future growth will inevitably be in the number of audio channels as human perception can hear many more directions than what current systems provide. With the coming of Internet2 and high capacity optical discs, the challenge of the future is to render the many channels of audio delivered from the media. The extra information provides more raw materials to the playback system with which to immerse the listener in the experience regardless of the number of loudspeakers available. From many loudspeaker channels, down to just two desktop speakers, algorithms we are developing will translate the experience to the widest possible range of listeners.

USC STUDENTS, DEGREES

There are currently 4 PhD students and 3 MS students working on projects in the Immersive Audio Lab

BRIEF DESCRIPTION OF DEMONSTRATIONS

- Virtual Microphones: Convert mono or stereo recordings to multichannel immersive audio in real time
- 10.2 Immersive Audio Rendering: Multichannel rendering algorithms that use acoustics, psychoacoustics, and adaptive audio signal processing to immerse a group of listeners in a seamless sonic environment
- Dynamic spatialization: Software for moving sound seamlessly using 5, 10, or more loudspeakers

UNIQUE OR DISTINGUISHING CHARACTERISTICS RELATIVE TO STATE-OF-THE-ART

- Virtual Microphones: All other methods are based on simple reverberation. Ours preserves the acoustical information of the space when synthesizing multiple channels.
- 10.2 Immersive Audio Rendering: Provides significantly better envelopment and imaging as compared to 5.1 channel surround sound
- Dynamic spatialization: Compatible with industry-standard digital audio workstation software, rather than proprietary

APPLICATIONS	RECENT HIGHLIGHTS, LEVEL OF DEVELOPMENT, UPCOMING MILESTONES
• Multichannel music, home theater, location-based entertainment, teleconferencing, distance education	• Real-Time Virtual Microphone technology demonstrated (May 2002) • First Immersive Audio live concert (Flying Sonics) combined live musicians and our rendering algorithms (April 2002) • World's first immersive concert recorded and streamed from the New World Symphony in Miami

UNDERLYING TECHNOLOGIES

- Time-frequency methods for audio; adaptive filters; fuzzy c-means clustering; Gaussian mixtures; Sub-gaussian distributions; Microphone arrays; Room equalization algorithms

LIST OF SELECTED PUBLICATIONS, REFERENCES, URLs

- http://audiolab.usc.edu
- S. Bharitkar and C. Kyriakakis, "Selective Signal Cancellation for Multiple-Listener Audio Applications Using Eigenfilters", accepted by IEEE Transactions on Multimedia. To appear June 2003.
- A. Mouchtaris, S. S. Narayanan, and C. Kyriakakis, "Virtual Microphones for Multichannel Audio Resynthesis" submitted to EURASIP Journal on Applied Signal Processing, Special Issue on Digital Audio for Multimedia Communications, May 2003.
- S. Bharitkar and C. Kyriakakis, "Perceptual Multiple Location Equalization with Clustering," in Proc. 36th IEEE Asilomar Conference on Signals, Systems, & Computers, Pacific Grove, CA, Nov. 2002.
- D. Yang, H. Ai, C. Kyriakakis and C.-C. Jay Kuo, "Error-Resilient Design of High Fidelity Scalable Audio Coding", Proc. SPIE Vol. 4740, Digital Wireless Communications IV, Orlando, Florida USA, April 1-5, 2002.
- C. Kyriakakis, "Virtual Loudspeakers and Virtual Microphones for Multichannel Audio", IEEE International Conference on Consumer Electronics, Los Angeles, June 15th, 2000

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