From High Order Ambisonics to Spatial PCM Sampling – application to auralization of measurements and computer simulations

Angelo Farina

Decomposition of a 3D spatial sound field has been done for long time employing Ambisonics, possibly with a spherical harmonics expansions extended to higher orders (3rd order or above). Increasing the order causes some drawbacks inherent to the Ambisonics technology to be exacerbated, making it almost impossible to go beyond 3rd order with real-world signals, and beyond 5th order with numerical simulations. An alternative decomposition method has been recently developed, called Spatial PCM Sampling (SPS) [1], based on the concept of "virtual microphones" (which can also be employed for representing HOA): instead of a set of virtual microphones possessing very complex directivity patterns, with sharp shapes and frequent polarity inversions (and hence very difficult to obtain in practice), the spatial analysis is performed employing a set of 32 cardioid microphones of 4th order (smooth shapes with no polarity inversion), pointed in the same directions as the 32 capsules of the well-known spherical microphone array Eigenmike32™.

The new SPS method corresponds, in time domain, to the PCM representation of a continuous waveform, whilst HOA corresponds to the Fourier representation of the same waveform. A sequence of "spatial pulses" of proper amplitudes (SPS), instead of a series of "spatial sine functions" with proper amplitude and phase (HOA).

The SPS approach was already proven to provide significant advantages regarding impulse response measurements of theatres and concert halls, making it very easy to chart the spatial distribution of sound arrivals [2]. In this paper the usage of SPS for auralization is shown, both for measured impulse responses, or for the results of computer simulations performed with room acoustics simulation programs.

A short audible demo will demonstrate the HOA-SPS comparison in two auralization cases, the first based on real-world recordings made inside a theater, the second based on numerical simulations with the Ramsete pyramid-tracing program.

[1] A. Farina, M. Binelli, A. Capra, E. Armelloni, S. Campanini, A. Amendola – "Recording, Simulation and Reproduction of Spatial Soundfields by Spatial PCM Sampling (SPS)" - International Seminar on Virtual Acoustics, Valencia (Spain), 24-25 November 2011.

[2] Angelo Farina, Alberto Amendola, Andrea Capra, Christian Varani – "Spatial analysis of room impulse responses captured with a 32-capsules microphone array" - 130th AES Conference, London, 13-16 May 2011.