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Real-time auralization system based on beam-tracing and mixed-order Ambisonics

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Auralization, the final step in computational room acoustic simulations, aims to make audible the acoustics of complex virtual architectural spaces in a realistic and accurate manner. This paper presents a novel real-time auralization system comprising a geometry engine, a beam-tracer, and an audio renderer. The computation of early reflection paths is based on an efficient beam-tracing algorithm capable of real-time detection of specular reflection paths in a static geometry with one or several moving listener(s). For simpler rooms, the real-time performance is maintained even with dynamic geometries and sources. Results of the beam-tracer, sent to the audio renderer, consist of visible reflection paths and their accumulated material attenuation. From this geometrical and acoustical data, listener position-related 3D room impulse responses are generated applying a higher-order virtual Ambisonics approach. Final rendering of the binaural room impulse response (BRIR) is made taking into account the listener's head-orientation. As higher order reflections are more diffuse in nature, they may be encoded using lower Ambisonic orders, thereby reducing computational load. The environment combines high quality audio with visual rendering realized using the open source platforms Pure Data and VirChor respectively. This auralization framework provides direct audio-visual feedback in real-time for VR environments.