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Real-time auralization of modifiable rooms

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Immersive virtual environments are a powerful tool for acousticians and architects to design buildings if the virtual reality system provides an interactive imaging of virtual sound sources with respect to the rooms' physical aspects. Current implementations using hybrid room acoustic simulation methods (e.g. combining image sources and ray tracing) enable the user to walk freely in such virtual architectural spaces, whereby the position/orientation of sound sources are interactively manipulable to detect possible acoustic defects, e.g., flutter echoes. In the case of coupled rooms, sound transmission effects must be included into the real-time simulation in order to identify deficient airborne sound insulation, whereby current implementations only support a change of state (open/closed) of fixed room-connecting elements, e.g., doors and windows. However, in scenarios like an architectural planning stage, it is convenient to manipulate the room geometry more freely, e.g., via the interactive positioning of stage reflector panels, but common spatial data structures, e.g., BSP- or Octrees do not efficiently support these operations. For this purpose, the concept of Spatial Hashing, which originates from computer graphics for collision detection of deformable objects, is applied to the simulation process. This adaptation also features an efficient identification and update process of image sources.