Simulation of realistic background noise using multiple loudspeakers

Three methods for reproduction of sound using a maximum of eight loudspeakers were investigated in the context of testing telecommunication devices. They are the four-loudspeaker-based method as described in ETSI EG 202 396-1, Higher-Order ambisonics (HOA), and a matrix inversion method. HOA optimizes the reproduced sound at a sweet spot in the center of the array with radius determined by a spherical microphone array, which is used to derive the spherical harmonics decomposition of the reference sound. The four-loudspeaker-based method equalizes the magnitude response at the ears of a head and torso simulator (HATS) for sound reproduction, while the matrix inversion method optimizes the local sound field around a few target positions. The matrix inversion method had two conditions, i.e. with or without the extra processing steps described in ETSI TS 103 224; and three sets of optimization positions were defined, i.e. the ears of the HATS, positions close to a device under test, and standardized positions as described in ETSI TS 103 224. A listening experiment was performed to evaluate the perceived quality of the reproduced sounds at the microphones close to a device under test and at the ears of the HATS. The matrix inversion method performed best when listening to the reproduced sounds at target positions used for sound-field optimization and when listening to the microphones close to the device. HOA resulted in similar perceived quality as the matrix inversion method while a large degree of perceptual degradation was observed using the four-loudspeaker-based method.