Dynamic, Room-Adapted Spatial Audio for Augmented Reality Telepresence

Motivation

- Holographic calling displays remote interlocuters in a user's own room using AR glasses
- Audio rendering could also make a hologram **sound as if it was in the user's own room**
- Requires room-adapted acoustic rendering that is perceived as matching to the own room

Technology

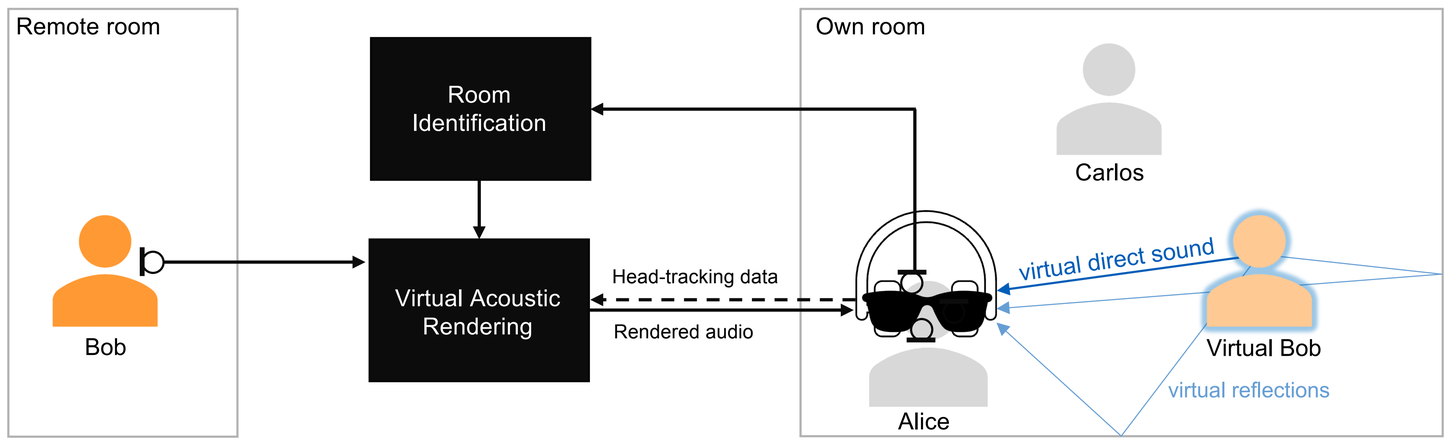

Fig. 1: Dynamic, room-adapted spatial audio system.

Project I: Blind room acoustic identification for room-adapted rendering

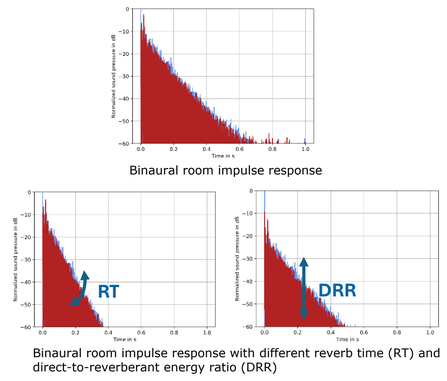

Fig. 2: Head-mounted mics and room impulse responses measured with them.

Project II: Perceptual limits of audiovisual room matching

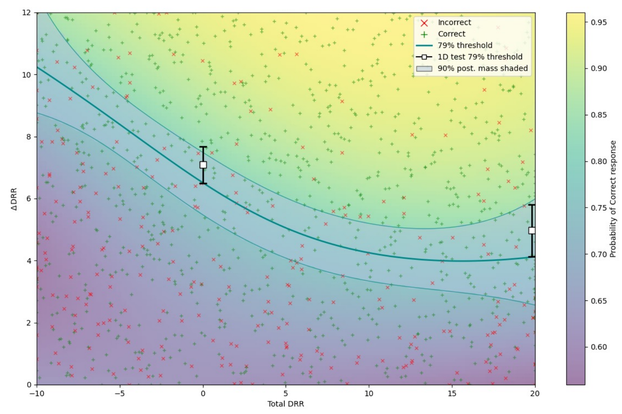

Fig. 3: Initial Result: JND of DRR.

Project III: User testing

Fig. 4: Holographic calling setup with HMD + transparent headphones.

Methods:

- Implementing and improving blind room acoustic identification algorithms based on Deppisch et al. (2024)
- Measurements and speech recordings in 20 different rooms using a head-mounted microphone array

Expected Results:

- Real-time implementation of room acoustic identification algorithms
- Evaluation in different rooms regarding room acoustic parameters like reverberation time (RT) and direct-to-reverberant energy ratio (DRR)

Methods:

- Tests of just-noticeable differences (JNDs) of room acoustic parameters using multidimensional threshold tests
- Audiovisual matching test for these parameters, extending previous work (Meyer-Kahlen et al., 2024)

Expected Results:

- Perceptual limits of noticeability of room acoustic parameters, especially DRR
- Limits of audiovisual matching depending on room acoustic parameters

Methods:

- Tests of plausibility / co-presence / quality of experience using a one-way, holographic calling system
- Different room acoustic conditions: none / generic / room-adapted rendering
- Quiet and noisy environments. Varying audio bitrate

Expected Results:

- Demonstrating preference for room-adapted rendering in high intelligibility conditions
- Possible adverse effects in low intelligibility conditions

References (Selection)

Deppisch, T., Meyer-Kahlen, N. & Garí, S. V. A. (2024) Blind Identification of Binaural Room Impulse Responses from Smart Glasses. IEEE/ACM Transactions on Audio Speech and Language Processing 32

Larsen, E., Iyer, N., Lansing, C. R. & Feng, A. S. (2008) On the minimum audible difference in direct-to-reverberant energy ratio. J. Acoust. Soc. Am. 124

Meyer-Kahlen, N., Amengual Garí, S. V., Schlecht, S. J. & Lokki, T. (2024) Testing Auditory Illusions in Augmented Reality: Plausibility, Transfer-Plausibility and Authenticity. J. Audio Eng. Soc. 72 (11), 797–812

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