Master Thesis

Benchmarking the simulation of finite and curved surfaces

Room acoustical simulation is an important tool for planning or improving the acoustics of new and existing rooms, and for generating auditory scenes for virtual and augmented reality. Although physically correct wave based simulations are becoming more feasible, geometric simulations are often used in practice. In this case the actual room geometry is approximated by means of a 3D model whose faces are often large in comparison to the wave length [1]. The geometrical nature of these algorithms and the size of the faces, however, make it challenging to correctly simulate relatively small and curved surfaces [2, 3]. This was recently demonstrated in a round robin on room acoustical simulation and auralization for the example of a 1 m^2 reflector where only one out of four simulation algorithms was able to correctly approximate the measured benchmark case [4].

This theses will benchmark the simulation of finite and curved surfaces using selected algorithms from the field of geometrical and wave based acoustics [5-7]. A benchmark scene for evaluating finite flat surfaces is already contained in the Benchmark for Room Acoustical Simulation (BRAS) and a scene for evaluating finite curved surfaces will be generated and added as part of this thesis [8]. The scene generation comprises the theory guided design of the scene (size and shape of the curved surface, measurement positions), the construction of the curved surface (in collaboration with workshops at TU Berlin), and the measurement and documentation of the scene. The evaluation includes applying the simulation algorithms to the selected scenes and interpreting the results. In case of interest, it may comprise improving the simulation algorithms themselves. The thesis offers the possibility to be published as a scientific publication and can be written in German and English.

Literature

[1] Välimäki, V., Parker, J. D., Savioja, L., Smith, J. O., and Abel, J. S. (**2012**). “Fifty Years of Artificial Reverberation,” IEEE Transactions on Audio, Speech, and Language Processing, **20**, 1421–1448. doi:10.1109/TASL.2012.2189567
[2] Savioja, L., and Svensson, U. P. (**2015**). “Overview of geometrical room acoustic modeling techniques,” J. Acoust. Soc. Am., **138**, 708–730. doi:10.1121/1.4926438
[3] Koutsouris, G., Norgaard, A. K., Christensen, C. L., and Rindel, J. H. (**2016**). “Discretisation of curved surfaces and choice of simulation parameters in acoustic modeling of religious spaces,” 23rd Int. Congress on Sound & Vibration, Athens, Greece.
[4] Brinkmann, F., Aspöck, L., Ackermann, D., Lepa, S., Vorländer, M., and Weinzierl, S. (**2019**). “A round robin on room acoustical simulation and auralization,” J. Acoust. Soc. Am., **145**, 2746–2760. doi:10.1121/1.5096178
[5] Schröder, D. (**2011**). *Physically based real-time auralization of interactive virtual environments* RWTH Aachen, Aachen, Germany.
[6] ORASE (**2021**). Pachyderm – Acoustic Simulation Software, Available: https://www.orase.org/resources, (date last viewed: 28-Sep-21).
[7] van der Harten, A. (**2019**). “Geometrical computation of arbitrary curved surface sound reflected impulse responses,” Int. Symp. on Room Acoustics (ISRA), Amsterdam, The Netherlands, 349–356.
[8] Brinkmann, F., Aspöck, L., Ackermann, D., Opdam, R., Vorländer, M., and Weinzierl, S. (**2021**). “A benchmark for room acoustical simulation. Concept and database,” Applied Acoustics, **176**, 107867. doi:10.1016/j.apacoust.2020.107867

Requirements

Knowledge of room acoustical simulation algorithms, acoustical measurements, and digital signal processing in Python and/or Matlab. Interest in learning how to use room acoustical simulation software (RAVEN, Pachyderm, SketchUp).

Supervision

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