Do Higher Order Modes at the Horn Driver's Mouth Contribute to the Sound Field of a Horn Loudspeaker?

The Boundary Element Method (BEM) is a well known tool in acoustics for the calculation of radiation from vibrating surfaces. When using BEM for the calculation of horn loudspeakers, the horn surface is described by its surface admittance; the connected driver is modeled by the velocity distribution at the common junction of driver and horn. Measurements of the velocity distribution have shown that higher order modes within the horn throat can be excited by the horn driver (presented at the 116th AES convention). On the other hand, a two-port description of the driver together with a plane-wave velocity distribution for the BEM calculation leads to good results. It is investigated to what extend higher order modes at the driver's mouth contribute to the sound radiation.

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Simulation of Harmonic Distortion in Horns Using an Extended BEM Postprocessing

The Boundary Element Method is a well-known tool to calculate sound radiation of horns. As the BEM is based on the linearized sound field equation, only linear properties of the sound field frequency response, directivity etc.) can be calculated. Besides these linear properties, the nonlinear wave propagation in horns is of great interest. It depends mainly on the shape of the horn and the growth rate of the first narrow part. This paper describes a method to combine the pure linear method BEM with the calculation of nonlinear wave propagation in horns. Simulation and measurement results of different horns are presented and discussed. As first results indicate, this method offers a fast and accurate way to calculate nonlinear wave propagation in horns.

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Determining Two-Port Parameters of Horn Drivers using only Electrical Measurements

The basic theory and a measurement procedure for the two-port description of horn drivers and horns was presented at the 111th AES Convention in New York, 2001 (Preprint 5409 "Two-port Representation of Horn Driver and Horn"). It was shown that this method is a powerful tool for the development of loudspeakers but it suffered from the restricted frequency range of the necessary acoustical impedance measurements with the Kundt's tube. A new method of measuring the driver's two-port parameters is presented here using only electrical measurements and an acoustical reference impedance. The frequency range of the two-port parameters could be extended using this method. The theoretical approach and first results are presented.

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On the Velocity Distribution at the Interface of Horn Driver and Horn

For the numerical simulation (BEM) of horns, the sound velocity distribution at the horn throat is required as one boundary condition. It is common to use plane wave excitation even at high frequencies since the shape of the real wave front in general is unknown. The error in the simulation result (directivity / frequency response) is difficult to predict and can only be judged by measurement of the real system. To achieve accurate simulation results the specific velocity distribution of each driver is required which must be measured at the interface between horn driver and horn. A more general approach for simulation techniques is created using modal composition. Measurements and simulations of different systems are compared to verify this method.

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Two-Port Representation of the Junction Between Horn-driver and Horn

Horn-drivers and horns in general are measured and characterized as combinations only. This is a restriction compared to the possibility of arbitrarily combining the two part at its standardized connection. With the method presented here an individual measurement of each part is possible and the overall transfer characteristics of the combined system is calculated by a computational tool.

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Two-Port Representation of the Connection between Horn Driver and Horn

A method for measuring and describing horn drivers and horns as independent parts was investigated. It is shown that the well-known two-port representation can be adopted for system characterization considering certain assumptions and limitations. The horn driver is represented as a two-port whereas the horn is characterized by its acoustical input impedance and, due to its three-dimensional sound radiation, by its on-axis transfer function and a relative directivity. With both sets of parameters the electrical input impedance, the transfer function, and the directivity of any horn driver/horn combination can be synthesized by a software tool without a need for measuring the real combination. This method speeds up procedures of either loudspeaker system design or the design and optimization of new horn drivers and horns, respectively. Besides the general-purpose measuring techniques, some specialized measuring equipment is required such as an impedance tube fitted to the horn throat and an anechoic chamber to record the directivity of the horn. Finally, all possible combinations of seven horn drivers and eleven horns have been studied to show the reliability of the method.

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Evaluation Strategies for the Optimization of Line Source Arrays

Line source arrays (LSAs) are used for large scale sound reinforcement, aiming at the synthesis of highly spatial aliasing-free sound fields for the whole audio bandwidth. Numerical optimization of the loudspeakers' driving functions can considerably improve the homogeneity of the intended sound field. In this paper we propose enhanced visualization techniques characterizing the array performance. This may lead to a more convenient interpretation of the LSA radiation behavior. By additionally recommended technical quality measures the LSA design and the optimization requirements might be improved. The approach is exemplarily discussed for fictitious LSA models. Based on a least-mean-square error optimization using a loudspeaker weight energy constraint, the driving functions are derived. It is shown by means of the visualizations and measures why this optimization scheme being common practice in sound field synthesis applications is inappropriate for the problem at hand and that spatial aliasing has a large impact on the synthesized sound fields. We recommend to incorporate the proposed quality measures as criteria for future optimization approaches.

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A Loudspeaker Management System With FIR/IIR Filtering

Most digital loudspeaker processor systems use cascaded IIR filters to perform the crossover function and system equalization. This work presents a multirate platform which allows FIR and IIR filters to be freely combined in each output channel. The pros and cons of both filter types are discussed and some techniques to obtain suitable FIR filter coefficients are described. Dual-range AD conversion satisfies the need for high dynamic input range, while look-ahead peak-limiters in the outputs avoid clipping and mechanical damage without introducing noticeable distortion.

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