ALTERNATIVE MODELS OF THE SOUND FIELD IN A REVERBERANT ROOM

by

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SUMMARY

Current standard test methods for acoustic measurements made in reverberant rooms have been found to yield inconsistent results at low frequencies. The theoretical basis of the standard test methods relies upon the assumption that the reverberant sound field can be modeled as completely diffuse at all frequencies. Thus, inconsistencies have been attributed to a lack of diffusivity at low frequencies. This thesis examines the appropriateness of the diffuse field assumption at low frequencies and shows that the strong modal characteristics of a low frequency reverberant sound field precludes the possibility of modeling such a field as diffuse.

A model of the reverberant sound field which includes the observed modal characteristics and is based upon well known solutions to the wave equation is presented. This model is dependent on the accurate prediction of the steady state amplitude and the decay rate of individual modes. In predicting the steady state amplitude of the modes contributing to a reverberant sound field, the assumption is usually made either implicitly or explicitly that there is equal energy distribution between modes. In this thesis, an alternative approach based on the assumption that there is equal power flow to all modes will also be considered. These assumptions are discussed and their influence on the relative difference in the steady state sound pressure level of any two modes is analytically investigated.

Two models for predicting the decay rate of individual modes are also examined. The first is based upon an approximate solution to the wave equation for a very lightly damped room. The second is based upon a combination of the modal approach and the ray tracing approach as applied to the rectangular room. Both models rely upon the assumption that the walls can be accurately modeled as locally reactive and that the wall
impedance can be modeled as constant over the wall surfaces and throughout the frequency range investigated.

Experimental results are presented for comparison of each model. Results indicate that the wall surfaces of the room cannot be modeled as being locally reactive as their response to excitation by the reverberant sound field in the frequency range investigated is characterized by modal vibration. In consequence it is shown that neither model accurately predicts the relative rates of decay of the measured modes. The relative amplitudes of individual modes are seen to be highly dependent on the effective coupling between each mode and the sound source. This is shown to be highly unpredictable for commonly used sound sources.

A widely recommended means of enhancing the diffusion in a reverberant room is the installation of a rotating diffuser. This thesis examines the effects of a rotating diffuser on the modal characteristics of a reverberant sound field and shows that it substantially disrupts the modal structure of the sound field.
To the best of the candidate's knowledge and belief, this thesis contains no material which has been accepted for the award of any degree or diploma in any University, and contains no material previously published or written by another person, except where due reference is made in the text.

Thomas J. Munro
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