ON THE USE OF TRANSPORT AND DIFFUSION EQUATIONS FOR ROOM-ACOUSTIC PREDICTIONS

By

Yun Jing

An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: ARCHITECTURAL ACOUSTICS

The original of the complete thesis is on file
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Examining Committee:

Ning Xiang, Thesis Adviser
William Siegmann, Member
Jonas Braasch, Member
Edward Larsen, Member
Wei Ji, Member

Rensselaer Polytechnic Institute
Troy, New York

July 2009
(For Graduation Aug 2009)

ABSTRACT

This thesis focuses on room-acoustic modeling in various spaces using transport equations and diffusion equations. The sound field modeling in long spaces is formulated using 1-D transport equations. The transport equation models are compared with the ray-tracing based method for different scenarios. In general, they are in good agreement, and the transport equation models are much less time consuming. Experiments obtained from a long room scale model are used to verify the transport equation models. In addition to transport equation models, the use of a diffusion equation to model sound field in various spaces is investigated. Particularly, a modified boundary condition to improve the room-acoustic prediction accuracy of the diffusion equation model is introduced. Previous boundary conditions for the diffusion equation model have certain limitations which restrict its application to a certain number of room types. Simulated and experimental data in a flat room scale model are compared to verify the modified boundary condition. In the end, the diffusion equation model is applied to the study of acoustics in coupled rooms. Acoustical measurements are conducted on a scale model of two coupled rooms. Using the diffusion model and the experimental results the current work conducts in-depth investigations on sound pressure level distributions, double-sloped energy decays, providing further evidence supporting the valid application of the diffusion equation model. Bayesian decay analysis confirms sound energy flux modeling predictions that time-dependent sound energy flows in coupled-room systems experience feedback in the form of energy flow direction change across the aperture connecting the two rooms in cases where the dependent room is more reverberant than the source room.