PennState College of Engineering | GRADUATE PROGRAM IN ACOUSTICS

The Graduate Program in Acoustics

announces the

M.S. Thesis Defense

of

Lane Miller

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AN ANALYSIS OF ACOUSTIC BEAM-FORMING WITH SPARSE TRANSDUCER ARRAYS FOR ACTIVE CONTROL

ABSTRACT

Recent research has aimed to apply multi-channel active noise control (ANC) to the sound transmitted through open windows. Moderate success, i.e. overall reductions of −10 dB, has been reported in the literature, though not all results have been over a wide range of frequencies, and not all reductions have necessarily been identified as "global". Typical loudspeaker arrays used in multi-channel ANC systems for window noise have fallen into two categories: uniformly distributed and edge distributed. The acoustically superior former has demonstrated larger reductions in sound energy over wide frequency ranges, while the latter has been shown to retain normal functionality of a window at the expense of limited sound reduction. The research outlined in this thesis was undertaken to assess the feasibility of using a cell-based sparse array of loudspeakers for multi-channel active control of window noise. The overarching objectives were to design, model, build, and test a sparse array system that would feature both of the above advantages: large reductions in sound energy and retained window functionality. Analytical models of an array-fitted open window system were developed, eventually culminating in an optimization-based scheme to solve for the ideal source strengths for the array elements and to predict the level of reduction in total sound power. The results of this model suggested that for a 0.45 m square rectangular opening, fitted with a 72-element 4-cell sparse array, large reductions (greater than −60 dB) were possible up to a frequency of 1200 Hz. Desirable reductions (at least −10 dB) were predicted up to 1550 Hz for the given system. A prototype array and window system was constructed and calibrated through measurement. Directivity measurements were performed on the prototype array to assess the reproducibility of the theoretically derived beam patterns. The measured data showed desirable reproduction below 700 Hz.

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