Modeling, Reconstructing and Active Control of Noise Sources: Bringing this All Together

Abstract:
The purpose of acoustic source modeling is to reconstruct the characteristics of an actual sound source and to predict the sound field at arbitrary locations in space based on sound field measurements at various spatial locations. This type of technique can be applied to source localization and identification, the study of source characteristics, sound field reproduction, etc. It will also be shown in this seminar that source modeling has a large potential when applied to active noise control. Source modeling usually involves the use of a series of mathematical basis functions to represent the sound field generated by the actual source, and the parameters of the basis functions are estimated based on the sound field measurements. Once this estimation is completed, the sound field at any location can be predicted. A reduced order modeling method based on the multipole decomposition of a sound field will be the focus in this seminar along with an introduction to several other recently developed source visualization procedures: specifically, Wide-Band Holography and an acoustic radiation mode-based method. Sound field decomposition techniques can also be implemented in Active Noise Control (ANC) applications, which allows the system to selectively control certain source content or important source characteristics with limited computing resources. After a general introduction of active noise control, this ANC method based on the independent sound field component decomposition will be briefly described together with other recent development in ANC techniques. Some further possible ways to combine source modeling with ANC will be mentioned as well.

Biography:
Yangfan Liu is currently a Post-Doctoral Research Associate at the Ray W. Herrick Laboratories of Purdue University. He received his Bachelor’s degree in 2009 at East China University of Science and Technology in Shanghai, and then a Masters and PhD degree at Purdue University in 2011 and 2016, respectively. Dr. Liu started his research in the area of acoustics shortly after he joined the graduate school in Purdue University. In his Masters and PhD program, his research was mainly focused on acoustical holography, noise source modeling and sound field reconstruction. He has proposed a reduced-order source modeling method based on using a multipole representation of the physical noise source and has extended this method from free-space sound field reconstruction to room acoustics simulations of sound fields generated by sources of finite size. At the same time, Dr. Liu completed the mathematical proof of the completeness property of the multipole series, which serves as the theoretical foundation for the use of the multipole method. After completing his PhD, Dr. Liu began working on Active Noise Control (ANC). In this area, he has proposed a new spatial filtering controller structure that can selectively control each statistically independent noise component; applied stochastic domain design methods to an ANC headrest that can accommodate the uncertainties of the person’s head position and gestures; and developed a new method to mitigate the noise enhancement phenomenon of an ANC system based on auto-correlation matrix decomposition and zero-phase filtering. Besides conducting his own research, Dr. Liu actively participates in collaborative research with Purdue colleagues and with industry partners. In such collaborations, he provided key contributions in the development of a holography method based on acoustic radiation modes and the application of Wide-Band Holography to diesel engine noise identifications.