

UC-SDRL: General Background and Information

Mission:

The mission of the University of Cincinnati, Structural Dynamics Research Lab (UC-SDRL) is to develop, investigate, and evaluate experimental approaches to the estimation of the dynamic properties of structural systems. The direction of this activity for more than forty years has centered on research related to the experimental determination of modal parameters (frequency, damping, and modal vectors). This continuing research is vital in order to understand existing vibration problems, in order to develop experimentally-based, structural system models, and in order to evaluate the validity of theoretically-based, structural system models originating from finite element analysis. The focus of recent work has broadened to include structural health monitoring, damage detection and prognosis, identification of general systems for control design, active vibration control, rotating machinery modeling and signature analysis, vibroacoustic interaction in structures and acoustic noise source identification utilizing microphone arrays.

Background:

The UC-SDRL activity began in 1965 as a research activity in the field of experimental modal analysis and structural dynamics. The original research involved the development of a mobile vibrations laboratory as part of an Air Force contract to study the structural dynamics of machine tools. Over the last forty years, the research activity has expanded to include all areas of experimental vibrations, noise, and controls. As a result of the knowledge gained from the research work in these areas at the University of Cincinnati, several companies have been formed as direct or indirect spin-offs from the UC-SDRL. These companies have all located in the Cincinnati area to create an international center of experimental vibrations and noise technology. These companies include: the Structural Dynamics Research Corporation (SDRC) (now part of Siemens PLM which includes the recent purchase of LMS), International Technegroup Inc., Manta, Etegent (formerly Sheet Dynamics) and The Modal Shop. The UC-SDRL was cited by the Ohio Board of Regents in a Resolution on March 18, 1983 for this contribution to industry and the State of Ohio. Complete details concerning the UC-SDRL can be found on the World Wide Web at <http://www.sdrl.uc.edu>.

Research:

The current research activity in the UC-SDRL consists of externally funded research projects (The Boeing Company, BMW Manufacturing, General Electric, etc.) and ongoing internal research projects funded by the UC-SDRL Seminar Series activity and the UC-SDRL Research Software Consortium. The following represents a short summary of the topics that are currently being investigated by the members of the UC-SDRL activity: Arrayed Measurement Methods, Digital Sensor System development, Perturbed Boundary Condition Test Methods, Multiple Input/Output (MIMO) Frequency Response Function (FRF) Estimation, Modal Parameter Identification/Estimation, Nonlinear System Identification and Analysis, Graphical User Interface Based Modal Analysis Software, On-Line and Autonomous Parameter Estimation, Characterization of Damping Coatings, Active Vibration Control, Acoustic Noise Source Detection, Rotating Machinery Analysis, Spatial Filtering of Structural Response Data, Actuator Modeling and Design, Control-Structure-Interaction, Structural Analysis Hardware Development, Experimental Modal Analysis Methods, General Multiple Input/Output (MIMO) Problem, Experimental Impedance/Modal Modeling Methods, Optimization of Dynamics Design, and Finite Element Model Calibration and Validation Methods and Metrics. Further details concerning each of these research projects can be found on the World Wide Web at <http://www.sdrl.uc.edu>.

Education:

In addition to actively involving undergraduate and graduate students in the research activity of the UC-SDRL, the faculty involved with the UC-SDRL routinely involve the facilities of the UC-SDRL in classroom

and laboratory activities. The UC-SDRL also offers the UC-SDRL Seminar Series for industry each year to provide industry access to current technology. This activity has involved 20-70 engineers each year since 1978.

Faculty/Staff:

The faculty/staff of the UC-SDRL consists of faculty, graduate students, and post doctorate researchers interested in the area of experimental structural dynamics, active control of structural vibrations, and machinery vibration diagnostics. Currently, this staff consists of four full time faculty members, two of which are very active, and several research assistants. The research assistants are graduate students working toward advanced degrees. Of the graduate students supported in this manner, two thirds are pursuing a Masters degree and one third are pursuing a Doctoral degree. In addition, there are 10-15 graduate students, full and part time, participating in academic interests relative to the activity of the UC-SDRL at the Masters and Doctoral levels.

Facilities:

The UC-SDRL activity is located in a laboratory that is ideally suited for the experimental emphasis of the research work. The experimental vibration area consists of a high bay laboratory (25 foot clearance x 2000 square feet of floor space) accessed by an overhead bridge crane. A loading dock and ramp entrance to the laboratory floor provide easy access to the testing area for any equipment that can be transported by truck. The UC-SDRL test area has great flexibility for any testing situation and includes two large isolation foundations, a spin pit, automotive lifts and a four axis MTS Road Simulator. The experimental acoustics area consists of a fully anechoic chamber that is suitable for research work in the 100 Hertz to 20,000 Hertz frequency range. Although most of the data analysis equipment is quite portable, all locations within the vibrations and acoustics laboratory areas are connected by data and communication lines to the data analysis laboratory that include hard wired and wireless networks. The data analysis laboratory houses the data analysis computer systems as well as providing office space for 14 members of the research staff and the UC-SDRL administrative staff.

Data analysis equipment represents the primary asset of the SDRL activity. The UC-SDRL has generated an equipment inventory of over \$2,000,000 worth of experimental data acquisition and analysis equipment. It is important to note that this equipment has been acquired entirely by way of equipment grants from industry or from funds generated from research contracts. The equipment includes a network of personal computer laptops and workstations with the capability to acquire up to 256 parallel channels of data at a frequency bandwidth of 12.5 KHz Hertz, 176 parallel channels of data at a frequency bandwidth of 50 KHz and 40 parallel channels of data at a frequency bandwidth of 50 KHz.

Further computational capability is also available through the College and University Computer Network. This network is a mix of hard wired and wireless connectivity that provides Internet and Internet II access for all computers in the UC-SDRL. Application packages currently available within UC-SDRL or through the College and University Network include: UC-SDRL X-Modal III, MSC-NASTRAN, ANSYS, ADAMS, Matlab and SimuLink. Complete details concerning the facilities located at the UC-SDRL can be found on the World Wide Web at <http://www.sdrl.uc.edu>.

For More Information:

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