



# Northeastern

Department of Civil and Environmental Engineering Distinguished Seminar Series

## **Sparse and Low-rank Methods for Structural System Identification**

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Professor of Civil Engineering & Environmental Engineering  
Rice University

**Monday, October 30, 2017 12:00 pm-1:00pm**  
**135 Shillman Hall**

### **Abstract**

By exploiting the sparse and low rank properties of structural dynamic responses data, data-driven approaches are developed to efficiently address the output-only structural system identification and damage detection problems, as well the data compression and data cleansing problems. First, the most popular blind source separation (BSS) technique, independent component analysis (ICA), which is able to extract sparse components, is combined with classic time-frequency representations (short-time-Fourier-transform (STFT) and wavelet transform (WT)) to develop new methods for modal identification and damage detection. Second, the system identification problem is solved using the complexity pursuit learning rule, which can identify a wide range of structures with highly-damped modes, closely-spaced modes, or complex modes even in the presence of non-stationary excitation. Third, the spirit of the sparsity property of modal responses, the sparse component analysis (SCA) modal identification method is presented; this algorithm handles the underdetermined problem (with an underlying sparse representation recovered by  $\ell_1$ -minimization) where limited sensors may be available compared to the active modes of the structure. Fourth, the low rank/sparse methods for data denoising (cleansing) and image/video analysis are presented. Fifth, a distributed strain sensing algorithm is presented. All the aforementioned research topics are presented briefly to highlight the versatility of sparsity and low rank algorithms for tackling a class of structural identification and structural health monitoring problems, while the seminar will get into to greater depth only on the SCA algorithm and low-rank/sparse algorithm for denoising to present the core concepts. The seminar will conclude with a brief presentation of low-rank/sparse algorithm to dynamic imaging for damage detection.

### **Biographical Sketch**

Satish Nagarajaiah is a Professor of Civil and Environmental Engineering at Rice University, Houston. He obtained his Ph.D. from University at Buffalo, where he was a post-doctoral researcher before he started his academic career. His expertise is in nonlinear structural dynamics, advanced protective systems, structural control, structural system identification, advanced sensing using nanomaterials, and monitoring. He has published extensively and presented several keynote lectures at international conferences. For full details visit his web site [satishnagarajaiah.rice.edu](http://satishnagarajaiah.rice.edu). Dr. Nagarajaiah currently serves as the managing editor of the journal of structural engineering [ASCE], editor of the structural control and health monitoring international journal [Wiley] and editor-in-chief (North America) of the structural monitoring and maintenance international journal

[Techno-press]. He is a fellow of ASCE and Structural Engineering Institute (SEI) of ASCE. He was awarded the NSF CAREER award in 1998, ASCE Moisseiff Award in 2015 and ASCE Reese Research Award in 2017 for his research on Adaptive Stiffness Structures and structural identification, respectively. Currently, he serves on the board of governors of ASCE SEI and the Technical Activities Division Executive Committee. He has founded and chaired numerous committees in SEI, EMI, and IASCM on Structural Control and Monitoring.



**Satish Nagarajaiah, Ph.D.**  
**Professor of Civil and Environmental Engineering**  
**RICE UNIVERSITY**



Education

- **PhD Structural Engineering, *SUNY BUFFALO***
- **MS Structural Engineering, *INDIAN INSTITUTE OF SCIENCE, BANGALORE***
- **BS Civil Engineering (Structures), *BANGALORE UNIVERSITY, INDIA***

Research Interests

- **Nonlinear Structural dynamics**
- **Advanced Protective Systems**
- **Structural Control**
- **Structural System ID**

Selected Service and Awards

- **Fellow – Structural Engineering Institute - 2012**
- **Raymond Reese Award – ASCE 2017**
- **Most cited paper – Nanotechnology Journal**
- **NSF CAREER Award - 1998**