Structures with complex geometries, material properties, and boundary conditions, exhibit spatially local, temporally transient, dynamic behaviors. High spatial and temporal resolution vibration measurements and modeling are thus required for high-fidelity characterization, analysis, and prediction of the structure’s dynamic phenomena. For example, high spatial resolution mode shapes are needed for accurate vibration-based damage localization. Also, higher order vibration modes typically contain local structural features that are essential for high-fidelity dynamic modeling of the structure. In addition, while it is possible to build a highly-refined mathematical model (e.g., a finite element model) of the structure, it needs to be experimentally validated and updated with high-resolution vibration measurements. However, it is a significant challenge to obtain high-resolution vibration measurements using traditional techniques. For example, accelerometers and strain-gauge sensors provide low spatial resolution measurements. Laser vibrometers provide high-resolution measurements, but are expensive and make sequential measurements that are time-consuming. On the other hand, digital video cameras are relatively low-cost, agile, and provide high spatial resolution, simultaneous, measurements. A new framework is first developed for the blind extraction and visualization of the full-field, high-resolution, dynamic parameters of an operating (output-only) structure from the digital video measurements using video motion manipulation and unsupervised machine learning techniques. See Fig. 1 for the experimental results of a vibrating cantilever beam and more video demos at http://www.lanl.gov/projects/national-security-education-center/engineering/research-projects/blind-modal-id.php.

![Figure 1. Video-based, output-only, full-field dynamic extraction technique applied to an operating building excited by a hammer impact. The original video is blindly and autonomously separated into three videos, each contains one individual vibration mode with very high spatial (pixel) resolution. More Video Demos: http://www.lanl.gov/projects/national-security-education-center/engineering/research-projects/blind-modal-id.php](image)