Full-field Digital Holographic Vibrometry for Characterization of Optoelectronic Packaging and MEMS

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Abstract

Development of quantitative full-field high-speed imaging modalities are indispensable to monitor the realtime transient performance of Micro Electro Mechanical Systems (MEMS). Their performance is a direct result of how devices are designed and fabricated and any imperfection in either one of them renders undesirable results. Furthermore, new devices are being designed to comply with tighter performance tolerances while operating at higher speeds. In this paper, we report progress in the development of a new High-speed Digital Holographic System (HDHS) for acquisition and quantification of the nanometer scale transient (i.e., >100 kHz) displacement of MEMS in full-field. We have optimized and implemented a 2+1 frame local correlation (LC) based phase sampling method in combination with a high-speed (i.e., >100 kfps) camera acquisition system. Comparisons of the results obtained with our high-speed acquisition system and those obtained with Laser Doppler Vibrometry (LDV) indicate differences of <10 μs. The high temporal and spatial (i.e., >150 k data points) resolution of our HDHS enables parallel measurements of all points on the surface of microstructures, which allows quantification of spatially dependent motion parameters such as modal frequencies, time constants, Q-factors, changes in shapes, and surface strains. Such capabilities allow inferring performance parameters that can directly be used to improve MEMS design and fabrication as well as to optimize their corresponding mechatronics and control systems. Representative applications of our HDHS to study specific high performance MEMS will be presented.

Keywords: high-speed digital holography, MEMS design and fabrication, MEMS performance, transient events.

Speaker's short bio: Cosme Furlong is a Professor or Mechanical, Electrical, Computer Engineering, and Physics at Worcester Polytechnic Institute (WPI). He is Director of the Center for Holographic Studies and Laser micromechaTronics (CHSLT) in the Mechanical Engineering Department at WPI. CHSLT, founded in 1978, develops and applies photonic, micro- and nano-Systems, and 3D optical metrology technologies for advanced and challenging applications in science and engineering.