AN OPTICAL SENSOR AND WIRELESS MESH NETWORK FOR DIRECT MEASUREMENT OF BUILDING INTERSTORY DRIFT

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Abstract

Advancements in sensor technologies and communication networks are creating new opportunities for advanced methods of measuring earthquake response and damage in critical infrastructure systems. Based on applied R&D sponsored by the U.S. Department of Energy (DOE), new optically-based sensor systems have been developed that provide for continuous measurement and rapid transmission of key infrastructure response observables immediately after an earthquake. The short latency of the underlying physics of optical sensors, and the ability to perform high resolution measurements across a broad frequency bandwidth are attributes that make optical-based measurement systems particularly attractive for applications in earthquake response measurement. Concurrently, transformational progress underway in wireless communications and the Internet of Things (IOT) are enabling new paradigms for expedient deployment of sensor systems and rapid extraction and analysis of time-critical data.

Building interstory drift is a key earthquake response observable that is broadly utilized as a design parameter in many engineering standards to define performance-based limit states, maximum allowable story deformations, and quantification of damage in post-earthquake assessments. Historically, drift measurement has been obtained through signal processing and double integration of accelerometer data, which is challenging particularly if inelastic, permanent drifts occur. To date, there has been no widely accepted methodology or technology for reliable and accurate direct measurement of building drift.

This presentation will describe recent advancements in a new optically-based sensor system for direct measurement of interstory drift. The third generation of a *Discrete Diode Position Sensor* (DDPS), which utilizes laser light to directly measure drift, is described and data from experimental laboratory tests illustrating high-resolution sensor performance are presented. The ability to measure both Transient Interstory Drift (TID(t)) and Residual Interstory Drift (RID) is demonstrated. To facilitate efficient deployment of the optical sensor systems, a practical, wireless mesh network for reliable, rapid extraction of building data has been developed. The mesh network is based on a system of dedicated low-power radio-frequency (RF) nodes that can self-configure and form a dynamic network throughout a building structure. Experience from the first field deployment of the optical sensor and mesh communication network are described for a DOE mission-critical facility in the San Francisco Bay Area.