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Heterogeneous Fusion of Sensor Data for Response Recovery During Earthquakes

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Abstract

In this study, a methodology is developed for the fusion of strain and absolute acceleration data by using weighted least squares for response recovery. For recovery of responses, modal displacement coordinates, a quantity termed the pseudo-modal acceleration coordinates, and the ground acceleration is estimated in the framework of classical estimation. This methodology is developed explicitly for application during earthquake events. It must be noted that the scheme requires a finite element model of the structure and explicitly considers the varying level of noise in different sensors. By fusing data from a sparse array of strain and acceleration sensors, the responses like displacements, strains, and accelerations at locations without instruments are recovered. The recovered strain data help assess the damage that the structure might have sustained during an earthquake. These recovered strains are especially beneficial for steel structures as they can keep track of fatigue. The methodology is verified on the numerical model of a real-life water-carrying steel bridge in Jhansi, India, subjected to earthquake excitation. It is observed that the scheme could successfully recover strains, relative accelerations, and relative displacement locations without sensors.

Keywords: Strain analysis, Sensor fusion, Classical estimation, Response recovery