Passive Imaging and Monitoring with Distributed Acoustic Sensing

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Seismic imaging and monitoring at high spatial and temporal resolution is important for understanding subsurface structure changes and assessing potential seismic hazards. However, it is usually costly and logistically prohibited, especially in urban settings. In recent years, solutions have been proposed for both seismic sources and receivers. Ambient noise interferometry, a well-established technique, employs ubiquitous long-period natural vibrations or high-frequency anthropogenic noise to transform receivers into virtual sources. Distributed acoustic sensing (DAS), an emerging technique, converts telecommunication fibers into cost-effective, meter-spacing sensors.

We utilized DAS connected to the telecom fiber throughout the city of Ridgecrest, CA, to demonstrate our workflow for subsurface imaging and monitoring through three case studies: (1) Sub-kilometer site amplification estimation via subsurface imaging; (2) Fault zone mapping and characterization; and (3) Monitoring of vadose zone soil moisture. Our findings indicate that by combining DAS with high-frequency traffic noise, we can achieve shallow subsurface imaging and monitoring with unprecedented spatial and temporal resolution.