Toward a time-lapse inversion of surface waves for the monitoring of soils and structures

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Rayleigh waves propagate along the surface of a solid with high energy and weak geometric attenuation, making them a popular choice for near-surface imaging [1], [2]. Provided that a source is emitting in a large frequency band and with a suitable array of sensors, surface waves can be measured for a variety of wavelengths. Since their penetration depth of surface waves is related to wavelength, analysis of seismic signal gives access to a large range of depth. In order to infer the mechanical properties of the medium as a function of depth, an inverse procedure is required that minimizes a misfit function between observed and modeled data. This process could be efficient for monitoring the temporal evolution of these properties. However, a small change of model parameters can have low or moderate effects on observed surface waves data [3], [4]. Moreover, noise is unavoidable in experimental acquisition, which further increases uncertainties in the inversion results. In this study, the effect of small variations of the medium properties is discussed against inversion of shear wave velocity profiles obtained from dispersion curves. Our objective is to determine a new formulation of the inverse problem, which makes it possible to directly invert the temporal variation of model parameters, rather than the parameters themselves at each time step. Therefore, both the direct and inverse problems need to be studied in order to select new observables which are sensitive to small variations of the medium.

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