Public Abstract
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Title:POINT TARGET ANALYSIS AS APPLIED TO THE CHARACTERIZATION OF LOCALIZED DEFORMATION FEATURES

Monitoring of ground deformation is a critical component of geotechnical engineering practice. This study investigated the application of synthetic aperture radar interferometry (InSAR) using point target analysis (IPTA) for detecting and characterizing localized deformation features that are often associated with geotechnical engineering activities. Initially used to infer tectonic deformation, Synthetic Aperture Radar interferometry (InSAR) is a remote sensing technique that enables the derivation of spatially continuous deformation fields. Satellite imagery acquired before and after a deformation event can be quantitatively manipulated to discern regions in the satellite image that deformed between the two acquisitions. In contrast to discrete point in-situ deformation measurement techniques, InSAR can be used to obtain a broader view of deformation processes at a site. The objectives of this research were to (1) evaluate the feasibility of using IPTA to detect localized deformation features characteristic of Civil Engineering activities (as opposed to large spatial scale tectonic deformation), (2) investigate the influence of SAR data characteristics on the ability to successfully apply IPTA processing and (3) quantify the dependence of the IPTA-derived deformation estimates on the number of SAR acquisitions used to constrain the analysis. To address these objectives, 52 SAR scenes that were acquired over Los Angeles, CA, during the construction of the Los Angeles Metro Rail Red Line between 1992 and 2000, were used. This site was chosen due to the availability of extensive SAR data and the known occurrence of localized settlements along the Red Line alignment during construction. The results from IPTA processing of the complete dataset successfully demonstrated the ability to detect the localized deformations associated with the subway construction. Deformation time histories for points along the Red Line alignment exhibited episodic settlements that were not observed for points located away from the alignment. To address the second objective of this study, IPTA processing was applied to subsets of the 52 SAR acquisitions available for the site. It was found that the number of interferometric pairs required for successfully applying point target analysis without patch errors, ranged between 20 and 25. The average baseline defining SAR acquisitions constituting a dataset was hypothesized to have a dominant influence on the ability to successfully apply IPTA processing to a dataset. However, no clear baseline dependence was identified. To address the third objective, a statistical assessment of the sensitivity of deformation rates and the associated standard errors to the size of the dataset analyzed, was performed by analyzing randomly generated subsets of data. From the sensitivity analysis, it was found that the variability of the derived estimates of deformation parameters varied inversely as a function of the size of the dataset used for analysis. Though applicable to small study areas located in urban settings, the results of this research enables the assessment of the applicability of the IPTA, given the number of SAR acquisitions available for analysis. Further characterization of the technique is recommended for a more comprehensive understanding.