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Long-Term Highway Tunnel Deformation Assessment Using PSInSAR Analysis

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Comparing to conventional Differential Interferometric Synthetic Aperture Radar (DInSAR) techniques, Persistent Scatterer Interferometric Synthetic Aperture Radar (PSInSAR) is considered having significant improvements, especially on de-correlation and noise resistance, in terms of ground deformation measurement. However, the applications of InSAR-based monitoring or analysis are usually carried out in a large area, at a regional scale at least; little has been explored for employing InSAR analysis in an engineering scale, such as monitoring of a bridge or highway. This study utilized PSInSAR algorithms to analyze multi-temporal C-Band and L-Band space-borne SAR images acquired during January 2007 to February 2018 in order to understand the deformations of a highway tunnel in southern Taiwan over the last decade. The tunnel runs through an active fault, which has caused significant fragmenting and deformations of the tunnel (and the ground above it). The PSInSAR analysis results of the SAR images acquired in both descending and ascending orbits clearly identified PS points along the highway and the tunnel and successfully calculated the deformations of the target during the years. The results also show that the highway has an annual deformation change rate at about 30 mm/year to 100 mm/year along the line of sight (LOS) directions of the observations. Several in-situ datasets collected from high-precision differential GPS stations along the highway and at nearby sites were used to verify and evaluate the PSInSAR analysis results by projecting the GPS measured three-dimensional movements onto the LOS directions. The analysis indicates the PSInSAR results have a high degree of agreement with the GPS-based deformation observations. The results of this study indicate that PSInSAR analysis has a great potential for the long-term monitoring of infrastructures such highways and tunnels at en engineering scale. However, detailed and sophisticated adjustments on the SAR data processing and parameters of PSInSAR analysis are necessary in order to achieve accurate and reliable assessment results.