CONTROLLED STUDY OF GROUND-BASED INTERFEROMETRIC RADAR FOR ROCKFALL HAZARD MONITORING

Joseph T. Gilliam

Dr. Brent L. Rosenblad, Thesis Supervisor

ABSTRACT

The ability to detect small and localized movements of geotechnical facilities is important for performance monitoring and early-warning hazard detection. Current deformation monitoring technology is limited in its ability to both scan massive structures and detect small and localized movements. Ground-based interferometric radar (GBIR) is an emerging remote sensing technology that has the potential to fill this gap in surface deformation monitoring technology. Much of the focus of previous research and application of GBIR has been on monitoring large spatial scale movements, such as mine walls, dams, and earth slopes experiencing deformational movements occurring over hundreds or thousands of square meters. In this study the focus is on evaluating the capabilities of GBIR for detecting and monitoring small movements (mm-scale) occurring over very localized regions (a few m^2). Specifically, this study focused on the application of GBIR for detecting and monitoring movements of individual boulders in a massive landscape. The potential long-term application is to use GBIR to detect and monitor precursor movements to rockfall events. Boulders, ranging from 0.5 to 5 meters in approximate facial dimensions, were moved using pry bars and airbag jacks in increments of a few to several mm. Two identical GBIR devices positioned at separate locations scanned a region covering approximately 20,000 m^2 after each boulder movement. Ground truth measurements were also performed after each boulder movement. The detectability of the boulder movements was assessed by comparing the distribution of measured phase values from the boulder to (1) phase values measured on the surrounding non-moving portion of the image and (2) phase values measured from the same boulder when it was not moving. The results from the study showed that movements of boulders with dimensions larger than about 2 m were detectable for range offset distances from about 75 to 150 m. Movements as small of 1.7 mm were detected on these larger boulders. Phase values associated with movements of the smaller boulders, with dimensions less than about 2 m, were more difficult to differentiate from the non-moving portions of the image. This study successfully demonstrated the potential of GBIR to fill existing gaps in current displacement and deformation monitoring technology for geotechnical applications.