World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:13, No:06, 2019

MIMO Radar-Based System for Structural Health Monitoring and Geophysical Applications

Authors : Davide D'Aria, Paolo Falcone, Luigi Maggi, Aldo Cero, Giovanni Amoroso

Abstract : The paper presents a methodology for real-time structural health monitoring and geophysical applications. The key elements of the system are a high performance MIMO RADAR sensor, an optical camera and a dedicated set of software algorithms encompassing interferometry, tomography and photogrammetry. The MIMO Radar sensor proposed in this work, provides an extremely high sensitivity to displacements making the system able to react to tiny deformations (up to tens of microns) with a time scale which spans from milliseconds to hours. The MIMO feature of the system makes the system capable of providing a set of two-dimensional images of the observed scene, each mapped on the azimuth-range directions with noticeably resolution in both the dimensions and with an outstanding repetition rate. The back-scattered energy, which is distributed in the 3D space, is projected on a 2D plane, where each pixel has as coordinates the Line-Of-Sight distance and the cross-range azimuthal angle. At the same time, the high performing processing unit allows to sense the observed scene with remarkable refresh periods (up to milliseconds), thus opening the way for combined static and dynamic structural health monitoring. Thanks to the smart TX/RX antenna array layout, the MIMO data can be processed through a tomographic approach to reconstruct the three-dimensional map of the observed scene. This 3D point cloud is then accurately mapped on a 2D digital optical image through photogrammetric techniques, allowing for easy and straightforward interpretations of the measurements. Once the three-dimensional image is reconstructed, a 'repeat-pass' interferometric approach is exploited to provide the user of the system with high frequency three-dimensional motion/vibration estimation of each point of the reconstructed image. At this stage, the methodology leverages consolidated atmospheric correction algorithms to provide reliable displacement and vibration measurements.

Keywords : interferometry, MIMO RADAR, SAR, tomography
Conference Title : ICCSHM 2019 : International Conference on Civil Structural Health Monitoring
Conference Location : London, United Kingdom
Conference Dates : June 27-28, 2019