Monitoring of airport runways by satellite-based remote sensing techniques: a geostatistical analysis on sentinel 1 SAR data

EGU22-2533
EGU General Assembly 2022

Monitoring of Airport Runways by Satellite-based Remote Sensing Techniques: a Geostatistical Analysis on Sentinel 1 SAR Data

Valerio Gagliardi[1], Sebastiano Trevisani[2], Luca Bianchini Ciampoli[1], Fabrizio D'Amico[1], Amir M. Alani[3], Andrea Benedetto[1], and Fabio Tosti[3]

[1]Roma Tre University, Department of Engineering,Via Vito Volterra 62, 00146, Rome, Italy (valerio.gagliardi@uniroma3.it)

[2]University IUAV of Venice, Dorsoduro 2206, 30123 Venezia, Italy

[3]School of Computing and Engineering, University of West London (UWL), St Mary's Road, Ealing, London W5 5RF, UK

Maintenance of airport runways is crucial to comply with strict safety requirements for airport operations and air traffic management [1]. Therefore, monitoring pavement surface defects and irregularities with a high temporal frequency, accuracy and spatial density of information becomes strategic in airport asset management [2-3]. In this context, Multi-Temporal Interferometric Synthetic Aperture Radar (MT-InSAR) techniques are gaining momentum in the assessment and health monitoring of infrastructure assets, proving their viability for the long-term evaluation of ground scatterers. However, the implementation of C-band SAR data as a routine tool in Airport Pavement Management Systems (APMSs) for the accurate measurement of differential displacements on runways is still an open challenge [4]. This research aims to demonstrate the viability of using medium-resolution (C-band) SAR products and their contribution to improve current maintenance strategies in case of localised foundation settlements in airport runways. To this purpose, Sentinel-1A SAR products, available through the European Space Agency (ESA) Copernicus Program, were acquired and processed to monitor displacements on "Runway n.3" of the "L. Da Vinci International Airport" in Fiumicino, Rome, Italy.A geostatistical study is performed for exploring the spatial data structure and for the interpolation of the Sentinel-1A SAR data in correspondence of ground control points.The analysis provided ample information on the spatial continuity of the Sentinel 1 data, also in comparison with the high-resolution COSMO-SkyMed and the ground-based topographic levelling data, taken as the benchmark.Furthermore, a comparison between the MT-InSAR outcomes from the Sentinel-1A SAR data, interpolated by means of Ordinary Kriging, and the ground-truth topographic levelling data demonstrated the accuracy of the Sentinel 1 data. Results support the effectiveness of using medium-resolution InSAR data as a continuous and long-term routine monitoring tool for millimetre-scale displacements in airport runways. Outcomes of this study can pave the way for the development of more efficient and sustainable maintenance strategies for inclusion in next-generation APMSs.

Acknowledgments and fundings: The authors acknowledge the European Space Agency (ESA), for providing the Sentinel 1 SAR products for the development of this research. The COSMO-SkyMed Products—©ASI (Italian Space Agency)- are delivered by ASI under the license to use.This research falls within the National Project "EXTRA TN", PRIN 2017, supported by MIUR. The authors acknowledge funding from the MIUR, in the frame of the "Departments of Excellence Initiative

2018–2022", attributed to the Department of Engineering of Roma Tre University

References

[1]Gagliardi V., Bianchini Ciampoli L., D'Amico F., Tosti F., Alani A. and Benedetto A. "A Novel Geo-Statistical Approach for Transport Infrastructure Network Monitoring by Persistent Scatterer Interferometry (PSI)". In: 2020 IEEE Radar Conference, Florence, Italy, 2020, pp. 1-6

[2]Gagliardi V, Bianchini Ciampoli L, Trevisani S, D'Amico F, Alani AM, Benedetto A, Tosti F. "Testing Sentinel-1 SAR Interferometry Data for Airport Runway Monitoring: A Geostatistical Analysis". 2021; 21(17):5769. https://doi.org/10.3390/s21175769

[3]Gao, M.; Gong, H.; Chen, B.; Zhou, C.; Chen, W.; Liang, Y.; Shi, M.; Si, Y. "InSAR time-series investigation of long-term ground displacement at Beijing Capital International Airport, China". Tectonophysics 2016, 691, 271–281.

[4]Department of Transportation Federal Aviation Administration (FAA), Advisory Circular 150/5320-6F, Airport Pavement Design and Evaluation, 2016