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A new implementation of full resolution SBAS-DInSAR processing chain for the effective monitoring of structures and infrastructures

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The advanced DInSAR technique referred to as Small BAseline Subset (SBAS) algorithm has already largely demonstrated its effectiveness to carry out multi-scale and multi-platform surface deformation analyses relevant to both natural and man-made hazards. Thanks to its capability to generate displacement maps and long-term deformation time series at both regional (low resolution analysis) and local (full resolution analysis) spatial scales, it allows to get more insights on the spatial and temporal patterns of localized displacements relevant to single buildings and infrastructures over extended urban areas, with a key role in supporting risk mitigation and preservation activities.

The extensive application of the multi-scale SBAS-DInSAR approach in many scientific contexts has gone hand in hand with new SAR satellite mission development, characterized by different frequency bands, spatial resolution, revisit times and ground coverage. This brought to the generation of huge DInSAR data stacks to be efficiently handled, processed and archived, with a strong impact on both the data storage and the computational requirements needed for generating the full resolution SBAS-DInSAR results. Accordingly, innovative and effective solutions for the automatic processing of massive SAR data archives and for the operational management of the derived SBAS-DInSAR products need to be designed and implemented, by exploiting the high efficiency (in terms of portability, scalability and computing performances) of the new ICT methodologies.

In this work, we present a novel parallel implementation of the full resolution SBAS-DInSAR processing chain, aimed at investigating localized displacements affecting single buildings and infrastructures relevant to very large urban areas, relying on different granularity level parallelization strategies. The image granularity level is applied in most steps of the SBAS-DInSAR processing chain and exploits the multiprocessor systems with distributed memory. Moreover, in some processing steps very heavy from the computational point of view, the Graphical Processing Units (GPU) are exploited for the processing of blocks working on a pixel-by-pixel basis, requiring strong modifications on some key parts of the sequential full resolution SBAS-DInSAR processing chain. GPU processing is implemented by efficiently exploiting parallel processing architectures (as CUDA) for increasing the computing performances, in terms of optimization of the available GPU memory, as well as reduction of the Input/Output operations on the GPU and of the whole processing time for specific blocks w.r.t. the corresponding sequential implementation, particularly critical in presence of huge DInSAR datasets. Moreover, to efficiently handle the massive amount of DInSAR measurements provided by the new generation SAR constellations (CSK and Sentinel-1), we perform a proper re-design strategy aimed at the robust assimilation of the full resolution SBAS-DInSAR results into the web-based Geonode platform of the Spatial Data Infrastructure, thus allowing the efficient management, analysis and integration of the interferometric results with different data sources.