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DInSAR time series generation within a cloud computing environment: from ERS to Sentinel-1 scenario

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One of the techniques that will strongly benefit from the advent of the Sentinel-1 system is Differential SAR Interferometry (DInSAR), which has successfully demonstrated to be an effective tool to detect and monitor ground displacements with centimetre accuracy. The geoscience communities (volcanology, seismicity, ...), as well as those related to hazard monitoring and risk mitigation, make extensively use of the DInSAR technique and they will take advantage from the huge amount of SAR data acquired by Sentinel-1. Indeed, such an information will successfully permit the generation of Earth's surface displacement maps and time series both over large areas and long time span.
However, the issue of managing, processing and analysing the large Sentinel data stream is envisaged by the scientific community to be a major bottleneck, particularly during crisis phases. The emerging need of creating a common ecosystem in which data, results and processing tools are shared, is envisaged to be a successful way to address such a problem and to contribute to the information and knowledge spreading.
The Supersites initiative as well as the ESA SuperSites Exploitation Platform (SSEP) and the ESA Cloud Computing Operational Pilot (CIOP) projects provide effective answers to this need and they are pushing towards the development of such an ecosystem.
It is clear that all the current and existent tools for querying, processing and analysing SAR data are required to be not only updated for managing the large data stream of Sentinel-1 satellite, but also reorganized for quickly replying to the simultaneous and highly demanding user requests, mainly during emergency situations. This translates into the automatic and unsupervised processing of large amount of data as well as the availability of scalable, widely accessible and high performance computing capabilities. The cloud computing environment permits to achieve all of these objectives, particularly in case of spike and peak requests of processing resources linked to disaster events.
This work aims at presenting a parallel computational model for the widely used DInSAR algorithm named as Small BAseline Subset (SBAS), which has been implemented within the cloud computing environment provided by the ESA-CIOP platform. This activity has resulted in developing a scalable, unsupervised, portable, and widely accessible (through a web portal) parallel DInSAR computational tool. The activity has rewritten and developed the SBAS application algorithm within a parallel system environment, i.e. in a form that allows us to benefit from multiple processing units. This requires the devising a parallel version of the SBAS algorithm and its subsequent implementation, implying additional complexity in algorithm designing and an efficient multi processor programming, with the final aim of a parallel performance optimization.
Although the presented algorithm has been designed to work with Sentinel-1 data, it can also process other satellite SAR data (ERS, ENVISAT, CSK, TSX, ALOS). Indeed, the performance analysis of the implemented SBAS parallel version has been tested on the full ASAR archive (64 acquisitions) acquired over the Napoli Bay, a volcanic and densely urbanized area in Southern Italy. The full processing – from the raw data download to the generation of DInSAR time series – has been carried out by engaging 4 nodes, each one with 2 cores and 16 GB of RAM, and has taken about 36 hours, with respect to about 135 hours of the sequential version. Extensive analysis on other test areas significant from DInSAR and geophysical viewpoint will be presented.
Finally, preliminary performance evaluation of the presented approach within the Sentinel-1 scenario will be provided.