IAF EARTH OBSERVATION SYMPOSIUM (B1)
Earth Observation Data System Development and Management (4)

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QUANTUM COMPUTING FOR EARTH OBSERVATION: GROUND MOTION MEASUREMENTS AND SUPER-RESOLUTION

Abstract

Tasks related to Earth Observation (EO) data processing present challenges related to both the large amount of data made available by the numerous constellations currently in orbit, and to the increasing computational complexity of algorithms aimed at providing the most accurate and exhaustive results. The search for solutions to these problems, which are often prohibitive in their original formulation, also involves the exploration of new approaches (such as AI) and new technologies. This study aims to analyse the potential offered by the emerging technologies based on Quantum Computing applied to EO data elaboration, starting from two reference scenarios deemed as highly representative for the selected domain. The identified scenarios cover two different use cases that make use of SAR and Optical EO data, respectively. The first scenario involves an application of Multi-Temporal Interferometry (MTI) for monitoring ground displacements based on the resolution of an optimization problem, thus making MTI a good candidate to be explored through QC-based techniques. The second scenario concerns Super-Resolution (SR) algorithms applied to optical data for generating high-resolution images from multiple low-resolution data composed in such a way as to increase the spectral content at high spatial frequencies and remove the degradations introduced by the imaging process. Such techniques, usually characterized by high computational costs, aim at minimising a cost function, whose formulation makes the problem well-suited for being solved by Quantum Annealing (QA) approaches. More specifically, our objective is to reformulate functions that characterise MTI and SR applications according to QA framework: to this end, critical aspects related to the recasting of the objective function into a QUBO (Quadratic Unconstrained Binary Optimization), and variable mapping (e.g. discretization/binarization, limitation within physically acceptable ranges) will be addressed to work with the quantum paradigm. The ultimate goal of the activity will be the creation of a dedicated SW library of functions for the application of the QC-based paradigm to the field of EO satellite image processing. To this end, the study aims to bring innovation on two levels. Firstly, it provides an added-value in the domain of technological development tailoring the QC-based paradigm towards "scientific" problems specific of the EO context, but at the same time it also frames the research of the solution in an engineering framework that will allow its generalisation and integration in operating systems and, in perspective, in services with industrial and commercial impacts.