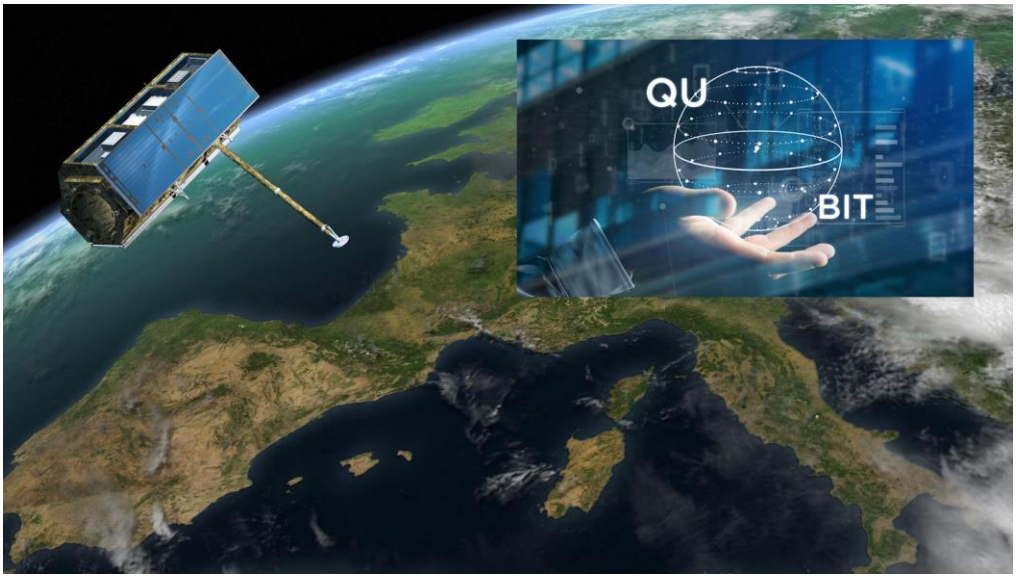
PhD Position

German Aerospace Center (DLR)
Microwaves and Radar Institute

Topic	Quantum Machine Learning for Automatic Target Detection	Date of announcement **November 06, 2023**



Description

Your Mission

Quantum computing, as a new paradigm for solving highly complex computational problems, is about to penetrate more and more application areas. In this context, the German Aerospace Center (DLR) supports young scientists through a specially established program, the Quantum Fellowship Program (QFP). With this research position, the DLR Microwaves and Radar Institute, with its world-renowned expertise in the design and development of Earth observation missions, offers anyone interested the opportunity to conduct research in an innovative research field within the framework of an industrial sponsorship. Our partner is the company HENSOLDT, an internationally leading supplier for defense and security electronics. The constellation of a large research institution and an industrial company gives the PhD student the unique opportunity to work in a team of DLR researchers and PhD students as well as with developers from industry and to gain insight into the developments of quantum computing in a larger context. The PhD student will be encouraged to enter this dynamic field of research and to tackle the challenges of the following topic with creative ideas in collaboration with other PhD students, researchers and developers from different disciplines.

Your Research

Innovation drivers for modern radar systems, for example with applications for drone detection or for the automatic evaluation of large synthetic aperture radar (SAR) images, are automatic target recognition algorithms.

In the field of radar, the so-called micro-Doppler-based classification is state of the art. Here, the Doppler spectrum is analyzed for characteristic peculiarities (e.g. Doppler shifts induced by vibration or rotation of the object) to identify whether a radar signature is clutter, drone, bird, or similar. In particular, the radar backscatter cross-section of e.g. birds and drones is often similar in size, so that the Doppler signature is decisive. In combination with tracking, issues quickly arise, such as track-before-detect, or a more comprehensive approach that classifies the range-Doppler time cube as a whole. Here, algorithms on classical hardware quickly reach their limits, which is why quantum machine learning will be investigated to cope with the complexity and parameter optimization.

The same applies to the requirements for automatic target recognition on SAR images. Increasingly larger sections are to be examined for more and more target classes. Furthermore, segmentation approaches for the subdivision of the scene into, for example, water, meadows, forest, urban areas, etc. are to be investigated. Again, quantum machine learning lends itself to meta-parameter optimization.

The aim is firstly to build up expertise both in the field of automatic target recognition, quantum algorithms and quantum machine learning and their application in the context of automatic target recognition, and secondly to design, implement, simulate and test quantum algorithms also on quantum computers such as those of the companies D-Wave Systems and IBM.

For this purpose, the following contents are to be addressed:

- Literature, software and hardware research on the current state of analog, digital and hybrid quantum computing, especially in the field of quantum machine learning, taking into account the special requirements in the field of automatic target recognition.

	• Study of relevant literature in the field of quantum computing as well as scientific publications and papers. • Development of a sound understanding of the potentials and challenges in transferring radar signal processing algorithms for automatic target recognition to analog and digital quantum computers. • Analyses of the use of innovative quantum processing techniques from the fields of artificial intelligence and machine learning. • Design, implementation, and testing of quantum algorithms for automatic target recognition on microdoppler spectra and SAR images (for example, exploiting quantum annealing). • Design of quantum machine learning algorithms for optimization of classical approaches and meta-parameter tuning. • Supervision of master students in the field of Quantum Machine Learning for automatic target recognition. • Documentation of results in the form of software and technical reports. • Presentation of research results at national and international conferences and publication in scientific journals. • Summarizing all relevant results into a dissertation.
Earliest Starting Date	January, 2024
Application Deadline	Until position filled
Required Skills	• a master's degree/diploma well above average in electrical engineering, informatics, computer science, mathematics, physics or a related discipline • profound knowledge in quantum computing and machine learning • good analytical skills and programming experience (e.g. Python, Matlab, or C/C++) • good self-organization and a high degree of initiative in dealing with complex technical and scientific problems • strong communication skills and ability to work together as part of an interdisciplinary team • good proficiency in written and spoken English
Benefits	Look forward to a fulfilling job with an employer who appreciates your commitment and supports your personal and professional development. Our unique infrastructure offers you a working environment in which you have unparalleled scope to develop your creative ideas and accomplish your professional objectives. Our human resources policy places great value on a healthy family and work-life-balance as well as equal opportunities for persons of all genders (f/m/x). Individuals with disabilities will be given preferential consideration in the event their qualifications are equivalent to those of other candidates.
Contact	Dr. Sigurd Huber, Radar Concepts Department, +49 8153 28 3343, sigurd.huber@dlr.de