DAAD Doctoral / Postdoctoral Fellow

German Aerospace Center (DLR)
Microwaves and Radar Institute

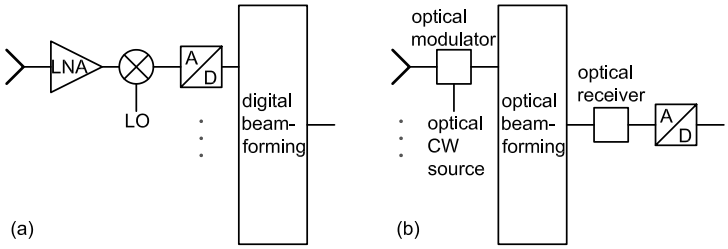
Topic	**Potentials of Photonic Beamforming with Application to Synthetic Aperture Radar Imaging**	Date of announcement **February 24, 2021**

Description

The Microwaves and Radar Institute of the German Aerospace Center (DLR) contributes to the advancement of spaceborne remote sensing through the execution of long-term research programs. The research work of the Institute encompasses the conception and development of new synthetic aperture radar (SAR) techniques and systems, as well as the retrieval of information from SAR data for several science applications.

SAR systems for Earth observation usually employ active phased array antennas, where the swath on ground is illuminated by a static antenna beam. The use of this classical beamforming approach imposes significant limitations to the current generation of spaceborne SAR systems in terms of imaging performance and capabilities. To overcome such limitations, future SAR systems consider digital beamforming, where entire filter banks are realized on field programmable gate arrays (FPGA). This allows for the simultaneous formation of multiple beams and eliminates typical challenges such as the narrow-band limitation or the discretization problem, but is disadvantageous in terms of digital hardware complexity and high power consumption.

In recent years a further technological option to implement beamforming has become viable. Microwave photonics, being heavily investigated for instance for the new wireless communications standard 5G, transfers beamforming back to the analogous domain, however, making use of optical networks. A basic block-diagram of a multi-channel beamforming receiver is shown in Fig. (a) below, while in (b) the block-diagram of an optical beamformer is sketched.



The main difference is, that the received microwave signal is transformed to optical frequencies, where true-time delay beamforming can be realised using optical components such as optical ring resonators. The main advantages of such a concept are the large bandwidth, low power and losses as well as a good scalability in terms of microwave frequencies. Challenges to be faced are the calibration of such systems, the adjustment of the initial response requiring many photonic phase shifters, the required dynamic range and a potentially high noise figure.
Currently, a beamforming demonstrator based on concept (a) is being built at the Microwaves and Radar Institute. A major goal of the new research activity is to develop an optical beamforming unit which shall be tested in conjunction with this demonstrator. For this, the following tasks shall be addressed:

- Familiarize with the current state-of-the-art in microwave photonics and perform a survey of the scientific literature in this field;
- Perform a theoretical treatment of the beamforming problem in the optical domain, e.g. by implementing an end-to-end simulation tool for the beamforming system, including the microwave, optical and digital building blocks. Derive meaningful performance metrics to be evaluated with measurement data;
- Develop end-to-end calibration strategies for the optical beamformer;
- Procure the components necessary to build up the optical beamforming unit and integrate the unit in an existing demonstrator;
- Elaborate and perform beamforming experiments and evaluate performance;
- Investigate optimization potentials regarding calibration accuracy, output signal-to-noise ratio, etc.

Output of this research activity should be a report including all research results, accompanied by journal and/or conference publications.

Please send your complete application (cover letter including preferred starting date, curriculum vitae, current enrollment and, if applicable, current transcript of records from your University).

	Please see also Fellowship No. 476 DLR Current offers - DAAD
Earliest Starting Date	April, 2021
Application Deadline	Until position filled
Required Skills	University diploma or master in electrical engineering or physics with a knowledge in microwave photonics and optical systems. Experience with optical hardware and integration. Analytical skills and programming experience in Python or equivalent. Knowledge in radar theory as well as microwave systems. Helpful is also an understanding of the principles of synthetic aperture radar and signal processing. Applicants should have good interpersonal and communication skills and should be able to work in an international and interdisciplinary environment, both independently and as part of a team. The communication and working language is English. English skill level for reading and writing research articles and reports is required.
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 unparalled scope to develop your creative ideas and accomplish your professional objectives. We are striving to increase the proportion of female employees and therefore particularly welcome applications from women. Disabled applicants with equivalent qualifications will be given preferential treatment.
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