Ph.D. in Information Technology
Thesis Defense

March 20, 2023
at 17:00
Room Alpha and online by Zoom

Vittorio GRIMALDI – XXXV Cycle

Advanced Control Techniques for Heterogeneous and Densely-Integrated Photonic Circuits

Supervisor: Prof. **Marco Sampietro**

Abstract:

Technologies advances have allowed the fabrication of complex yet reasonably cheap integrated photonic chips. However, integrated photonic systems have not reached the expected diffusion, hindered by the necessity of an electronic layer to be operated. Electronic control algorithms are indeed fundamental to counteract the effect of fabrication mismatches and thermal instabilities, that prevent open-loop operations. In this work, a closed-loop control scheme is proposed, designed to easily scale up for heterogeneous and densely-integrated photonic circuits. The dithering technique is first presented, allowing the implementation of a power-independent and calibration-free feedback loop to stabilize the controlled devices on the stationary points of their transfer function. An experimental validation is presented, where multiple cascaded devices are controlled with a single external photodetector. The dithering technique is then further developed, showing how it is possible to realize a similar control loop for integrated modulators, stabilized on the maximum-slope working condition. This allows the use of the same control scheme in heterogeneous architectures combining both classes of devices, paving the way for the integration of complex functionalities on the same chip. The huge flexibility achieved has been made possible by the adoption of an FPGA-based digital core that allows an unprecedented grade of parallelization. An efficient implementation of all the building blocks of the digital design is presented, allowing to further scale the system to accommodate future growth of photonic circuits. Finally, a plasmonic-assisted ultra-compact bolometric sensor is presented, opening the way for the extension of the proposed control system for new technologies. The detector is also validated in a first control experiment.

PhD Committee

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Prof. **Olav Solgaard**, Stanford University