Photonic Reservoir Computing using thermal nonlinearities in microrings

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Reservoir computing (RC) is a recent information processing paradigm from the field of neural network theory, successfully used in e.g. speech recognition. At the Photonic Research Group, we try to implement RC in a photonic way. Our end goal? Building devices able to think at the speed of light.

During our life, our brain is continuously confronted with new challenges. Often it needs to learn how to solve tasks it never has solved before. Sometimes we can follow a fixed set of rules to solve such a new task. However, our brain is also able to solve tasks without knowing in detail the rules needed to solve them. It's this behaviour neural network scientists try to mimic: by training a 'network', which can be seen as an ersatz brain, we are able to teach it new things. One of the possible frameworks to do this is RC.

The starting point of RC is a reservoir network, which consists of two parts: a recurrent untrained network (the reservoir) and an easy trainable feedforward network (the readout). In a similar way as in our brain synapses connect different neurons a neural network consist of nodes which are connected by branches. The principal idea of Photonic Reservoir Computing (PRC) is to substitute the nodes and branches of the reservoir respectively by optical components and waveguides. Simulation results show that this concept works when using Semiconductor Optical Amplifiers in a waterfall topology. In this poster however, we present the possibilities of a new node type: a Silicon On Insulator (SOI) microring.

These microrings show interesting nonlinear behaviour. They can be bistable, the output of the microring then does not only depend on the current input, but also on the previous input values. This means the microring has some internal memory. In some cases they even self-pulsate, for a fixed input-power they generate pulse trains. We hope that by this dynamic variety the microrings can imitate the neurons in our brain.

Thomas VanVaerenbergh is supported by the Flemish Research Foundation (FWO-Vlaanderen) for a PhD grant.

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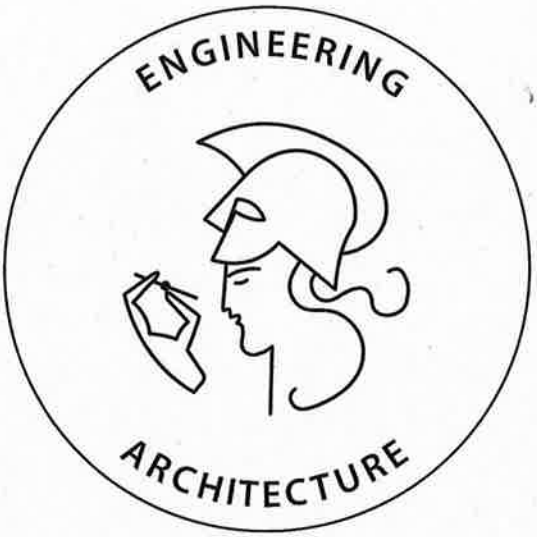

12th FEA PhD Symposium
Aula, 7 december 2011