A Photonic Implementation of Reservoir Computing

Kristof Vandoorne

Supervisor(s): Prof. Dr. ir. P. Biensman,Prof. Dr. ir. R. Baets

Abstract

Reservoir Computing (RC) or liquid computing is a new concept in the world of *Recurrent Neural Networks* (RNN). RNN's have been studied for a long time but attempts to find a fast and stable learning rule have failed. Reservoir Computing uses a different approach by splitting the network up into two parts. The reservoir is a RNN which is further left untrained. Its function is to transform the temporal correlations in the input data to spatial correlations in the reservoir. This is because the information resonates in the reservoir for some time.

The other part is an easy read-out function — for example a linear discrimant — that gets its input from the reservoir and has to be trained to deliver the correct output. This splitting up keeps the interesting temporal aspects from RNN's and simultaneously facilitates the training process. Promising results have already been obtained by means of software implementations for applications like speech recognition.

The theory of reservoir computing doesn't put rigid limitations on the nature of the reservoir and therefore reservoirs are not limited to RNN's and basicly any form of network with coupled non-linearities could act as one. Nanophotonics with its intrinsic non-linearities would be an interesting platform to achieve a fast and powereconomic hardware implementation for reservoirs. This could be achieved by coupling a large number of microcavities. These cavities could be SOA's, microdisklasers or *photonic crystal* (PC) cavities and they are necessary for a high confinement of light which provides an enhancement of the non-linearity.

In the first stage of the research the individual cavity is modelled and this information will be used to group a huge amount of these cavities into a reservoir. This will be studied for different interconnection topologies and microcavities until a reservoir is found which can solve interesting problems.

Keywords

Nanophotonics, Reservoir Computing, Photonic Crystal, cavities, non linear

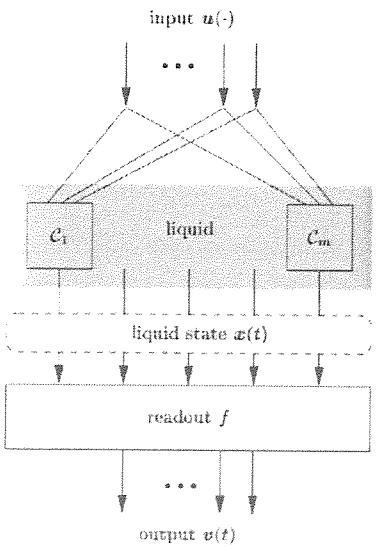

Fig. 1. Reservoir computing

K. Vandoorne is a PhD student at the Photonics Research Group at Ghent University (UGent). Email: Kristof.Vandoorne@UGent.be.

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