

Using Silicon Nanophotonics for Digital and Analog Signal Processing with Reservoir Computing

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Abstract— Reservoir computing is a decade old framework from the field of machine learning to use and train recurrent neural networks and it splits the network in a reservoir that does the computation and a simple readout function. This technique has been among the state-of-the-art for a broad class of classification and recognition problems such as time series prediction, speech recognition and robot control. However, so far implementations have been mainly software-based, while a hardware implementation offers the promise of being low-power and fast. Despite essential differences between classical software implementation and a network of optical components, we will show that photonic reservoirs can offer a promising alternative for a hardware implementation.

We will show experimental and theoretical results on the use of a generic photonic reservoir on a silicon-on-insulator chip, which can be used to perform arbitrary digital calculations involving input from up to four bit periods in the past. Using simulations, we also show that such a network can handle more analog tasks like speech recognition.

We also show that phase is an important asset that can be exploited using an integrated photonics approach. By using complex-valued signals as opposed to traditional real-valued signals, the effective size of the reservoir doubles, which is beneficial for performance.