Coherent Optical Computing in Silicon Photonics

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ABSTRACT

We will present our latest results in several areas in the field of coherent optical computing, mainly using silicon photonics.

First, we will discuss how **integrated photonic reservoir computing** is a promising approach for solving a number of problems in telecommunications, e.g. **non-linear dispersion compensation**. We have shown experimentally that using a reservoir consisting of only 20 nodes can achieve sub-FEC error performance on on-off keying (OOK) signals at 32 Gbaud/s. Such a neuromorphic approach has the potential for being a high-speed low-power alternative for traditional electronic DSP.

The weighting in the experiments above were done off-line, on an external computer. However, recently we also showed the first integrated reservoir computing experiment with **optical weights**, using heaters to weigh the different reservoir channels, successfully performing a number of bit-level tasks.

We also showed in simulations that the scheme can be extended from simple modulation formats like OOK to complex coherent formats like **64QAM**. We used the **Kramers-Kronig** (KK) detector configuration to achieve below-FEC-error-limit communications at 64 Gbaud/s, by including the nonlinear KK receiver in the training procedure.

Additionally, we have shown experimentally a completely new **self-learning** paradigm of optimising the weights inside a recurrent neural network, without relying on an offline algorithm or on a generated error feedback signal. Our network consists of ring resonators covered by a phase change material. By feeding the network with different binary sequences to be recognised, at powers above the plasticity threshold for the phase change material, we have shown that the network self-organises to better identify these sequences, without external intervention.

Finally, we investigated using both reservoir computing and traditional recurrent neural networks in the **quantum regime**. We showed how these networks can solve both classical tasks (like Boolean operations), as well as novel fully quantum tasks (like quantum channel equalisation). A proof-of-concept of this last application was run on Xanadu's Borealis setup.

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REFERENCES

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