Matrix-Vector Multiplication with Error-Tolerant Programmable Photonics

M Yu Saygin[1,2,3], S A Fldzhyan[1,4], S P Kulik[1,2], and S S Straupe[1,3,4]

[1] *Quantum Technology Centre of Moscow State University, Moscow, Russia*
[2] *South Ural State University , Chelyabinsk, Russia*
[3] *Sber Quantum Technology Center, Moscow, Russia*
[4] *Russian Quantum Center, Moscow, Russia*
Contact Email: saygin@physics.msu.ru

In traditional electronic neural networks, matrix-vector multiplication (MVM) is the most computationally and power-intensive operation. Implementing MVM using photonics offers a promising path towards developing power-efficient analog neural networks. This presentation focuses on our progress in creating architectures for programmable multimode interferometers that are robust against hardware errors, that come in the form of deviations in the static optical components from their designed values. In the first part of the presentation, we will discuss universal architectures of programmable interferometers based on static multimode mixing blocks [1,2]. Because these are fully-connected mixing blocks requiring interaction between all participating modes simultaneously, the fabrication of large-scale programmable circuits is challenging, especially with planar integrated photonics technologies. The second part of the presentation will cover a more practical architecture compatible with planar manufacturing technologies [3]. These rely on partially mixing static blocks, which can be easily realized by making minor modifications to the beam-splitter mesh, a method we have previously studied for implementing programmable unitaries [4]. The proposed programmable circuits are more suited to planar manufacturing technologies because they do not require multimode mixing. Consequently, the overall footprint, which includes both static and programmable elements, is more compact than that of existing alternatives.

References

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