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Stochastic Optical Quantum Circuit Simulator (SOQCS) physical model and software structure.

Linear optical elements in combination with post-selection can be used to perform general quantum computation [1]. SOQCS is a C++ library (with a Python port) [2] aimed to simulate optical circuits for light modeled as Fock wavepackets. The objectives of the library are to work as a design tool of optical circuits and to provide a mean to calculate the effect of different imperfections in the circuit operations such as unbalanced beamsplitters or partial distinguishability of photons [3].

Arbitrary optical circuits can be defined from their non-ideal basic components connected by a lossy medium. The library also provides support for non-ideal emitters and physical detectors considering detection efficiency, dead time, dark counts and noise effects. Detectors can also be configured to establish post-selection conditions on the circuit. Circuit measurements provide detection statistics in the form of probability outcomes and density matrices that can be handled by the library.

The simulations can be carried out using different numerical methods present in literature like the calculation of the output distribution of amplitudes of probability using permanent calculations [4]. At the same time its modular design will allow for the future addition of new methods. We will present some details of the library software structure and how the different imperfections are handled to provide a meaningful set of outcomes for arbitrary circuit definitions and initial states.

[1] E. Knill, R. Laflamme, G. J. Milburn, A scheme for efficient quantum computation with linear optics, Nature 409 (2001) 46-52. doi:10.1038/35051009.

[2] Stochastic Optical Quantum Circuit Simulator (SOQCS), https://github.com/SOQCSAdmin/SOQCS

[3] Javier Osca and Jiri Vala. Implementation of photon partial distinguishability in a quantum optical circuit simulation. arXiv:2208.03250 (2022).

[4] Javier Osca and Jiri Vala. Implementation of an Stochastic Optical Quantum Circuit Simulator (SOQCS) . In preparation.

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