Docket #: S20-514

Optimized Quantum Transduction for Long-Distance Quantum Communication

Researchers at Stanford have developed an approach to dramatically improve the efficiency of microwave-to-optical quantum transduction – a significant step towards realizing efficient communication between distant superconducting quantum systems. While superconducting quantum circuits are a promising platform for Noisy Intermediate-Scale Quantum (NISQ) computation in the near future, these circuits operate at microwave frequencies. Thus direct quantum communication between distant systems is precluded by the high propagation loss of microwave photons over commercial microwave cables. Efficient, coherent, and noise-free transduction of single photons from microwave to optical frequencies (and vice versa) is necessary to achieve coupling of distant superconducting quantum systems over optical fibers and, eventually, networking and distributed quantum computing. Ensembles of quantum emitters that can couple to both microwave and optical modes can be utilized to construct such single photon transducers. The new approach is built upon the insight that the temporal shape of the laser pulse that drives the quantum emitters and supplies the energy required for transduction can be experimentally tuned and poses the design of the driving laser pulse as an optimization problem to be solved by numerical optimization techniques.

Stage of Development
The researchers have demonstrated that their technique can compensate for the detrimental effects of inhomogeneous broadening in quantum emitter ensembles to help realize more efficient transducers.

Applications

- Design of more efficient quantum emitter ensemble-based microwave-to-optical quantum transducers

Advantages

- Order of magnitude improvement in transduction efficiencies
- Step towards scalable, distributed quantum computing

Publications

- Mishra, Sattwik Deb, et al. "Quantum control for inhomogeneous broadening compensation in single-photon transducers." *arXiv preprint arXiv:2012.01718* (2020).

Patents

- Published Application: 20220327415

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