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End-to-end workflow for ML-based qubit readout with QICK + hls4ml

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High-fidelity single-shot quantum state readout is crucial for advancing quantum technology. Machine-learning (ML) assisted qubit-state discriminators have shown high readout fidelity and strong resistance to crosstalk. By directly integrating these ML models into FPGA-based control hardware, fast feedback control becomes feasible, which is vital for quantum error correction and other applications. Here, we developed an end-to-end workflow for real-time ML-based qubit readout by integrating a neural network designed through hls4ml into the Quantum Instrumentation Control Kit (QICK). In our recent experiment test for single transmon qubit readout, we achieved single-shot readout fidelity of 92% in 1.3 μs readout time with an inference latency of less than 50 ns and resource usage of approximately 10% LUTs and 2% FFs for the FPGA RFSoC that host the QICK system. Our works can also serve as guidance for others to use these tools for their own research.

Focus areas

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