Qudit system identification and control using graybox models

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Quantum computing aims to harness the capabilities of quantum mechanics to surpass classical computing. However, challenges such as fabrication imperfections and environmental noise impede progress, particularly in non-Markovian environments. This work utilises a "graybox" machine learning approach [1–4], in which physics-based "whitebox" models are combined with "blackbox" machine learning structures. Here we created a platform to generate simulated datasets of finite-dimensional quantum systems in the presence of non-Markovian noise, consisting of control pulses and the corresponding quantum measurements. This was utilised to create 2-qubit and qutrit datasets. Subsequently, we designed and implemented a graybox model for qudit system identification. Then, we trained the graybox model on the simulated datasets and tested it against standard machine-learning models showcasing superior performance. Finally, the trained graybox model is utilised to optimise the control pulses leading to improved fidelity for a universal gate set. This work advances quantum technology by providing a robust framework for system identification and control addressing key challenges in the field.

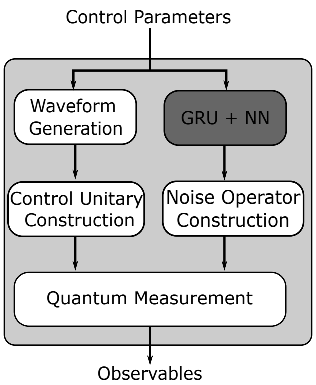

Figure 1: The proposed Graybox structure

References

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