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Improving Quantum Gate Performance using Optimal Control with Feedback YUCHEN PENG, Univ of Maryland-College Park, FRANK GAITAN, Laboratory for Physical Science — We present a procedure for improving the performance of a quantum gate based on optimal control theory with feedback. Starting with a quantum gate U_0 produced by a known control field $\mathbf{F}_0(t)$ that provides a good approximation to a target gate U_t, we show how optimal control theory with feedback can be used to determine a modified control $\mathbf{F}(t) = \mathbf{F}_0(t) + \Delta\mathbf{F}(t)$ which yields a quantum gate U that better approximates the target gate U_t. We illustrate the procedure by applying it to the gates in a universal set of quantum gates produced using non-adiabatic rapid passage [1]. We first examine the performance improvements produced with ideal controls, and then examine the robustness of these improvements in the presence of control field imperfections such as finite bandwidth, finite precision control parameters, and phase jitter. We find that this procedure reduces the gate error probability P_e by 1-4 orders of magnitude even in the presence of control imperfections ($P_e \sim 10^{-4}$ improved to $10^{-8} < P_e < 10^{-5}$).

[1] R. Li and F. Gaitan, *J. Mod. Opt.* **58**, 1922 (2011).

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