Efficient control pulses for continuous quantum gate families through coordinated re-optimization

Jason D. Chadwick, Lennart Maximilian Seifert, Andy J. Goldschmidt, and Frederic T. Chong Department of Computer Science, University of Chicago

Introduction

basis operations. However, pulse optimizations are **computationally** pulses for arbitrary operations can be instantly retrieved.

$$J = \underbrace{1 - \frac{1}{h^2} \left| \operatorname{Tr} \left(U_{\text{target}}^{\dagger} U_T \right) \right|^2}_{\text{gate infidelity}} + \underbrace{\widetilde{\lambda} \sum_{k}^{n_f} \| \vec{\alpha}_k - \vec{\alpha}_{0,k} \|_2^2}_{\text{Tikhonov regularization}}$$
$$\widetilde{\lambda} = \frac{\lambda}{n_f \cdot n_p \cdot \alpha_{\max}^2}.$$
$$\widehat{\alpha}_i = \frac{1}{|\eta(p_i)|} \sum_{p_j \in \eta(p_i)} \vec{\alpha}_j,$$
$$\vec{\alpha}_{\widetilde{p}} = \sum_{p_i \in S_{\widetilde{p}}} b_i \vec{\alpha}_i$$

Methods

- **1.** Choose **reference points** that cover parameter space.
- **2.** Solve optimal control problem for each reference point to obtain reference pulses.
- each reference point:
 - vertices.
- c. Calculate **Tikhonov penalty** for each reference point.
- optimize control pulse to be similar (Eq. 1+2).
- **f.** Repeat as needed.
- **4.** Obtain a pulse for any other point by **interpolation**:
 - a. Generate simplicial mesh.
 - simplex.
 - c. Calculate barycentric coordinates with respect to vertices.
 - pulse vector.



