Karlsruhe Institute of Technology

Communications Engineering Lab (CEL)
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Construction of Finite Length Quantum Error Correcting Codes

Master's Thesis

Project

Quantum error correction is an essential component in the implementation of practical quantum computers. Constructing quantum codes can be converted into a problem of constructing classical linear codes with certain self-orthogonal properties. Among the various options, quantum Low-Density Parity-Check (QLDPC) codes have emerged as the most promising candidates.

In recent years, breakthroughs have been made in developing asymptotically good QLDPC codes. For instance, the family of lifted product codes is a family of codes that exhibit a linear scaling of minimal distance with the block length [1]. This code construction also allows for the utilization of classical codes, including cyclic codes and quasi-cyclic codes, as tools for creating new quantum codes.

Despite the progress made, the availability of finite-length lifted product codes with good parameters remains limited, as the majority of research has concentrated on their asymptotic properties. Consequently, this thesis aims to explore the construction of finite-length lifted product codes through the application of classical methodologies.

[1] Panteleev, Pavel, and Gleb Kalachev. "Asymptotically good quantum and locally testable classical LDPC codes." Proceedings of the 54th Annual ACM SIGACT Symposium on Theory of Computing. 2022.

Tasks

1. Acquiring fundamental knowledge in quantum error correction
2. Understanding and Implementing existing construction methods
3. Evaluation of the constructed codes

Requirements

- ✔ Good knowledge of channel coding
- ✔ Solid mathematical knowledge in group and field theory
- ✔ Basic skills in programming

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