題目

A review of the Surface code and its novel improvement

Abstract

Despite that the quantum computing has proved its benefit compared to the classical computer, quantum computers have high error rates compared to the classical computer. In order to make quantum computers useful, error rates have to be as low as 1 in a trillion. However, the quantum bits become randomized in about one one-thousandth of a second. For classical error correction, redundancy is enough for the correction. But the quantum one is not as straightforward as it due to the no-cloning theorem. That is why several groups of quantum experts are exploring the potential method for future scalability of quantum computer. Several methods have been proposed, such as LDPC(Low Density Parity-Check Code), topological codes, holographic codes. In this review, we will summarize one of the promising method – surface code. Not only will the basic conception be provided, the novel improvement of the implementation and decoding algorithm will also be provided in this essay.

To be mpdified

In Section II, we provide a comprehensive review of the surface code, including its foundational principles and its importance in quantum error correction. In Section III, we delve into recent improvements in surface code decoders, a tensor-network based decoder with the noise map have shown its potential in both accuracy and efficiency. Section IV discusses advancements in stabilizer codes which is also called bandage-like automated stabilizer. Finally, in Section V, we explore recent practical implementations that leverage the surface code, highlighting their potential impact on the future of quantum computing.