Image transmission over quantum communication systems with three-qubit error correction

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Abstract

Quantum communication is expected to become the cornerstone of global communication systems, addressing critical issues of classical communication while providing unprecedented security and efficiency. A crucial aspect of advancing this field is quantum channel coding, which ensures data integrity by detecting and correcting errors specific to quantum systems. This research evaluates the performance of the three-qubit error correction code, the fundamental and simplest technique in quantum channel coding, for image transmission over error-prone channels. JPEG and HEIF format images are encoded using the three-qubit error correction method and compared to the 1/3 rate polar codes. Our results demonstrate that the three-qubit error correction code significantly outperforms advanced classical polar codes in both classical and quantum domains, achieving a maximum PSNR of 61.5 dB (SSIM = 0.9997) in HEIF and 58.3 dB (SSIM = 0.9994) in JPEG. This showcases its potential as a robust solution for quantum communication.

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