

Advancements in Quantum Teleportation: Exploring Hardware, Software, Mathematical Formalism, and New Versions

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Abstract : Quantum computing is on the verge of surpassing classical computing, unlocking a realm of possibilities. One ground-breaking application is quantum teleportation, which allows the transmission of information between quantum device users, regardless of distance. Initially, an Italian group led by Sandu Popescu conducted the first experimental implementation of quantum teleportation, validating that classical channels alone couldn't achieve it [1]. More recently, in 2017, Chinese scientists demonstrated successful teleportation from Tibet to a satellite [2]. This paper comprehensively explores quantum teleportation from various angles, covering hardware, software, and mathematical formalism, including traditional linear algebra and cutting-edge string diagrams. It also introduces novel adaptations of the classical quantum teleportation protocol. The paper seamlessly integrates various topics to elucidate quantum teleportation's creation, operation, and applications. It thoroughly examines the protocol's architecture, functionality, and practical implications. In summary, this cohesive framework provides a comprehensive understanding of quantum teleportation, addressing its theoretical underpinnings, hardware requirements, and the motivation behind adapting the innovative protocol. A new perspective on the Spectral Theorem through linear algebra, a new scalable multiqubit protocol, and the integration of string diagrams for quantum teleportation comprehension is included in this paper.

Keywords : quantum teleportation, quantum mechanics, communication, information processing, mathematical formalism, quantum bits, superposition, entanglement, quantum circuits, quantum algorithms, qiskit, quantum computers, linear algebra, hilbert spaces, quantum measurement, eigenvalues, eigenvectors, mixed states, density matrices, quantum gates, bell measurement, non-maximally entangled states, hybrid quantum teleportation, diagrammatic reasoning, string diagrams, scalable multi-qubit teleportation, quantum networks, quantum internet, secure communication, quantum applications

Conference Title : ICLOQE 2025 : International Conference on Lasers, Optics, and Quantum Electronics

Conference Location : Tokyo, Japan

Conference Dates : February 24-25, 2025