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Bidirectional quantum teleportation of an arbitrary number of qubits over a noisy quantum system using 2*n* Bell states as quantum channel

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Abstract
This article presents a new bidirectional teleportation protocol for an arbitrary number of qubits which employs 2*n* entangled Bell-states (4n-qubits) as the quantum channel. Alice intends to transmit an arbitrary unknown qubit state to Bob in the proposed scheme and vice versa. For establishing the protocol, 2*n* Bell-states are specified in the channel for both parties to load their qubits. Using Bell-states, input states are teleported over the channel using Bell-basis measurements and applying a proper unitary operator. Thus, the communication purpose is more privileged than recently presented protocols since the proposed protocol is more straightforward and uses the minimum resources. Furthermore, the circuit of the scheme is implemented in the IBM Quantum experience platform using qasm_simulator and Qiskit library, and the outcomes verify the validation of the protocol. Moreover, the amplitude damping noise effect is analyzed and simulated using Qiskit.

Keywords Bidirectional quantum teleportation · IBM quantum experience · Noise analysis · Qiskit · Quantum teleportation

1 Introduction

Quantum teleportation (QT) is a newly emerged field that transmits an unknown quantum state between two parties. This operation needs a pre-shared entangled state, employed as the communication channel. The very first quantum teleportation scheme in which Alice was able to send an unknown quantum state to Bob, was proposed by Bennett et al. (1993), where they used quantum mechanical-based resources like quantum entanglement. Controlled quantum teleportation (CQT) is another QT type proposed by Karlsson et al. (1998), which used a third party to monitor the communication

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