



SCHOLARLY PUBLICATIONS Centre of Quantum Technology KIIT Deemed to be University

Journal Name: Advanced Quantum Technologies

IF: 4.3

Title: Efficient Algorithm for Fidelity Estimation of Two Quantum States

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Details: Volume-9, Issue-8, August 2026

Abstract: The fidelity estimation between two quantum states is crucial for quantum computation and information science. However, an efficacious method for this, especially for mixed states and higher-dimensional density matrices, remains elusive. While there are many existing algorithms on computing the fidelity between two pure states, there is not much work on how to obtain the fidelity between two mixed states. Here, an efficient quantum algorithm for the fidelity estimation is proposed, based primarily on the density matrix exponentiation and interferometric scheme for mixed states, with a time complexity of $(\text{Formula presented.})$, where $(\text{Formula presented.})$ is the system size, $(\text{Formula presented.})$ is the condition number of the density matrices and $(\text{Formula presented.})$ is a precision error. This algorithm may serve as a resource-efficient technique to deduce fidelity of any two (pure or mixed) unknown or known quantum states, when the density matrices of the quantum states commute with each other.



URL: <https://advanced.onlinelibrary.wiley.com/doi/10.1002/qute.70406>

