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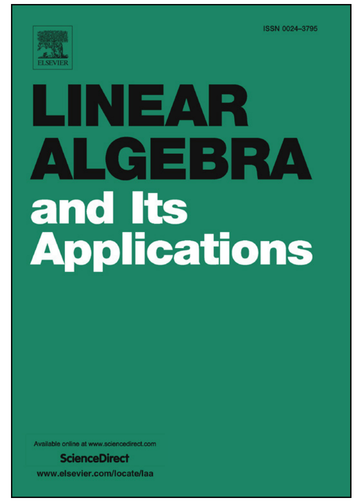

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Perfect quantum state transfer using Hadamard-diagonalizable graphs

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Abstract

Quantum state transfer within a quantum computer can be achieved by using a network of qubits, and such a network can be modelled mathematically by a graph. Here, we focus on the corresponding Laplacian matrix, and those graphs for which the Laplacian can be diagonalized by a Hadamard matrix. We give a simple eigenvalue characterization for when such a graph has perfect state transfer at time $\pi/2$; this characterization allows one to choose the correct eigenvalues to build graphs having perfect state transfer. We characterize the graphs that are diagonalizable by the standard Hadamard matrix, showing a direct relationship to cubelike graphs. We then give a number of constructions producing a wide variety of new graphs that exhibit perfect state transfer, and we consider several corollaries in the settings of both weighted and unweighted graphs, as well as how our results relate to the notion of pretty good state transfer. Finally, we give an optimality result, showing that among regular graphs of degree at most 4, the hypercube is the sparsest Hadamard-diagonalizable connected unweighted graph with perfect state transfer.

Keywords: Laplacian matrix, Hadamard diagonalizable graph, quantum state transfer, cubelike graphs, double cover, perfect state transfer
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