Abstract

Currently, we are in the Noisy Intermediate Scale Quantum (NISQ) era, where the number of qubits that can be used in a single quantum computer is increasing. However, this development brings challenges in handling large quantum systems. Distributed quantum computing is gaining importance to overcome these challenges. In this approach, multiple quantum computers or quantum processing units are interconnected to work together on a problem. This enables the utilization of larger computational capacities and more efficient solutions to complex tasks. In distributed quantum computing, different units or subsystems communicate with each other to exchange quantum information. The fundamental teleportation protocol plays an important role in this process. It allows the transfer of quantum information between subsystems. An important aspect is to minimize the number of teleportations. The goal is to increase the accuracy of quantum computations, reduce the susceptibility to errors in qubits, and make resource consumption more efficient. This work applies and investigates various graph partitioning algorithms such as the Kernighan-Lin algorithm and Spectral Partitioning, a Genetic Algorithm (GA) and two hybrid Genetic Algorithms (HGA) that combine the graph partitioning algorithms with a GA. The aim is to minimize the number of global quantum gates and the associated teleportation costs. Initially, the graph partitioning algorithms are used to evenly partition the nodes. In addition, a GA is implemented to handle the qubit partitioning using random partitions. The two HGAs result in a nearly optimal arrangement of the global quantum gates after the qubits are partitioned using the graph partitioning algorithms. Finally, the proposed approaches are examined using nine benchmark circuits and compared in terms of the number of global quantum gates and teleportation costs. Random search runs are also performed for the GA and the two HGAs to assess their performance in achieving the optimization objective. The results indicate a significant improvement in teleportation costs.