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A DELAYED-STATE ALGORITHM USING HOPFIELD NEURAL NETWORK WITH CHN FOR MCP

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Abstract. *The goal of maximum cut problem is to partition the vertex set of an undirected graph into two parts in order to maximize the cardinality of the set of edges cut by the partition. Many optimization problems can be formulated in terms of finding the maximum cut in a network or a graph. In this paper, we propose a new parallel algorithm using Hopfield neural network with continuous hysteresis neurons (CHN) for efficiently solving maximum cut problem. We prove theoretically that the emergent collective properties of the Hopfield neural network with HBN also are present in the Hopfield network with CHN. A large number of instances have been simulated to verify the proposed algorithm. The simulation results show that our proposed algorithm finds the optimum or near-optimum solution for the maximum cut problem superior to that of the best existing parallel algorithms in both the computation time and the solution quality.*
Keywords: Maximum cut problem, Hopfield neural network, Hysteresis, Collective properties, NP-complete problem

1. **Introduction.** One of the best known and the most important combinatorial optimization graph problems is the maximum cut problem [1]. Many optimization problems can be formulated in terms of finding the maximum cut in a network or a graph. In this problem, we have a weighted, undirected graph $G = (V, E)$ and we look for a partition of vertices of graph G into two disjoint sets, such that the total weight of the edges that go from one to the other is as large as possible. Besides its theoretical importance, the maximum cut problem has applications in the design of VLSI circuits, the design of communication networks, circuit layout design and statistical physics [2, 3, 4]. This problem is one of the Karp's original NP-complete problems [1], and has long been known to be NP-complete even if the problem is unweighted [5]. For planar graphs, this problem has been shown to be polynomial solvable [6]. However, in general, the weighted graph may not be planar. Because of its theoretical and practical importance and because efficient algorithms for NP-complete combinatorial optimization problems are unlikely to exist, many polynomial time approximation algorithms have been proposed to solve it. In 1976, Sahni and Gonzales [7] presented an approximation algorithm for the maximum cut problem. Their algorithm iterates through the vertices and decides whether or not to assign vertex i to S based on which placement maximizes the weight of the cut of vertices 1 to i. This algorithm is essentially equivalent to the randomized algorithm that flips an