International Journal of Innovative Computing, Information and Control
Volume **6**, Number **8**, August **2010**

ICIC International ©2010 ISSN 1349-4198
pp. 3573–3583

SOLVING THE MAXIMUM CUT PROBLEM USING TWO-PHASE HOPFIELD NEURAL NETWORK

Rong-Long Wang[1], Shang-Ce Gao[2] and Zheng Tang[2]

[1]Faculty of Engineering
University of Fukui
Bunkyo 3-9-1, Fukui-shi 910-8507, Japan
wang@u-fukui.ac.jp

[2]Faculty of Engineering
Toyama University
Toyama-shi 930-8555, Japan
ztang@eng.u-toyama.ac.jp

Received February 2009; revised December 2009

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 present a two-phase Hopfield network algorithm for maximum cut problem. The proposed method can be divided into two phases. The first phase uses the Hopfield network to find a local minimum which corresponds a near-maximum solution of the problem. The second phase makes the network escape from the state of the near-maximum solution to maximum solution or a better one by updating the state of neurons using another neural network. A large number of instances are simulated to verify the proposed method with the simulation results showing that the proposed algorithm is much better than the previous works for solving the maximum cut problem.*
Keywords: Maximum cut problem, Hopfield neural network, NP-complete problem

1. **Introduction.** Maximum cut problem [1] is one of the best known and best important combinatorial optimization graph problem. In this problem, we have a weighted, undirected garph $G = (V, E)$ 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 [2-4]. 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 unbiased coin for each vertex to decide which vertices are assigned to the set S. Since 1976, a number of researchers have presented approximation algorithms for the maximum cut problem. Hsu