An Effective Genetic Algorithm for Improving Wireless Sensor Network Lifetime

Chih-Chung Lai Chuan-Kang Ting Ren-Song Ko

Department of Computer Science and Information Engineering
National Chung Cheng University
Chia-Yi, Taiwan 621
{laicc, ckting, korenson}@cs.ccu.edu.tw

ABSTRACT

An important scheme for extending sensor network lifetime is to divide sensor nodes into disjoint groups such that each group covers all targets and works alternatively. This scheme can be transformated to the Disjoint Set Covers (DSC) problem, which is proved to be NP-complete. Existing heuristic algorithms either get barely satisfactory solutions or take exponential time complexity. In this paper, we present a genetic algorithm to solve the DSC problem. Simulation results show that the proposed genetic algorithm can improve the most constrained-minimum constraining heuristic algorithm (MCMCC) in solution quality by 99% with only polynomial computation time complexity.

Categories and Subject Descriptors: I.2.8 [**Artificial Intelligence**]: Problem Solving, Control Methods, and Search—*heuristic methods*; C.2.1 [**Computer Communication Network**]: Network Architecture and Design—*wireless communication*

General Terms: Algorithms

Keywords: Disjoint set covers, wireless sensor network, genetic algorithms

1. INTRODUCTION

Sensor networks bring up a wide range of new applications such as battlefield surveillance, biological detection, and environmental monitoring. One approach to extend sensor network lifetime is dividing sensor nodes into disjoint groups, or *sensor covers*. Each sensor cover must encompass all targets and works alternatively. To find maximum disjoint sensor covers has been solved via transformation to the Disjoint Set Covers (DSC) [1] problem, which has been proved to be NP-complete. In this paper, we propose *genetic algorithm for maximum disjoint set covers* (GAMDSC) to solve the DSC problem.

2. GAMDSC AND SIMULATION RESULTS

An intuitive way to find sensor covers is that each sensor randomly joins one of the prescribed groups, where a group forms a sensor cover if it can cover all targets. Based on this idea, we use integer representation to encode a grouping combination of the sensors. A gene indicates the group that the corresponding sensor joins. Note that if a target is only covered by k sensors, we can find at most k sensor covers. Thus the number of the prescribed groups is set as the upper bound of number of sensor covers, ub, which can be decided by the number of sensors covering the most sparsely covered target. The fitness value of a chromosome is defined as the number of sensor covers that can be found by the grouping combination represented by the chromosome.

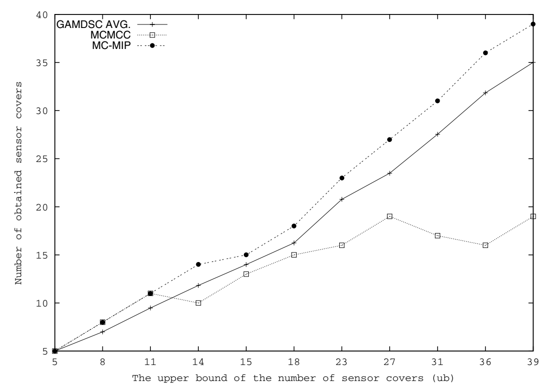

Figure 1: Comparison of the number of sensor covers obtained by MC-MIP, MCMCC, GAMDSC

Figure 1 compares the simulation results of GAMDSC with those of two existing heuristic algorithms, MC-MIP [1] and MCMCC [2]. MC-MIP always returns the optimal solution but takes exponential computation time, which is impractical in large-scale applications. MCMCC takes polynomial computation time but gets barely satisfactory results. GAMDSC can get near-optimal solutions with polynomial computation time, and can even improve the number of sensor covers obtained with MCMCC by 99%.

In conclusion, GAMDSC can efficiently find near-optimal number of sensor covers and can effectively prolong the sensor network lifetime.

3. REFERENCES

[1] M. Cardei and D. Z. Du. Imporving wireless sensor network lifetime through power aware organization. *Wireless Networks*, pages 333–340, 2005.

[2] S. Slijepcevic and M. Potkonjak. Power efficient organization of wireless sensor networks. IEEE international conference on Wireless Communications, Helsinki, Finland, June 2001.

GECCO '07, July 7-11, 2007. London, England, UnitedKingdom.
ACM 978-1-59593-697-4/07/0007.