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Efficient scheduling of a mobile charger in large-scale sensor networks ☆

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ABSTRACT

Schedule a mobile charger to replenish energy to sensor nodes for the wireless sensor networks has attracted great attention recently, due to its efficiency and flexibility. Some existing works study the mobile charger scheduling problem by considering that only the depot can recharge or replace the battery for the mobile charger. However, for large-scale wireless sensor networks, the mobile charger is energy inefficient or even may run out of energy during the travel for charging. In this paper, we consider the scenario that there are some service stations in the network area which can be used to replace the battery for the mobile charger, and we study the problem of minimizing the number of used batteries for a mobile charger to charge a wireless sensor network (MBA). We first consider a special case of the MBA problem, in which the depot is the only service station, and we present an approximation algorithm to address it. Then we propose an approximation algorithm for the MBA problem with the assumption that the distance of any two service stations is limited. And finally, we consider the general MBA problem and propose an approximation algorithm. We validate the performance of our algorithms by extensive simulations, and the results show that our proposed algorithms are promising.

1. Introduction

In the past few decades, using Wireless Sensor Networks (WSNs) to monitor the physical world has been widely used [1, 2]. The sensor nodes in a wireless sensor network are usually powered by batteries, and can only operate for a limited time due to the limited energy capacity of the on-board batteries. Therefore, it's a critical task to prolong the lifetime of a wireless sensor network. Many approaches have been proposed to extend the wireless sensor network lifetime, such as battery replacement [3] and energy harvesting [4,5]. However, battery replacement is not suitable for large-scale wireless sensor networks as it is very time-consuming and costly [6]. Energy harvesting sensor nodes harvest ambient energy from their surroundings such as solar [5] and wind [7] energy, these environmental energy sources are time-varying and not stable in nature, besides, this approach requires sensor nodes to be equipped with some expensive equipments, and therefore, the energy harvesting approach remains limited benefits for WSNs in practice.

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