Accepted Manuscript

Regular paper

Distributed Trajectory Design for Data Gathering Using Mobile Sink in Wireless Sensor Networks

Areej Alsaafin, Ahmed M. Khedr, Zaher Al Aghbari

PII: S1434-8411(18)31064-1
DOI: https://doi.org/10.1016/j.aeue.2018.09.005
Reference: AEUE 52484

To appear in: *International Journal of Electronics and Communications*

Received Date: 25 April 2018
Revised Date: 5 August 2018
Accepted Date: 2 September 2018

Please cite this article as: A. Alsaafin, A.M. Khedr, Z. Al Aghbari, Distributed Trajectory Design for Data Gathering Using Mobile Sink in Wireless Sensor Networks, *International Journal of Electronics and Communications* (2018), doi: https://doi.org/10.1016/j.aeue.2018.09.005

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Distributed Trajectory Design for Data Gathering Using Mobile Sink in Wireless Sensor Networks

Areej Alsaafin[1], Ahmed M. Khedr[2], Zaher Al Aghbari[3]
[1,2,3]Department of Computer Science, University of Sharjah, UAE
{U15100713, akhedr, zaher}@sharjah.ac.ae
[2]Mathematics Department, Faculty of Science, Zagazig University, Zagazig, Egypt
amkhedr@zu.edu.eg

***Abstract*— Several studies have demonstrated the benefits of using a mobile sink (MS) to reduce energy consumption resulting from multi-hop data collection using a static sink in wireless sensor networks (WSNs). However, using MS may increase data delivery latency as it needs to visit each sensor node in the network to collect data. This is a critical issue in delay-sensitive applications where all sensed data must be gathered within a given time constraint. In this paper, we propose a distributed data gathering protocol utilizing MS for WSNs. The proposed protocol designs a trajectory for the MS, which minimizes energy consumption and delay. Our protocol operates in four main phases: data sensing, rendezvous point (RP) selection, trajectory design, and data gathering. In data sensing, a number of deployed sensor nodes keep sensing the target field for a specific period of time to capture events. Then, using a cluster-based RP selection algorithm, some sensor nodes are selected to become RPs based on local information. The selected RPs are then used to determine a trajectory for the MS. To do so, we propose three trajectory design algorithms that support different types of applications, namely reduced energy path (REP), reduced delay path (RDP), and delay bound path (DBP). The MS moves through the constructed path to accomplish its data gathering according to an effective scheduling technique that is introduced in this work. We validate the proposed protocol via extensive simulations over several metrics such as energy, delay, and time complexity.**

Keywords*— Distributed algorithm; wireless sensor network; data gathering; mobile sink; trajectory design

I. INTRODUCTION

In recent years, wireless sensor networks (WSNs) have emerged as a new information-gathering paradigm in a wide range of critical applications that employ sensor nodes to collect data in harsh environments such as high temperatures, outer-space, underwater, battlefield, and radiation exposure [1]–[3]. Sensor nodes, usually, have limited batteries, which makes energy efficiency essential for effective performance in WSNs due to difficulty in recharging or replacing sensor batteries in many cases. In fact, a sensor node consumes most of its energy during two major tasks: sensing the field and uploading data to the sink [4]. Energy consumption during sensing task is relatively stable since it is only related to sampling rate and does not depend on the location of sensor nodes or the network topology. Therefore, the scheme of data gathering is the most important factor for determining the network lifetime. Energy efficiency of data gathering in WSNs requires some design trade-offs [5].

Classical data gathering algorithms make all decisions in a central location such as the sink, which has a full knowledge of the network. This type of algorithms is called centralized algorithms. Most of centralized algorithms require either (or both) a global view of the network or multiple synchronization constraints between processes [6]. They also have excessive energy consumption since the communication between the sink and sensor nodes is always going through broadcast messages. In addition, after each round, sensor nodes have to wait for the sink to broadcast the required updated information as it is the only node responsible for handling all network decisions. This results in a significant delay in delivering data. On the other hand, distributed algorithms consider many of these limitations by distributing the decision making across the entire network. Therefore, every sensor node makes decisions on its own based on local information. This feature enables a sensor network to reduce its information management and energy consumption as well as reduce delay of data delivery [7]. In addition, distributed algorithms handle the scalability issue of WSNs more efficiently than centralized algorithms by reducing the communication overhead in the network.

Recently, there is growing demand to connect low resource devices (e.g. sensor nodes) to interact with each other in an effective scheme [8], [9]. Many researchers [10]–[15] have shown that sink mobility can effectively improve network lifetime by significantly conserving the energy consumption resulting from multi-hop communication as a mobile sink (MS) acts as “data transporter” that roams in the network and gathers data from sensor nodes through short-range communication. However, the main disadvantage of such an approach is the increased latency of data delivery. In practice, the path length of the MS is usually bounded by a given constraint, either due to time restriction on the sensed data or a limit on the amount of energy available in the MS itself. The path in this context refers to the trajectory that the MS follows to achieve its data gathering in a WSN. A possible solution to solve this problem is to employ more than one MS. However,

ACCEPTED MANUSCRIPT

Download English Version:

https://daneshyari.com/en/article/10151295

Download Persian Version:

https://daneshyari.com/article/10151295

Daneshyari.com