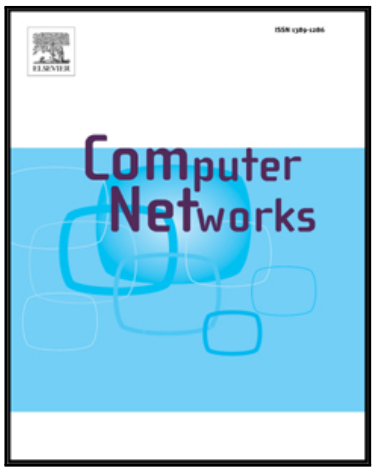

An annulus sector grid aided energy-efficient multi-hop routing protocol for wireless sensor networks

Jianhua Huang , Danwei Ruan , Weiqiang Meng

PII: S1389-1286(18)30986-1
DOI: https://doi.org/10.1016/j.comnet.2018.09.024
Reference: COMPNW 6608

To appear in: *Computer Networks*

Received date: 9 May 2018
Revised date: 22 August 2018
Accepted date: 28 September 2018

Please cite this article as: Jianhua Huang , Danwei Ruan , Weiqiang Meng , An annulus sector grid aided energy-efficient multi-hop routing protocol for wireless sensor networks, *Computer Networks* (2018), doi: https://doi.org/10.1016/j.comnet.2018.09.024

An annulus sector grid aided energy-efficient multi-hop routing protocol for wireless sensor networks

Jianhua Huang[a], Danwei Ruan[b], Weiqiang Meng [c]

a,b,c East China University of Science and Technology, Shanghai 200030, China.

b E-mail address: rdw1226@163.com

Abstract: Wireless sensor networks (WSNs) consist of a large number of sensor nodes which usually have very limited energy and are deployed in the wild environment. The batteries of the nodes cannot be recharged or replaced. Therefore, it is necessary to design energy-efficient routing protocols to maximize the network lifetime. This paper proposes an annulus sector grid aided routing protocol (ASGRP) which uses an annulus sector grid clustering method to improve WSNs' energy efficiency and prolong the network lifetime. The annulus sector grid clustering method based on arithmetic progression is presented to divide the network area into clusters with various sizes. From the base station (BS) outwards, the network area is divided into different levels with incremental equal difference distance. This paper also presents an inter-level multi-hop routing algorithm to improve the energy efficiency of data transmission between the BS and cluster head (CH) nodes. The algorithm combines the communication management (CM) nodes with CH nodes to establish routes to transmit data. Simulation results show that compared with multi-hop EEBCDA, EEMRP and CAMP, ASGRP prolongs the network lifetime by 24.36%-70.68% in the 200m*200m network and 25.47%-90.34% in the 400m*400m network. The proposed protocol significantly reduces the energy consumption of each round and has better performance of energy balance and efficiency in the larger network area.

Keywords: Wireless sensor networks; Routing protocol; Grid clustering; Network lifetime; Multi-hop routing

1 Introduction

Wireless sensor networks (WSNs) consist of a large number of low-cost and energy-constrained micro-sensor nodes [1]. The low-cost sensor nodes make WSNs widely applicable in different fields such as medical care, environmental monitoring, military defenses, etc. [2-5] As wireless sensor nodes are supplied by non-rechargeable batteries to gather data and communicate with the base station (BS) [6-7], designing an energy-efficient routing protocol to save node energy and maximize the network lifetime is of great concern.

There are two main classes of routing protocols of WSNs: flat routing and hierarchical routing [8]. Flat routing protocols are simple and all the nodes are at the same level. They are poor in scalability because these protocols have large amount of control packet overhead and consume more energy when the size of the network increases. Hierarchical routing divides a network area into clusters. In each cluster, there is a cluster head node which collects data from the other nodes of the cluster and sends the collected data to the BS. This approach effectively balances the energy consumption of the sensor nodes and prolongs the network lifetime [9]. Compared with flat routing protocols, hierarchical routing protocols have better flexibility and scalability. In recent years, most researches on routing protocols are based on hierarchical routing protocols [10-12].

~~LEACH (Low Energy Adaptive Clustering Hierarchy) [13] proposed in 2000 is the earliest energy efficient hierarchical routing protocol. In LEACH nodes are grouped into clusters. Every cluster has a cluster head for higher level communication to reduce the communication overhead. The operation of LEACH was broken up into rounds. Each round is divided into two phases: the set-up phase and the steady-state phase. In the set-up phase, each node decides whether or not to become a cluster head for the current round by choosing a random number between 0 and 1. All the elected CH nodes broadcast an ADV message to all ordinary nodes (non-cluster heads). Based on the signal strength of the received~~