Energy-Efficient Distance Based Clustering Routing Scheme for Wireless Sensor Networks

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Abstract. Clustering scheme enabling the efficient utilization of the limited energy resources of the deployed sensor nodes can effectively prolong the lifetime of wireless sensor networks. The most common technique in famous clustering schemes is a probabilistic clustering scheme based on a randomized cluster-head rotation for distributing the energy consumption among nodes in each cluster. Because most of those schemes utilize mainly the residual energy of each node as the criterion of cluster-head election, those schemes have demerit which the unbalanced energy consumption among cluster-heads is occurred. To overcome this demerit, we consider a distance from the base station to cluster-heads as well as the residual energy as the criterion of cluster-head election for balanced energy consumption among cluster-heads. Our scheme provides fully distributed manner by utilizing local information and good energy-efficiency by load balanced clustering scheme. Through simulation experiments, we showed that the proposed scheme is more effective than LEACH and EECS in prolonging the lifespan of wireless sensor networks.

Keywords: Wireless Sensor Network, Routing Protocol, Clustering Algorithm, Distributed Algorithm.

1 Introduction

Wireless sensor networks consist of a number of sensor nodes deployed over a geographical area for the purpose of monitoring certain phenomena of interest. Wireless sensor networks enable the reliable surveillance of a variety of environment for heath, military, home and civil applications[15]. Each sensor node has

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wireless communication capability, data aggregating ability, and self-organizing capability\[1\].

The lifetime of a network is one of the important performance metrics of wireless sensor networks. In general, sensor nodes originally have resource constraints which have to rely on a limited supply of energy (using batteries) because they are fixed after original deployment and are not replaced even if they dissipate the total amount of their initial energy\[2\]. So, to lengthen the lifespan of wireless sensor networks, an energy-efficient way of operation of wireless sensor networks is necessary\[1,2,11\].

Clustering scheme enabling the efficient utilization of the limited energy resources of the deployed sensor nodes can effectively prolong the lifetime of wireless sensor networks\[3,4,5,8,10\]. The basic operation of clustering scheme in wireless sensor network is to partition network into clusters. After formatting clustering, the cluster-head of each cluster aggregates sensed data from non-cluster-heads for energy efficiency of data processing and then sends the data to base station\[7,13\]. The most common technique in famous clustering schemes such as LEACH and HEED is a probabilistic clustering algorithm based on a randomized cluster-head rotation for distributing the energy consumption among nodes in each cluster\[7,13\]. In addition, communication within a cluster(intra-cluster) as well as communication between different clusters(inter-cluster) can be organized as a combination of one-hop and multi-hop communication.

In clustering scheme, how to control the balance of the energy consumption among cluster-heads can greatly affect the network lifespan which is generally determined by the first dead-node\[8\]. Among the sources of energy consumption in a cluster-head, wireless data transmission is the most critical\[2\]. Because the energy consumption of wireless data transmission increases generally in proportion with the distance from sending node to receiving node\[2\], the energy consumption of cluster-head depends on its location from the base station. For example, in one-hop inter-cluster communication, the cluster-heads farther to the base station will die much faster than the other cluster-heads.

Most of clustering schemes utilize mainly cluster-head frequency or residual energy of each node as criterion of cluster-head election and don’t consider the distance from the base station to the cluster-head. So, let those schemes occur unbalanced energy consumption among cluster-heads in spite those schemes are able to prolong the network lifetime.

In this paper, we describe an energy-efficient distance based clustering scheme. We consider the distance from the base station to cluster-heads as well as the residual energy as the criterion of cluster-head election for balanced energy consumption among cluster-heads. Our scheme provides fully distributed manner by utilizing local information and good energy-efficiency by load balanced clustering scheme.

This paper is organized as follows. Section 2 introduces backgrounds of the proposed scheme. Section 3 presents our goal and some assumptions that are needed for describing the proposed scheme. Section 4 describes the procedures of the proposed scheme in detail. Section 5 explains the results of the performance