An Efficient Cluster-Based Routing Protocol for WSNs Using Time Series Prediction-Based Data Reduction Scheme

Dhirendra Pratap Singh, Department of Electronics & Communication Engineering, Shri Ramswaroop Memorial Group of Professional Colleges, Lucknow, Uttar Pradesh, India

Vikrant Bhateja, Department of Electronics & Communication Engineering, Shri Ramswaroop Memorial Group of Professional Colleges (SRMGPC), Lucknow, Uttar Pradesh, India

Surender Kumar Soni, Department of Electronics & Communication Engineering, National Institute of Technology (NIT), Hamirpur, Himachal Pradesh, India

ABSTRACT

Wireless Sensor Networks (WSNs) consists of number of tiny, low cost and low power sensor nodes to monitor some physical phenomenon like temperature, pressure, vibration, seismic events, landslide detection etc. The communication subsystem in WSNs is primarily responsible for energy consumption. This becomes a constraint in these N/Ws owing to the usage of non-rechargeable battery having a limited power supply. Hence, the present work incorporates a time series prediction based data reduction scheme to develop an energy efficient routing protocol for minimizing energy consumption of WSNs. In this paper, three approaches have been devised involving energy efficient cluster based routing protocol with residual energy and distance based cluster head selection method. The cluster formation in the proposed approaches is different from Low Energy Adaptive Clustering Hierarchy (LEACH) routing protocol as its clusters will be fixed throughout the life of WSN. This leads to a reduction in overheads during cluster formation. Further, inter-cluster and intra-cluster transmissions are also minimized which results in an overall reduction in energy consumption of WSNs.

Keywords: Data Reduction Approach, Energy Consumption, GM (1, 1) Prediction Model, Low Energy Adaptive Clustering Hierarchy (LEACH), Measurement of FND & HND, Wireless Sensor Networks (WSNs)

DOI: 10.4018/ijmtie.2013070102
1. INTRODUCTION

Initially WSNs were mainly used and motivated by military applications. Later on, their utility has found to be extended to many civilian applications, like environmental and species monitoring, production and medical, smart home automation etc. (Lay-Ekuakille et al., 2001; Lay-Ekuakille et al., 2009; Massaro et al., 2011; Lay-Ekuakille et al., 2012; Urooj et al., 2013). WSNs may consist of heterogeneous and mobile sensor nodes depending on the specific applications, the network topology may be as simple as a star topology; the scalability and density of a network varies depending on the particular application. WSNs also find application in computer-aided detection of the life threatening diseases like cancers of skin (Caratelli et al., 2012), breast (Bhateja et al., 2013a; Bhateja et al., 2013b; Bhateja et al., 2013c; Jain et al., 2013) and brain (Raj et al., 2011; Srivastava et al., 2011) as well as pulmonary and breathing disorders (Urooz et al., 2011; Urooz et al., 2012; Lay-Ekuakille et al., 2013). These computer aided detection techniques employed for breast cancer diagnosis have been separately devised for each type of abnormalities like tumors (Bhateja & Devi 2011; Pandey et al. 2013a, 2013b, 2013c) and calcifications (Bhateja & Devi 2011, 2013; Bhateja et al., 2013). These abnormalities are prominent in the bio-medical sensor responses of X-rays (mammograms) (Bhateja & Devi 2010, Gupta et al. 2012a, 2012b, 2012c; Srivastava et al. 2013) as well as ultrasounds (Singh et al. 2012; Bhateja et al. 2013a, 2013b). To optimize the usage of WSNs for various applicative trends requires addressing of important design issues (Romer & Mattern, 2004; Wang, 2008). These issues include: Fault Tolerance, Scalability factor, Production Costs, Operating Environment, Power Consumption, Data Delivery Mode, Data Aggregation/Fusion, Quality of Service (QoS) and Node Deployment (Kulik et al., 2002; Tilak et al., 2002; Krishnamachari et al., 2002). Among these design issues, power (energy) consumption forms the major cause of concern because WSNs are mostly used in such areas where human approach is nearly impossible and non-rechargeable batteries of sensor nodes cannot be recharged which may be the cause of network failure. In WSNs, the major cause of power consumption is transmission of data. Sensor nodes can send their data directly to the sink but this is feasible only for short distances because this mode of communication will not be efficient in case of longer distances. In such cases, multi-hop mode of transmission gives comparatively good results. Hierarchical routing using multi-hop mode reduces a good amount of energy of WSNs; in this scheme, the entire network is divided into clustered layers as illustrated in Figure 1. It can be seen that the sensor nodes are grouped into clusters with a specific sensor node known as ‘cluster head (CH)’ that performs the task to route the data from the cluster to the cluster heads of other clusters or base stations (BS). In this way data can be transmitted from source to sink with low power consumption (Heinzelman et al., 2002; Akkaya & Younis, 2005).

In the cluster-based hierarchical model, data is sent from all cluster members to the cluster head of corresponding cluster. This model is better than the single hop or multi-hop model. The CH can prolong the battery life of the individual sensors and the network lifetime as well by implementing optimized management strategies (Younis et al., 2003). Clustering also cuts down the topology maintenance overhead and therefore sensors would care only for connecting with their CHs (Hou et al., 2005). A CH performs data aggregation in its cluster and reduces the number of redundant packets. A CH can reduce the rate of energy consumption by scheduling activities in the cluster (Dasgupta et al., 2003). Another protocol for basic hierarchical routing is LEACH, which is self-organizing, application specific and incorporates adaptive clustering that uses randomization to distribute the energy consumption evenly among the sensor nodes (in the network). This protocol aims at increasing the lifetime and reducing the latency for transferring the data. In LEACH, sensor nodes deployed over the field of interest are also responsible for the medium access among the...
Related Content

The Technology of Writing Assessment and Racial Validity
www.igi-global.com/chapter/technology-writing-assessment-racial-validity/19666?camid=4v1a

www.igi-global.com/article/observation-least-action-principle-classical/62654?camid=4v1a
An Architectural and Evaluative Review of Implicit and Explicit SIP Overload Handling
www.igi-global.com/article/architectural-evaluative-review-implicit-explicit/68155?camid=4v1a

Electrical Resistivity Measures in Cohesive Soils for the Simulation of an Integrated Energy System Between CCS and Low-Enthalpy Geothermal