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Hierarchical Data Gathering with Network Area Verification Scheme for WSN

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Abstract

The sensor nodes are deployed to manage the area monitoring tasks. All the sensed data values are maintained under the storage provided in the sensor nodes. The data values are transferred to the users with reference to the query values. The data query process is carried out in different ways. Intermediate sensor based data transmission model and cluster based data transmission models are adapted for the data gathering process. Mobile objects are also employed to manage the data collection process.

The data collection process is managed with multiple layer model. The hierarchical data gathering method is constructed with three layers. They are sensor, cluster and mobile collector layers. The sensor layer is bottom level layer employed to sense data values. Cluster layer is an interface between the sensor and mobile collector layers. The mobile collector is an interface between the user and sensor nodes. Distributed Load Balanced Clustering with Dual Data Upload (LBC-DDU) scheme is adapted to carry out the hierarchical data gathering process. The sensor node data values are uploaded to the cluster head. The cluster head redirects the data values into the mobile collector. All the user query responses are delivered through the mobile collector.

The hierarchical data gathering scheme is constructed with efficient cluster head pairing and polling point selection mechanism. The mobile collector trajectory plan is build with reference to the cluster head pairs and polling points. The network area verification process is initiated to analyze the data monitoring area and the data transmission reach ability measure. Trajectory plan, cluster construction and polling point selection operations are recalled to achieve complete network coverage. The bandwidth scheduling is also performed with network area details.

***Index Terms:** Data Gathering Schemes, Mobile Collector, Load Balanced Clustering and Wireless Sensor Networks*

1. Introduction

Wireless sensor networks (WSNs) recently have been deployed and used for a large variety of critical applications, such as environmental monitoring, field estimation, field reconstruction and precision agriculture. In many applications, more than one physical attribute of a sensor field need to be sensed simultaneously. WSN deployed in a greenhouse for precision agriculture, where the soil temperature, moisture and fertility need to be measured for farmers to control the growth of crops with greater precision. These applications normally have strict coverage requirements for the deployed WSNs.

Coverage, which reflects how well a sensor field is monitored, is a critical factor for the success of a WSN. The coverage problems are highly dependent on the coverage model of individual sensor. The sensor coverage model is used to reflect sensors' sensing capability and capacity and is subject to a wide range of interpretations due to a large variety of sensors and applications. Most of the current studies on the coverage problem are based on the disk model, which defines a disk centered at the sensor with the radius of its sensing range. The disk model is too simple and idealistic to be applied in many real-world applications. Based on a simple single-value parameter, some new sensor coverage models have been proposed according to some signal processing technologies for WSNs. They are not enough in some applications that need to reconstruct field physical characteristics, such as the temperature and moisture in precision agriculture.

Motivated from the precision agriculture applications and based on the ordinary kriging a coverage model is proposed, in our previous study from the perspective of field reconstruction. Field reconstruction is to estimate some spatially distributed physical attributes with a given reconstruction quality for the whole sensor field. Network lifetime is another

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fundamental criterion for evaluating a WSN, which defines how long the deployed WSN can function well to its designed service requirements. Since the nodes are powered by non-rechargeable batteries and in many cases, sensor nodes are scattered in a hazardous environment, which is unpractical to recharge or replace their battery, how to improve the energy efficiency and prolong the network lifetime is a significant issue in WSNs. As in many previous studies, the lifetime of a WSN in this paper is defined as the time span from the network deployment to the time when the network coverage requirement cannot be satisfied.

Sensor activity scheduling is an effective way to prolong network lifetime while maintaining the network coverage requirement in a densely deployed WSN. If the area covered by a sensor is also covered by other sensors, then this sensor can go into an energy saving sleep state without loss of network coverage. We can divide the time line into intervals and schedule different sensor sets to guarantee network coverage in different intervals.

2. Related Work

Existing literature in the realm of TDMA based interference aware link scheduling can be classified with respect to their objective functions. In some works like the objective is to increase throughput and minimize delay without any consideration for the energy consumption, while studies in [9], [10] aim at minimizing the energy consumption by minimizing the energy wasted during sleep-wakeup transitions [3]. With stronger processors, more memory on board and availability of higher bandwidth, sensor nodes are more equipped and are widely deployed to perform extensive computation tasks. Thus task scheduling should be given explicit consideration. But the solution approach of all the studies mentioned above do not take into account the computation task scheduling performed by each node.

Prior work on joint scheduling of computation and communication subsystems is presented in [2]. The objective is maximizing the number of clients that can be scheduled with limited processor capacity and link capacity. In [2] the interference issues are not taken into account. An energy aware computation communication scheduling is studied where DVS is used for computation energy reduction. They consider a very simplistic model of one-hop network, ruling out parallel transmission and interference. They only leverage the energy-delay tradeoff for computation tasks using DVS, as opposed to our scheme which uses a combination of DVS and DMS. Their approach to reduce energy consumption by slack reclamation using DVS equally scales down the CPU speed of all the sensors. This approach will yield poorer results when applied to a system where both DVS and DMS is available. This is because any two processors will yield the same energy savings when scaled down equally that is from a frequency level f1 to f2. But two messages might differ in their energy savings when scaled down from same modulation levels m1 to m2 owing to different distances that these messages need to be transmitted over. So a combination of DVS and DMS needs an iterative scheme to yield better energy savings.

System-wide energy reduction using the combination of DVS and DMS is also studied in [4]. But in all these works, the interference issues are not considered. Also the assumption of monotonically decreasing energy consumption of messages employing DMS is not correct. Authors investigate the problem of task allocation to a single-hop cluster of homogeneous sensor nodes with multiple wireless channels with the objective to minimize the balanced energy consumption of the network [6]. The multiple wireless channel model can serve to solve the interference issues only in small sized networks as considered. In large scale WSNs, interference issues need explicit consideration. On a different note, environmental resource harvesting schemes can reduce the problem of limited energy budget but they have low unstable efficiency due to uncontrollable environmental conditions rendering them unsuitable for real-time applications.

To the best of our knowledge, this is the first work that addresses the joint scheduling of communication and computation to minimize energy consumption in an interference-aware network. The joint scheduling problem poses several challenges. The time taken by the different task execution and message transmission are different, preventing the use of graph coloring approaches where each color denotes a fixed size slot. Time intensive computation tasks must be executed at the node itself. They cannot be offloaded to a distant server owing to the large energy consumption of the wireless transmitted messages. Additionally, the precedence and interference conflicts present among the scheduled entities prevent the optimal allocation of resources in order to reduce energy consumption.

3. Data Gathering with Mobile Collectors

The proliferation of the implementation for low-cost, low-power, multifunctional sensors has made wireless sensor networks (WSNs) a prominent data collection paradigm for extracting local measures of interests. In such applications, sensors are generally densely deployed and randomly scattered over a sensing field and left unattended after being deployed, which makes it difficult to recharge or replace their batteries. After sensors form into autonomous organizations, those sensors near the data sink typically deplete their batteries much faster than others due to more relaying traffic. When sensors around the data sink deplete their energy, network connectivity and coverage may not be guaranteed. Due to these constraints, it is crucial to design an energy-efficient data collection scheme that consumes energy uniformly across the sensing field to achieve long network lifetime [11]. Furthermore, as sensing data in some applications are time-sensitive, data collection may be required to be performed within a specified time frame. Therefore, an efficient, large-scale data collection scheme should aim at good scalability, long network lifetime and low data latency.

Several approaches have been proposed for efficient data collection in the literature. Based on the focus of these works, we can roughly divide them into three categories. The first category is the enhanced relay routing data are relayed among sensors. Besides relaying, some other factors, such as load balance, schedule pattern and data redundancy, are also considered. The second category organizes sensors into clusters and allows cluster heads to take the responsibility for forwarding data to the data sink. Clustering is particularly useful for applications with scalability requirement and is very effective in local data aggregation since it can reduce the collisions and balance load among sensors. The third category is to make use of mobile collectors to take the burden of data routing from sensors.

Although these works provide effective solutions to data collection in WSNs, their inefficiencies have been noticed. Specifically, in relay routing schemes, minimizing energy consumption on the forwarding path does not necessarily prolong network lifetime, since some critical sensors on the path may run out of energy faster than others. In cluster- based schemes, cluster heads will inevitably consume much more energy than other sensors due to handling intra-cluster aggregation and inter-cluster data forwarding. Though using mobile collectors may alleviate non-uniform energy consumption, it may result in unsatisfactory data collection latency. Based on these observations, in this paper, we propose a three-layer mobile data collection framework, named Load Balanced Clustering and Dual Data Uploading (LBC-DDU). The main motivation is to utilize distributed clustering for scalability, to employ mobility for energy saving and uniform energy consumption, and to exploit Multi-User Multiple-Input and Multiple-Output (MU-MIMO) technique for concurrent data uploading to shorten latency.

4. Virtual MIMO Scheduling Scheme

The research discovers some issues on data gathering using the vMIMO technology, there are three main limitations we aim to overcome. First, the work in [8] used the vMIMO transmission on a fixed topology. It would be more beneficial if, in conjunction with the use of vMIMO, one constructs a suitable topology and designs energy-efficient routing protocol for data gathering. Second, the works in [5], did not fully explore the advantages ofvMIMOsince only the SISO and MISO communication modeswere employed. Finally, none of the works obtained any approximate performance guarantee for the data gathering problem in sensor networks.

An energy-efficient data gathering method is applied using vMIMO for wireless sensor networks. We first define the joint vMIMO and data gathering (vMDG) problem and formally prove that this problem is NP-Hard. As the problem is difficult to solve optimally due to its high computational complexity, we propose a distributed and heuristic algorithm called D-vMDG, which consists of two steps [1]. The first step selects a set of cooperative node pairs and constructs a tree-like topology by taking the unique features of vMIMO into consideration. Then, an energy-efficient routing protocol based on dynamic programming is proposed for the constructed topology. Our theoretical analysis shows that the proposed algorithm can achieve a constant approximation guarantee for the vMDG problem with respect to the optimal performance [7]. Our simulation results illustrate that the proposed D-vMDG algorithm decreases the energy consumptions by about 81 and 36 percent compared with the well-known MDT and MIMO-LEACH algorithms respectively.

5. Hierarchical Data Gathering with Network Area Verification Scheme

Cluster head pair selection is improved with node property values. Discretization method is integrated with the system to select optimal polling point for the clusters. The Distributed Load Balanced Clustering with Dual Data Upload (LBC-DDU) scheme is enhanced to manage the overall spatial coverage. The MIMO scheduling is enhanced to support multiple cluster based transmissions.

Mobile collector (SenCar) based data collection scheme is constructed to perform data gathering operations in WSN. Network coverage analysis is adapted to identify the missing data collection regions. The data transfer process is improved with cluster based channel allocation mechanism. The system is partitioned into six modules. They are Sensor Layer, Clustering Process, Polling Point Selection, Scheduling Mobile Collector, Channel Assignment Process and Spatial Coverage Analysis.

Sensor node deployment operations are carried out under sensor layer module. Clustering process is designed to group the sensor nodes with resource details. Polling point selection module is designed to assign data collection points. Mobile collector movements are planned using scheduling process. MIMO scheduling operations are carried out under Channel assignment process. Network coverage is verified under spatial coverage analysis.

The wireless sensor nodes are installed to capture the data from environment. Sensor node deployment operations are carried out under the sensor layers. Node properties are collected and updated under sensor layers. The initialization phase is applied to collect the residual energy and coverage details of the neighbor nodes. The clustering process is designed to group the nodes with the resource details. Residual energy, sensing coverage and transmission coverage factors are considered in the clustering process. Status claim algorithm is used to update the node status as member or cluster head. Distributed Load Balancing Cluster (LBC) algorithm is adapted for the cluster formation.

Cluster head pairs are analyzed for polling point selection process. Polling point identification is improved with Discretization method. Polling points are assigned to the clusters using Optimal polling point selection algorithm. Cluster head coverage is used in the polling point selection process. Mobile collector moves across the network area to perform data collection. The data collection is initiated under the polling points. Cluster head information is used to schedule the moving trajectory for mobile collectors. Mobile collector fetches the data from the cluster head pairs.

Channel assignment process is carried out to schedule the Dual Data Upload (DDU) process. Multi User Multi Input and Multi Output (MU-MIMO) technique is adapted for the data uploading process. The MU-MIMO scheme is enhanced to manage multi cluster environment. The Virtual Multi Input Multi Output (V-MIMO) scheme is applied to schedule the bandwidth for data upload process. Network coverage verification is performed in the spatial coverage analysis. Node coverage and proximity details are analyzed to estimate the cluster coverage. Cluster coverage details are summarized to estimate the data sensing coverage for the network. Network coverage and data collection regions are compared to identify the coverage missing area

6. Conclusion

Sensor data gathering is performed using mobile collectors. The Distributed Load Balanced Clustering with Dual Data Upload (LBC-DDU) scheme is employed for the data collection process. LBC-DDU scheme is enhanced with optimal polling point selection and spatial coverage management features. The Multiple Input and Multiple Output (MIMO) scheduling is improved to support multiple cluster model. The system reduces energy consumption in sensor node and cluster head level. Wireless sensor network data collection process is handled with energy and network lifetime management factors. Traffic level and mobile collector movement are controlled with Optimal polling point selection mechanism. Spatial coverage analysis is carried out to verify the network coverage achievement. The system reduces the computational and communication load in the data collection process.

REFERENCES

[1] Hongli Xu, Liusheng Huang, Chunming Qiao, Weichao Dai and Yu-e Sun, “Joint Virtual MIMO and Data Gathering for Wireless Sensor Networks”, IEEE transactions on parallel and distributed systems, vol. 26, no. 4, April 2015

[2] B. Fateh and G. Manimaran, “Energy-aware joint scheduling of tasks and messages in wireless sensor

networks," in Proc. IPDPSW IEEE, Atlanta, GA, USA, 2010.

[3] Benazir Fateh and Manimaran Govindarasu, "Joint Scheduling of Tasks and Messages for Energy Minimization in Interference-Aware Real-Time Sensor Networks", IEEE Transactions On Mobile Computing, Vol. 14, No. 1, January 2015

[4] G. S. A. Kumar, G. Manimaran, and Z. Wang, "End-to-end energy management in networked real-time embedded systems," IEEE Trans. Parallel Distrib. Syst., vol. 19, no. 11, pp. 1498–1510, Nov. 2008.

[5] H. Xu, L. Huang, Y. Zhang, H. Huang, S. Jiang, and G. Liu, "Energy-efficient cooperative data aggregation for wireless sensor networks," J. Parallel Distrib. Comput., vol. 70, no. 9, pp. 953–961, Sep. 2010

[6] IBM ILOG CPLEX Mathematical Optimization Technology [Online]. Available: http://www-01.ibm.com/software/integration/optim ization/cplex optimization-studio/cplex-optimizer/cplex-perfor mance

[7] S. C. Ergen and P. Varaiya, "TDMA scheduling algorithms for wireless sensor networks," Wireless Netw., vol. 16, no. 4, pp. 985–997, May 2010.

[8] Y. Gai, L. Zhang, and X. Shan, "Energy efficiency of cooperative MIMO with data aggregation in wireless sensor networks," in Proc. IEEE Wireless Commun. Netw. Conf., Mar. 2007, pp. 792–797.

[9] Y. Wu, X. Li, Y. Liu, and W. Lou, "Energy-efficient wake-up scheduling for data collection and aggregation," IEEE Trans. Parallel Distrib. Syst., vol. 21, no. 2, pp. 275–287, Feb. 2010.

[10] J. Ma, W. Lou, Y. Wu, X. Li, and G. Chen, "Energy efficient TDMA sleep scheduling in wireless sensor networks," in Proc. INFOCOM, Rio de Janeiro, Brazil, 2009.

[11] Prateek Mathur, Rasmus H. Nielsen, Neeli R. Prasad and Ramjee Prasad, "Data collection using miniature aerial vehicles in wireless sensor networks", IET Wireless Sensor Systems, Vol. 6, Iss. 1, pp. 17–25, 2016.