

A Review on Geographic Routing in Duty Cycled Wireless Sensor Networks

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Abstract- Recently, the research focus on geographic routing, a promising routing scheme in wireless sensor networks (WSNs), is shifting toward duty-cycled WSNs in which sensors are sleep scheduled to reduce energy consumption. However, except the connected-k neighborhood (CKN) sleep scheduling algorithm and the geographic routing oriented sleep scheduling (GSS) algorithm, nearly all research work about geographic routing in duty cycled WSNs has focused on the geographic forwarding mechanism; further, most of the existing work has ignored the fact that sensors can be mobile. In this project, we focused on sleep scheduling for geographic routing in duty-cycled WSNs with mobile sensors and proposed two geographic-distance-based connected-k neighborhood (GCKN) sleep scheduling algorithms. The first one is the geographic-distance-based connected-k neighborhood for first path (GCKNF) sleep scheduling algorithm. The second one is the geographic-distance-based connected-k neighborhood for all paths (GCKNA) sleep scheduling algorithm. By theoretical analysis and simulations, we show that when there are mobile sensors, geographic routing can achieve much shorter average lengths for the first transmission path explored in WSNs employing GCKNF sleep scheduling and all transmission paths searched in WSNs employing GCKNA sleep scheduling compared with those in WSNs employing CKN and GSS sleep scheduling.

1. INTRODUCTION

Geographic routing [1]–[4] is one of the most promising routing schemes in wireless sensor networks (WSNs) [5], due to its simplicity, scalability, and efficiency [6]. In such a scheme, regardless of the network size, the forwarding decision is determined purely based on the location of each node and it can be done even when there are irregular radio ranges and localization errors. Recently, the research focus of geographic routing is centering on WSNs with duty-cycles, since duty cycled WSNs have a natural advantage of saving energy by dynamically putting nodes to sleep and waking them according to some sleep scheduling algorithms [7]–[10]. However, nearly all these works overlook one important fact that sensors can actually be mobile to gain better energy efficiency, channel capacity, etc., and enable a lot of new application scenarios [11]–[14]. For example, because sensors can move, they can transmit their data from different locations and avoid the problem that sensors near the gateway or sink always exhaust their energy first; thus, energy usage can be more efficient [15]. Also, mobile sensors such as mobile phones or cars can become the interface between the information center and the mobile customers; thus, real-time information (e.g., traffic information) transmitted from the information center to these mobile objects can be provided to nearby customers [16], [17]. Moreover, almost all current works about geographic routing in duty-cycled WSNs [18]–[21] try to change the

geographic forwarding mechanism to deal with the dynamic topology caused by some nodes being cycled off or going to sleep mode.

For instance, it is suggested in [18] to wait for the appearance of the expected forwarding successor first and select a backup node if the first mechanism fails. In [19], the sensor field is sliced into some k-coverage fields, then some always-on cluster heads are selected to collect the data from their nearby sensors and finally transmit all data to the sink. Apart from the connected-k neighborhood (CKN) sleep scheduling algorithm proposed in [22] and the geographic routing oriented sleep scheduling (GSS) algorithm presented in [23], few research works have tackled the node availability uncertainty issue in duty-cycled WSNs from the view of sleep scheduling.

2. RELATED WORK

2.1. Geographic Routing

The basic idea of geographic routing is greedy routing. Specifically, each packet is tagged with the coordinates of its destination, all nodes know their own coordinates, and a node forward the packet to its neighbor that is geographically closest to the destination. The earliest proposal for geographic routing is in [24], which has a local minimum problem in that a node may have no closer neighbor to the destination. For this reason, face routing [1] and its variants are proposed to use

geometric rules (e.g., right hand rule) to route around voids near the local minimum in case it happens. However, these algorithms require converting the network into a planar graph (e.g., [25]) or removing the problematic cross links from the network (e.g., [3], which are not very applicable in realistic conditions [26]. Moreover, there is also a hole problem in geographic routing, in that a hole can be formed by a set of dead sensor nodes running out of energy or being damaged. To solve this problem, some research work (e.g., [27]) try to identify the hole boundary nodes first and then use these boundary nodes to avoid the hole. Others (e.g., [28]) try to use geometric modeling to find an optimized holebypassing routing path. Recently, by using a *step back and mark* strategy when it cannot find the next-hop node, a two-phase geographic forwarding (TPGF), which does not have the local minimum or the hole problem, is shown in [29]. With a *labelbased optimization* method, TPGF can optimize the routing paths by finding one with the least number of hops. However, all these works only consider WSNs with static nodes. Recently, many opportunistic routing protocols [18], [19], [30], [31]) have been proposed to extend geographic routing to duty-cycled WSNs. They all try to achieve this goal by dynamically choosing the forwarding node based on the best potential node that can transmit packets. Specially, these protocols typically take into account such factors as link uncertainty to adapt routing accordingly. However, few of these works address the local minimum or hole problem, and nearly all these works do not consider the situation that sensor nodes can be mobile.

2.2. Sleep Scheduling

The basic mechanism for sleep scheduling is to select a subset of nodes to be awake in a given epoch while the remaining nodes are in the sleep state that minimizes power consumption, so that the overall energy consumption can be reduced.

Existing works on sleep scheduling in WSNs mainly focus on two targets: *point coverage* and *node coverage*. For *point coverage* (also known as spatial coverage), the awake nodes in each epoch are chosen to cover every point of the deployed field. Existing *point coverage* oriented algorithms differ in their sleep scheduling goals: minimizing energy consumption [7], or minimizing average event detection latency [8]. For *node coverage* (also called network coverage), awake nodes are selected to construct a globally connected network such that each asleep node is an immediate neighbor of at least one awake node [32], [33]. However, all these works generally focused on the medium access layer of static WSNs with static nodes. The only recent works addressing sleep scheduling in dutycycled WSNs employing geographic routing are the CKN scheme

proposed in [22] and the GSS method presented in [23]. CKN is a sleep scheduling method providing node coverage and a probabilistic point coverage, which tunes the number of awake nodes in the network by changing the value of k in CKN. GSS is based on CKN and differs from CKN only by making the potential nearest neighbor nodes to the sink to be awake. However, both CKN and GSS do not consider the scenarios in which sensor nodes can be mobile, and both CKN and GSS determine the awake or asleep state of each node based only on a random rank, which may keep awake many nodes far away from the destination and thus degrade the performance of geographic routing.

Threats in mobile environment are social engineering, web browser exploitation and OS vulnerability, compromised devices, vulnerable applications. Some of threats in mobile environment are similar to traditional desktop environment such as malware, data interception, and loss or theft of devices [3]. Figure 1 highlights some of the major threats in mobile environment.

3. ANALYSIS OF PROBLEM

Geographic routing is centering on WSNs with duty-cycles, since duty-cycled WSNs have a natural advantage of saving energy by dynamically putting nodes to sleep and waking them according to some sleep scheduling algorithms. However, nearly all these works overlook one important fact that sensors can actually be mobile to gain better energy efficiency, channel capacity, etc., and enable a lot of new application scenarios.

Disadvantages of Existing System:

- Geographical forwarding mechanism failure.
- Tackle the node availability uncertainty issue in duty-cycled WSNs from the view of sleep scheduling.

4. OBJECTIVES

Objectives are as follows:

- Addresses the sleep scheduling problem in duty cycled WSNs with mobile nodes.
- Implementation geographic-distance-based connected-kneighborhood for first path1 (GCKNF) sleep scheduling algorithm.
- Implementation geographic-distance-based connected-kneighborhood for all paths2 (GCKNA) sleep scheduling algorithm.
- Implementation geographic-distance-based connected-kneighborhood for all paths2 (GCKNA) sleep scheduling algorithm.

5. PROPOSED WORK

In this project, we have explored geographic routing in duty-cycled mobile WSNs and proposed two geographic-distance-based connected-k neighbourhood (GCKN) sleep scheduling algorithms for geographic routing schemes to be applied into duty-cycled mobile WSNs which can incorporate the advantage of sleep scheduling and mobility.

The first geographic-distance-based connected-kneighbourhood for first path (GCKNF) sleep scheduling algorithm minimizes the length of first transmission path explored by geographic routing in duty-cycled mobile WSNs.

The second geographic-distance based connected-kneighbourhood for all paths (GCKNA) sleep scheduling algorithm reduces the length of all paths searched by geographic routing in duty-cycled mobile WSNs.

Advantages of Proposed System:

- The GCKNF and GCKNA are very effective in shortening the length of the transmission path explored by geographic routing in duty-cycled mobile WSNs compared with the CKN sleep scheduling algorithm and the GSS algorithm.
- Our work will show that sleep scheduling is a worthy research direction to adapt geographic forwarding methods into duty-cycled mobile WSNs.

6. REFERENCES

- [1] B. Karp and H. T. Kung, "GPSR: Greedy perimeter stateless routing for wireless networks," in Proc. MobiCom, 2000, pp. 243–254.
- [2] B. Leong, B. Liskov, and R. Morris, "Geographic routing without planarization," in Proc. NSDI, 2006, pp. 339–352.
- [3] Y.-J. Kim, R. Govindan, B. Karp, and S. Shenker, "Lazy cross-link removal for geographic routing," in Proc. SenSys, 2006, pp. 112–124.
- [4] L. Zhang and Y. Zhang, "Energy-efficient cross-layer protocol of channelaware geographic-informed forwarding in wireless sensor networks," IEEE Trans. Veh. Technol., vol. 58, no. 6, pp. 3041–3052, Jul. 2009.
- [5] Z. Jiang, J. Ma, W. Lou, and J. Wu, "An information model for geographic greedy forwarding in wireless ad-hoc sensor networks," in Proc. IEEE INFOCOM, 2008, pp. 825–833.
- [6] H. Zhang and H. Shen, "Energy-efficient beaconless geographic routing in wireless sensor networks," IEEE Trans. Parallel Distrib. Syst., vol. 21, no. 6, pp. 881–896, Jun. 2010.
- [7] C.-F. Hsin and M. Liu, "Network coverage using low duty-cycled sensors: Random & coordinated sleep algorithms," in Proc. IPSN, 2004, pp. 433–442.
- [8] Q. Cao, T. Abdelzaher, T. He, and J. Stankovic, "Towards optimal sleep scheduling in sensor networks for rare-event detection," in Proc. IPSN, 2005, pp. 20–27.
- [9] H. Le, J. V. Eck, and M. Takizawa, "An efficient hybrid medium access control technique for digital ecosystems," IEEE Trans. Ind. Electron., vol. 60, no. 3, pp. 1070–1076, Mar. 2013.
- [10] P. Cheng, F. Zhang, J. Chen, Y. Sun, and X. Shen, "A distributed TDMA scheduling algorithm for target tracking in ultrasonic sensor networks," IEEE Trans. Ind. Electron., vol. 60, no. 9, pp. 3836–3845, Sep. 2013.
- [11] K. Morioka, J.-H. Lee, and H. Hashimoto, "Human-following mobile robot in a distributed intelligent sensor network," IEEE Trans. Ind. Electron., vol. 51, no. 1, pp. 229–237, Feb. 2004.
- [12] C. Zhu et al., "A survey on communication and data management issues in mobile sensor networks," Wireless Commun. Mobile Comput., vol. 14, no. 1, pp. 19–36, Jan. 2014.
- [13] R. C. Luo and O. Chen, "Mobile sensor node deployment and asynchronous power management for wireless sensor networks," IEEE Trans. Ind. Electron., vol. 59, no. 5, pp. 2377–2385, May 2012.
- [14] H. Song, V. Shin, and M. Jeon, "Mobile node localization using fusion prediction-based interacting multiple model in cricket sensor network," IEEE Trans. Ind. Electron., vol. 59, no. 11, pp. 4349–4359, Nov. 2012.
- [15] J. Pan, L. Cai, Y. T. Hou, Y. Shi, and X. X. Shen, "Optimal base-station locations in two-tiered wireless sensor networks," IEEE Trans. Mobile Comput., vol. 4, no. 5, pp. 458–473, Sep./Oct. 2005.
- [16] K. Yuen, B. Liang, and B. Li, "A distributed framework for correlated data gathering in sensor networks," IEEE Trans. Veh. Technol., vol. 57, no. 1, pp. 578–593, Jan. 2008.
- [17] K. Almi'ani, A. Viglas, and L. Libman, "Energy-efficient data gathering with tour length-constrained mobile elements in wireless sensor networks," in Proc. IEEE LCN, 2010, pp. 598–605.
- [18] Z. Jiang, J. Wu, and R. Ito, "A metric for routing in delay-sensitive wireless sensor networks," in Proc. IEEE MASS, 2010, pp. 272–281.
- [19] H. M. Ammari and S. K. Das, "Joint k-coverage, duty-cycling, and geographic forwarding in wireless sensor networks," in Proc. IEEE ISCC, 2009, pp. 487–492.
- [20] K. Wang, L. Wang, C. Ma, L. Shu, and J. Rodrigues, "Geographic routing in random duty-cycled wireless multimedia sensor networks," in

- Proc. IEEE GLOBECOM Workshops, 2010, pp. 230–234.
- [21] K. P. Naveen and A. Kumar, “Tunable locally-optimal geographical forwarding in wireless sensor networks with sleep-wake cycling nodes,” in Proc. IEEE INFOCOM, 2010, pp. 1–9.
- [22] S. Nath and P. B. Gibbons, “Communicating via fireflies: Geographic routing on duty-cycled sensors,” in Proc. IPSN, 2007, pp. 440–449.
- [23] C. Zhu, L. T. Yang, L. Shu, J. J. P. C. Rodrigues, and T. Hara, “A geographic routing oriented sleep scheduling algorithm in duty-cycled sensor networks,” in Proc. IEEE ICC, 2012, pp. 5473–5477.
- [24] H. Takagi and L. Kleinrock, “Optimal transmission ranges for randomly distributed packet radio networks,” *IEEE Trans. Commun.*, vol. COM-32, no. 3, pp. 246–257, Mar. 1984.
- [25] H. Frey and I. Stojmenovic, “On delivery guarantees of face and combined greedy-face routing in ad hoc and sensor networks,” in Proc. MobiCom, 2006, pp. 390–401.
- [26] K. Seada, A. Helmy, and R. Govindan, “Modeling and analyzing the correctness of geographic face routing under realistic conditions,” *Ad Hoc Netw.*, vol. 5, no. 6, pp. 855–871, Aug. 2007.
- [27] Q. Fang, J. Gao, and L. J. Guibas, “Locating and bypassing routing holes in sensor networks,” in Proc. IEEE INFOCOM, 2004, pp. 2458–2468.
- [28] F. Yu et al., “A modeling for hole problem in wireless sensor networks,” in Proc. IWCMC, 2007, pp. 370–375.
- [29] L. Shu et al., “TPGF: Geographic routing in wireless multimedia sensor networks,” *Telecommun. Syst.*, vol. 44, no. 1/2, pp. 79–95, Jun. 2010.
- [30] M. Zorzi and R. R. Rao, “Geographic random forwarding (GERAF) for ad hoc and sensor networks: Energy and latency performance,” *IEEE Trans. Mobile Comput.*, vol. 2, no. 4, pp. 349–365, Oct.–Dec. 2003.
- [31] C. Ma et al., “A geographic routing algorithm in duty-cycled sensor networks with mobile sinks,” in Proc. MSN, 2011, pp. 343–344.
- [32] B. Chen, K. Jamieson, and H. Balakrishnan, “Span: An energy efficient coordination algorithm for topology maintenance in ad hoc wireless networks,” *Wireless Netw.*, vol. 8, no. 5, pp. 481–494, Sep. 2002.
- [33] C. Zhua, L. T. Yang, L. Shu, T. Q. Duong, and S. Nishio, “Secured energyaware sleep scheduling algorithm in duty-cycled sensor networks,” in Proc. IEEE ICC, 2012, pp. 1953–1957.
- [34] E. M. Royer, P. M. Melliar-Smith, and L. E. Moser, “An analysis of the optimum node density for ad hoc mobile networks,” in Proc. IEEE ICC, 2001, pp. 857–861.
- [35] J. Reich, V. Misra, D. Rubenstein, and G. Zussman, “Connectivity maintenance in mobile wireless networks via constrained mobility,” *IEEE J. Sel. Areas Commun.*, vol. 30, no. 5, pp. 935–950, Jun. 2012.