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ES2 Approach for Geographic Routing In Mobile Sensor Networks

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ABSTRACT*:* Geographic routing is 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 paper, we focus on sleep scheduling for geographic routing in duty-cycled WSNs with mobile sensors and propose two geographic-distance-based connected-k neighborhood (GCKN) sleep scheduling algorithms. The first one is the geographic-distance-based connected-kneighborhood 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. 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 inWSNs employing GCKNA sleep scheduling compared with those in WSNs employing CKN and GSS sleep scheduling

KEYWORDS: GCKNA , WSN , GCKNF , GPSR

I. INTRODUCTION

A wireless sensor network (WSN) is increasingly being envisioned for collecting data, such as physical or environmental properties, from a geographical region of interest. WSNs are composed of a large number of low cost sensor nodes, which are powered by portable power sources, e.g. batteries .

In many surveillance applications of WSNs, tracking a mobile target (e.g., a human being or a vehicle) is one of the main objectives. Unlike detection that studies discrete detection events a target tracking system is often required to ensure continuous monitoring, i.e., there always exist nodes that can detect the target along its trajectory (e.g., with low detection delay or high coverage level). Since nodes often run on batteries that are generally difficult to be recharged once deployed, energy efficiency is a critical feature of WSNs for the purpose of extending the network lifetime. However, if energy efficiency is enhanced, the quality of service (QoS) of target tracking is highly likely to be negatively influenced. For example, forcing nodes to sleep may result in missing the passing target and lowering the tracking coverage. Therefore, energy efficient target tracking should improve the trade off between energy efficiency and tracking performance e.g., by improving energy efficiency at the expense of a relatively small loss on tracking performance.

As a compensation for tracking performance loss caused by duty cycling and sleep scheduling, proactive wake-up has been studied for awakening nodes proactively to prepare for the approaching target. However, most existing efforts about proactive wake-up simply awaken all the neighbor nodes in the area, where the target is expected to arrive, without any differentiation. In fact, it is sometimes unnecessary to awaken all the neighbor nodes. To sleep-schedule nodes precisely, so as to reduce the energy consumption for proactive wake-up. For example, if nodes know the exact route of a target, it will be sufficient to awaken those nodes that cover the route during the time when the target is expected to traverse their sensing areas.

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A probability-based target prediction and sleep scheduling protocol (PPSS) to improve the efficiency of proactive wake-up and enhance the energy efficiency with limited loss on the tracking performance. With a target prediction scheme based on both kinematics rules and theory of probability, PPSS not only predicts a target's next location, but also describes the probabilities with which it moves along all the directions. Unlike other physics based prediction work, target prediction of PPSS provides a directional probability as the foundation of differentiated sleep scheduling in a geographical area. Then, based on the prediction results, PPSS enhances energy efficiency by reducing the number of proactively awakened nodes and controlling their active time in an integrated manner. In addition, we design distributed algorithms for PPSS that can run on individual nodes. This will improve the scalability of PPSS for large-scale WSNs. Since PPSS depends on kinematics-based target prediction, it primarily aims at tracking a vehicle that usually moves in a smooth curvilinear trajectory without abrupt direction changes. We evaluated the efficiency of PPSS with both simulation-based and implementation-based experiments.

II. RELATED WORK

In [1] Greedy Perimeter Stateless Routing (GPSR), a novel routing protocol for wireless datagram networks that uses the positions of routers and a packet's destination to make packet for- warding decisions. GPSR makes greedy forwarding decisions using only information about a router's immediate neighbors in the network topology. When a packet reaches a region where greedy forwarding is impossible, the algorithm recovers by routing around the perimeter of the region. By keeping state only about the local topology, GPSR scales better in per-router state than shortest-path and ad-hoc routing protocols as the number of network destinations increases. Under mobility's frequent topology changes, GPSR can use local topology information to find correct new routes quickly The GPSR protocol has been proposed, and use extensive simulation of mobile wireless networks to compare its performance with that of Dynamic Source Routing. [2] The robots that will be needed in the near future are human-friendly robots that are able to coexist with humans and support humans effectively. To realize this, humans and robots need to be in close proximity to each other as much as possible. Moreover, it is necessary for their interactions to occur naturally. It is desirable for a robot to carry out human following, as one of the human-affinitive movements. The human-following robot re- quires several techniques: the recognition of the target human, the recognition of the environment around the robot, and the control strategy for following a human stably. In this research, an intelligent environment is used in order to achieve these goals. An intelligent environment is a space in which many sensors and intelligent devices are distributed. Mobile robots exist in this space as physical agents providing humans with services. A mobile robot is controlled to follow a walking human using distributed intelligent sensors as stably and precisely as possible. The control law based on the virtual spring model is proposed to mitigate the difference of movement between the human and the mobile robot. The proposed control law is applied to the intelligent environment and its performance is verified by the computer simulation and the experiment. In [3] authors propose a new energy- efficient local metric, which is called the efficient advancement metric (EAM), for sensor networks. EAM considers both the maximum forwarding distance and the packet's successful trans- mission probability by taking into account the wireless channel condition. This will enable the forwarding node to choose the most energy-efficient relay node in the geographic-informed routing protocol. Theoretically, we show the existence of the unique optimal relay node to maximize EAM over a typical Nakagami-me channel of a code-division multiple-access (CDMA)-based WSN. Furthermore, based on the proposed metric EAM, we present a cross-layer packet-forwarding protocol channel-aware geographic- informed forwarding (CAGIF) by optimally selecting the relay nodes. CAGIF only requires that nodes have the knowledge of their own location information and the location information of the source and destination nodes. Numerical examples are presented to show the characteristics of EAMand the optimal distance. Compared with the previous geographic packet-forwarding schemes in WSNs, CAGIF consumes much lower energy and generates a significantly decreased signal overhead. In [4] authors propose a novel online routing scheme, called Energy-efficient Beaconless Geographic Routing (EBGR), which can provide loop-free, fully stateless, energy-efficient sensor-to-sink routing at a low communication overhead without the help of prior neighborhood knowledge. In EBGR, each node first calculates its ideal next-hop relay position on the straight line toward the sink based on the energy-optimal forwarding distance, and each forwarder selects the neighbor closest to its ideal next-hop relay position as the next-hop relay using the Request-To-Send/Clear-To-Send (RTS/CTS) handshaking mechanism. We establish the lower and upper bounds on hop count and the upper bound on energy consumption under EBGR for sensor-to-sink routing, assuming no packet loss and no failures in greedy forwarding. Moreover, we demonstrate that the expected total energy consumption along a route toward the sink under EBGR approaches to the lower bound with the increase of node deployment density. In [5] authors addresses an

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approach to estimating the location of a mobile node based on the range measurements of Cricket sensor network (CSN), where the coordinates of the mobile node are calculated via the method of trilateration. There are, in general, two kinds of obstacles to be tackled and overcome in CSN: One is noisy distance measurements, and the other is the low data rates of Cricket sensors. To overcome these problems, authors propose a fusion prediction-based interacting multiple model (FPB-IMM) algorithm. The FPB-IMM algorithm utilizes multiple position measurements produced by trilateration and a self-tuning algorithm; it takes advantage of these multiple measurements to minimize the effect of noisy measurements and the low data rates by modifying a cycle of IMM with fusion prediction.

III. PROPOSED ALGORITHM

A. *Description of the Proposed Algorithm:*

The formal description : GCKNF

Each node sends probe packets to its neighbor nodes and receives the ACK packet from its neighbor nodes (Step 1 of the first part of GCKNF). With that, each node calculates whether it currently satisfies the connected-k neighborhood requirement or not (Step 2 of the first part of GCKNF). If it already belongs to a connected-k neighborhood or its transmission radius is the maximum, the node maintains its transmission radius. Otherwise, the node increases its transmission radius until the connected-k neighborhood appears (Step 3 of the first part of GCKNF). In the second part of GCKNF, the geographic locations (e.g., gu) of each node u and the sink are obtained (Step 1 of the second part of GCKNF) and the each node's neighbor that is nearest to sink is identified (Step 3 of the second part of GCKNF). In the third part of GCKNF, a randomrank ranku of each node u is picked (Step 1 of the third part of GCKNF) and the subset Cu of u's currently awake neighbors having rank >ranku is computed (Step 5 of the third part of GCKNF). Before u can go to sleep, it needs to ensure that 1) all nodes in Cu are connected by nodes with rank <ranku, 2) each of its neighbors has at least k neighbors from Cu, and 3) it is not the neighbor node closest to the sink for any other node (Step 6 of the third part of GCKNF).

The formal description : GCKNA

Each node u also sends a probe packet to each neighbor node and receives the corresponding ACK packet (Step 1 of the first part of GCKNA). Then, whether it currently belongs to a connected-k neighborhood is also checked (Step 2 of the first part of GCKNA). The transmission radius of the node is increased if the connected-k neighborhood requirement is not satisfied and the transmission radius is maintained if the nodes form a connected-k neighborhood or the transmission radius is already the maximum (Step 3 of the first part of GCKNA). In the second part of GCKNA, the geographic distance between itself and the sink granku is picked (Step 1 of the second part of GCKNA) and the subset Cu of u's currently awake neighbors having grank< granku is computed (Step 5 of the second part of GCKNA). Before u can go to sleep, it needs to ensure that 1) all nodes in Cu are connected by nodes with grank < granku and 2) each of its neighbors has at least k neighbors from Cu (Step 6 of the second part of GCKNA).

IV. PSEUDO CODE

GCKNF ALGORITHM :

First: Run the following at each node *u*.

1) Send probe packet p_u to neighbors and receive the ack packet.
2) Compute whether *u*'s current neighbors $CN_u \geq \min(k, d_u)$.
3) Maintain its transmission radius if the above condition holds or its current transmission radius is the maximum. Otherwise, increase its transmission radius until $CN_u \geq \min(k, d_u)$.

Second: Run the following at each node *u*.

1) Get its geographic location g_u and sink location g_s.
2) Broadcast g_u and receive the geographic locations of its all neighbors A_u. Let G_u be the set of these geographic locations.
3) Unicast a flag to w, $w \in A_u$ and g_w is the closest to sink in G_u.

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Third: Run the following at each node *u*.

1) Pick a random rank $rank_u$.
2) Broadcast $rank_u$ and receive the ranks of its currently awake neighbors N_u. Let R_u be the set of these ranks.
3) Broadcast R_u and receive R_v from each $v \in N_u$.
4) If $|N_u| < k$ or $|N_v| < k$ for any $v \in N_u$, remain awake. Return.
5) Compute $C_u = \{v|v \in N_u$ and $rank_v < rank_u\}$.
6) Go to sleep if the following three conditions hold. Remain awake otherwise.
   - Any two nodes in C_u are connected either directly themselves or indirectly through nodes within u's two-hop neighborhood that have *rank* less than $rank_u$.
   - Any node in N_u has at least k neighbors from C_u.
   - It does not receive a flag.
7) Return

GCKNA algorithm

First: Run the following at each node *u*.

1. Send probe packet p_u to neighbors and receive the ack packet.
2. Compute whether u's current neighbors $CN_u \geq \min(k, d_u)$.
3. Maintain its transmission radius if the above condition holds or its current transmission radius is the maximum. Otherwise, increase its transmission radius until $CN_u \geq \min(k, d_u)$.

Second: Run the following at each node *u*.

1. Get its geographic location g_u and sink location g_s. Further get the geographic distance between itself and sink $grank_u$.
2. Broadcast $grank_u$ and receive the geographic distance ranks of its currently awake neighbors N_u. Let R_u be the set of these ranks.
3. Broadcast R_u and receive R_v from each $v \in N_u$.
4. If $|N_u| < k$ or $|N_v| < k$ for any $v \in N_u$, remain awake. Return.
5. Compute $C_u = \{v|v \in N_u$ and $grank_v < grank_u\}$.
6. Go to sleep if both the following conditions hold. Remain awake otherwise.
   a. Any two nodes in C_u are connected either directly themselves or indirectly through nodes within u's two-hop neighborhood that have *grank* less than $grank_u$.
   b. Any node in N_u has at least k neighbors from C_u.
7. Return.

V. SIMULATION RESULTS

The simulation analysis for GCKNA is implemented using Network Simulator NS2
The simulation is done for Energy consumption , Lifetime and Residual energy whose results are shown in Figure 1 ,2 & 3 respectively.

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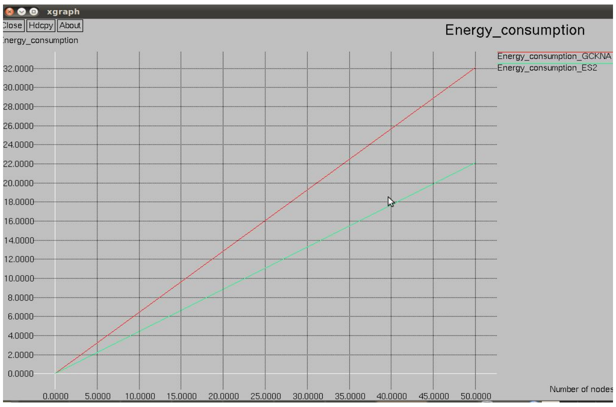

Figure 1 : Energy Consumption

Figure 1 shows that the energy consumption using GCKNA is less when compared to ES2

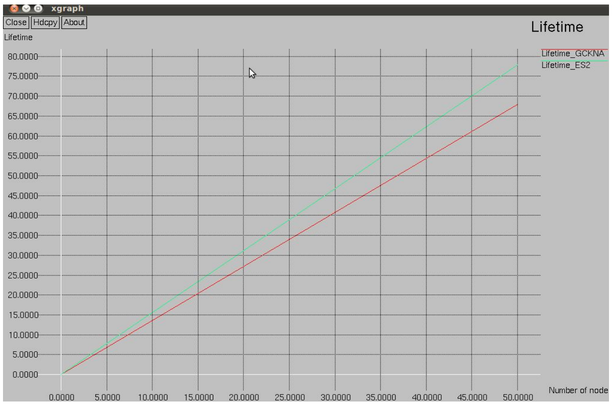

Figure 2 : Lifetime

Figure 2 shows that the lifetime calculated using GCKNA is high when compared to ES2

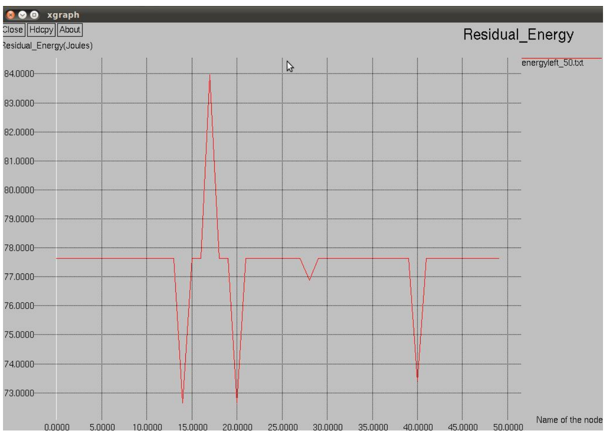

Figure 3 : Residual energy

Figure 3 shows that the residual energy using GCKNA is high

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VI. Conclusion and Future Work

In duty-cycled mobile WSNs, from the view of sleep scheduling, GCKNF and GCKNA do not require the geographic routing to change its original geographic forwarding mechanism, and they both consider the connected-k neighborhood requirement and geographic routing requirement to change the asleep or awake state of sensor nodes. Detailed design of both GCKNF and GCKNA as well as further theoretical analysis and evaluation with respect to GCKNF and GCKNA has been shown in this paper. They demonstrate that GCKNF and GCKNA are very effective in reducing the energy consumption and increasing the lifetime explored by geographic routing in duty-cycled mobile WSNs compared with the CKN sleep scheduling algorithm and the GSS algorithm. In a duty-cycled sensor network, proactive wake-up and sleep scheduling can create a local active environment. To awake the nodes which are in the working condition and change the remaining nodes into sleeping mode. It gives more overhead and delay . The Future scheme selects the nodes to awaken and reduces their active time, so as to decrease the overhead and delay.

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