DATA GATHERING AND ROUTE OPTIMIZATION PROTOCOL FOR MOBILE SINK IN WIRELESS SENSOR NETWORKS

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ABSTRACT

Wireless sensor networks are the grouping of tiny sensor node collects the information by sensing activeness from the surroundings. The way the sinks are not move freely in the deployed space. The pre-calculated trajectories may not applicable. To avoid this constant sink location updating, by using mobile sinks rather than static for data collection is the proposed system. This project is focusing on moving patterns of the mobile sink to achieve optimized network performance, and also collecting a small area of sensed data in the network.

Keywords: Wireless Sensor Networks, Energy Efficiency, Sink Trail and Sink Trail-S

1 INTRODUCTION

WIRELESS Sensor Networks (WSNs) have enabled a wide spectrum of applications through networked low-cost low-power sensor nodes, e.g., habitat monitoring, precision agriculture, and forest fire detection. In these applications, the sensor network will operate under few human interventions either because of the hostile environment or high management complexity for manual maintenance. Since sensor nodes have limited battery life, energy saving is of paramount importance in the design of sensor network protocols. Recent research on data collection reveals that, rather than reporting data through long, multihop, and errorprone routes to a static sink using tree or cluster network structure, Allowing and leveraging sink mobility is more promising for energy efficient data gathering. Mobile sinks, such as animals or vehicles equipped with radio devices, are sent into a field and communicate directly with sensor nodes, resulting in shorter data transmission paths and reduced energy consumption.

Wireless sensor networks promises a wide variety of application and to realize these application real world, we need more efficient protocol and algorithms. Designing a new protocol or algorithm address some challenges which are need to be clearly understood. These challenges are summarized below.

Physical resource constraints: The most important constraint imposed on sensor network is the limited battery power of sensor nodes. The effective life time of a sensor node is directly determined by its power supply. Hence the energy consumption is main design issue of a protocol. Limited computation power and memory size is another constraint that affects the amount of data that can be stored in individual sensor nodes. So the protocol should be simple and light weighted. Communication delay in sensor network can be high due to limited communication channel shared by all the nodes within each other's transmission range.

Ad-hoc deployment: Many applications or most of them requires the ad-hoc deployment of sensor nodes in the region. Sensor nodes are randomly deployed over the region without any infrastructure which requires the system to be able to cope up with random distribution and form connection between the nodes. As an example for fire detection in the forest the nodes typically would be dropped into the forest from a plane. The task management team balances and schedules the sensing tasks given to specific region. Not all sensor nodes in that region are required to perform the sensing task at the same time.

Fault-Tolerance: In a hostile environment, a sensor node may fail due to physical damage or lack of energy. If some nodes fail, the protocols that are working upon must accommodate this change in the network. As an example, rooting or aggregation protocols, they must find suitable paths or aggregation point in case of these kinds of failures.

Scalability: In a region, depending upon the application, the number of sensor nodes deployed could be in the order of hundreds, thousands or more. The protocols must be scalable enough to respond and operate with such large number of sensor nodes

Quality of service: Some sensor applications are very critical which means the data should be delivered within a certain period of time from the moment it is sensed; otherwise the data will be careless. So it could be a QOS parameter for some applications.

2 LITERATURE REVIEW

WSN with static sink [1] is composed of static sensor node and a static sink placed within the determined region. In such a group, the main energy user is the communication element of each node. In observe, multi-hop communication is needed for sending data from sources to sink nodes. Accordingly, the energy utilization depends up on the communication distance. There is a way to reduce the communication distance is to use multiple static sinks [2] and to program every sensor node such it routes data to Trail points the nearest sink. This reduces the average path distance from origin to sink. The authors of [2, 3] propose to deploy multiple static sinks. These static sinks divide the WSN into little sub-fields each with one static sink. However, a significant drawback with multiple static sinks is that one has to decide wherever to deploy them within the monitored region therefore that the data relaying loads well balanced amongst the nodes.

If the positions of the static sinks [4] are given, then the solution of this drawback may be used for locating the best partitioning of the sphere. However, even though we have a tendency to assume location-optimal deployment of static sinks, the nodes near a sink can expand their energy rather speedily. Adding some mobile sinks to a group of static sinks has been shown to boost the data delivery rate and to scale back energy dissipation of the detector nodes [5]. Some of the advantages of multiple static sinks for energy effectiveness can also be accomplished with one static sink by logically partitioning [6] the sensing element field at one level or hierarchically. Such a partitioning is often either static or dynamic, and it are often preset or self-organized among the network. Besides the sector partitioning, the selection of a cluster head in every partition is associate important issue. In order to avoid the dying of nodes near the sink, partitioning of the sector into subareas (clusters) [7] has been investigated. Among every cluster, a cluster head is decided to which native nodes send their knowledge. Cluster heads tend to possess higher capacity than regular nodes and are accountable for forwarding collected knowledge to the sink over single or multiple hops. Both the cluster formation and therefore the choice of the cluster head is finished in such some way that the energy dissipation throughout routing are often reduced [8].This approach may be extended to structure hierarchies [9]. In order to increase the life of the cluster head node, the task of being a cluster head is revolved among a cluster [10]. The cluster head is chosen either stochastically (e.g. [7]) or primarily based on settled methods [6].

3 PROPOSED SYSTEM

SinkTrail, a proactive data reporting protocol that is self-adaptive to various application scenarios, and its improved version, SinkTrail: A Proactive Data Reporting Protocol for Wireless Sensor Networks. SinkTrail-S, with further control message suppression. Main contributions of this paper are in SinkTrail, mobile sinks move continuously in the field in relatively low speed, and gather data on the fly. Control messages are broadcasted at certain points in much lower frequency than ordinarily required in existing data gathering protocols. These sojourn positions are viewed as “footprints” of a mobile sink. Considering each footprint as a virtual landmark, a sensor node can conveniently identify its hop count distances to these landmarks. These hop count distances combined represent the sensor node’s coordinate in the logical coordinate space constructed by the mobile sink.

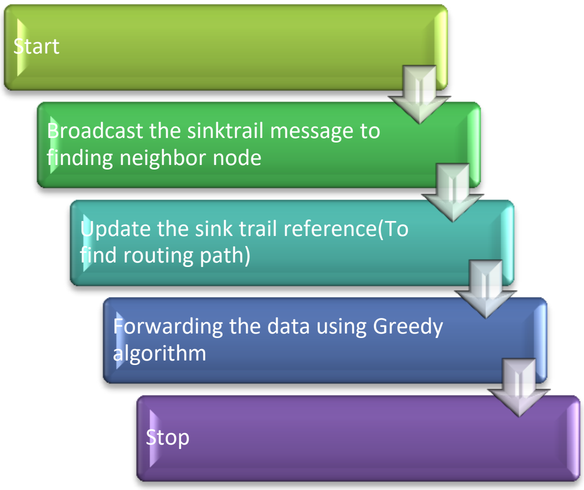


Fig.1. **Data Flow in Mobile sinks**

Similarly, the coordinate of the mobile sink is its hop count distances from the current location to previous virtual landmarks.

The destination coordinate and its own coordinate; each sensor node greedily selects next hop with the shortest logical distance to the mobile sink. As a result, SinkTrail solves the problem of movement prediction for data gathering with mobile sinks. In this paper, the proactive data reporting protocol, SinkTrail, which achieves energy efficient data forwarding to multiple mobile sinks, and effectively reduces the number of sink location broadcasting messages. SinkTrail is unique in two aspects that is it allows sufficient flexibility in the movement of mobile sinks to dynamically adapt to unknown terrestrial changes; and without assistance of GPS or predefined landmarks, SinkTrail establishes a logical coordinate system for predicting and tracking mobile sinks locations, thereby significantly saves energy consumed during the data reporting process. The systematic analyze the impact of several design factors in SinkTrail and explore potential design improvements. The simulation results demonstrate that SinkTrail outperforms the Frequent Flooding Method (FFM) in finding shorter routing path and consumes less energy during data gathering process.

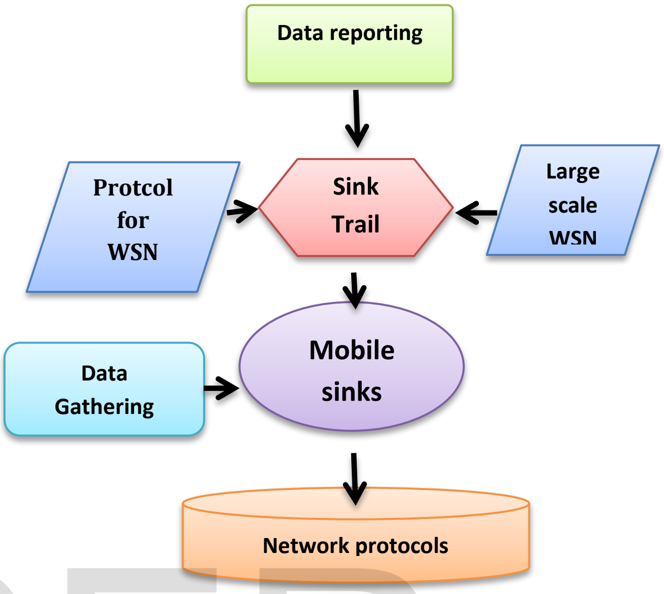


Fig.2. **WSN architecture and SinkTrail with Mobile sink**

4 MODULES

4.1 Network topology Generation

In communication networks, a topology is a usually schematic description of the arrangement of a network, including its nodes and connecting lines. There are two ways of defining network geometry: the physical topology and the logical (or signal) topology. The physical topology of a network is the actual geometric layout of workstations. Logical (or signal) topology refers to the nature of the paths the signals follow from node to node. The number nodes is going to participate in the simulation is decided. Here we conduct experiments to a group of wireless nodes in a network that operates on a suitable protocol. We hence use only a logical topology as it is wireless environment.

4.2 Finding neighbor

During the data gathering process, the mobile sink moves around in N with relatively low speed, and keeps listening for data report packets. It stops at some places for a very short time, broadcasts a message to the whole network, and moves on to another place. We call these places “Trail Points”, and these messages “Trail Messages”. Let τ be the average transmission range. Apparently two adjacent trail points should be separated by a distance longer than τ , otherwise, the hop count information won’t be significantly different. To facilitate the tracking of a mobile sink, we assume that the distances between any two consecutive trail points are same (or similar), denoted as Kτ, K ≥ 1. However, distribution of these trail points doesn’t necessarily follow any pattern.

A trail message from a mobile sink contains a sequence number (msg.seqN) and a hop count (msg.hopC) to the sink. The time interval between a mobile sink stops at one trail point and arrives at the next trail point is called one “move”. There are multiple moves during a data gathering round.

4.3 Destination identification

Sinktrail facilitates the flexible and convenient construction of a logical coordinate space. Instead of scheduling a mobile sink’s movement, it allows a mobile sink to spontaneously stop at convenient locations according to current field situations or desired moving paths. These sojourn places of a mobile sink, named trail points in sinktrail, are footprints left by a mobile sink, and they provide valuable information for tracing the current location of a mobile sink. Considering these footprints as virtual landmarks, hop count information reflects the moving trajectory of a mobile sink. A logical dv- dimensional coordinate space is then established.

4.4 Forwarding data

The data reporting procedure consists mainly two phases. The first phase is called logical coordinate space construction. During this phase, sensor nodes update their trail references corresponding to the mobile sink’s trail messages. After dv hop counts have been collected, a sensor node enters the greedy forwarding phase, where it decides how to report data packets to the sink.

4.5 Performance Evaluation:

During simulation time the events are traced by using the trace files. The performance of the network is evaluated by executing the trace files. The events are recorded into trace files while executing record procedure. In this procedure, we trace the events like packet received, Packets lost, Last packet received time etc. These trace values are write into the trace files. This procedure is recursively called for every 0.05 ms. so, trace values recorded for every 0.05 ms.

5 ASSUMPTIONS AND SIMULATION METHODOLOGY

Protocol Design is consider a large scale, uniformly distributed sensor network IN deployed in an outdoor area. An example deployment Nodes in the network communicate with each other via radio links. We assume the whole sensor network is connected, which is achieved by deploying sensors densely. We also assume sensor nodes are awake when data gathering process starts (by synchronized schedule or a short “wake up” message). In order to gather data from IN, we periodically send out a number of mobile sinks into the field. These mobile sinks, such as robots or vehicles with laptops installed, have radios and processors to communication with sensor nodes and processing sensed data. Since energy supply of mobile sinks can be replaced or recharged easily, they are assumed to have unlimited power.

Algoritm 1. Mobile sink’s strategy

```
/*——Initialization——*/
msg.seqN ← 0;
msg.hopC ← 0;
Announces step size parameter K
/*——Moving strategies——*/
while Not get enough data or Not timeout do
    Move to next trail point;
    msg.seqN ← msg.seqN+1;
    Stop for a very short time to broadcast trail message;
    Concurrently listen for data report packets;
end while
End data gathering process and exit;
```

Destination Identifications is the SinkTrail facilitates the flexible and convenient construction of a logical coordinate space. Instead of scheduling a mobile sink’s movement, it allows a mobile sink to spontaneously stop at convenient locations according to current field situations or desired moving paths. These sojourn places of a mobile sink, named trail points in SinkTrail, are footprints left by a mobile sink, and they provide valuable information for tracing the current location of a mobile sink.

Broadcasting Frequency is the impact of sink broadcast frequency is two sided. If the mobile sink broadcasts its trail messages more frequently, sensor nodes will get more up-to-date trail references, which is helpful for locating the mobile sink. On the other hand, frequent trail message broadcast results in heavier transmission overheads. Suppose the time duration between two consecutive message broadcasting.

Algorithm 2. Trail reference update algorithm

```
while Data gathering process is not over do
    /*——Receive a trail message——*/
    if msg.seqN > λ then
        λ ← msg:seqN;
        Shift $v_i$ to left by one position;
        $e_i^{d_v}$ msg:hopC+1;
        msg.hopC ← msg.hopC +1;
        Rebroadcast message;
    else if msg.seqN =λ then
        Compare $e_i^{d_v}$ with (msg:hopC+1);
        if $e_i^{d_v}$ > (msg:hopC+1) then
```

```
        $e_i^{d_v}$ msg:hopC+1;
        msg.hopC ← msg.hopC +1;
        Rebroadcast message;
      **else**
        Discard the message;
      **end if**
    **else if** msg.seqN < λ **then**
      Discard the message;
    **end if**
**end while**
/*——Reset Variables——*/
For j = 1;...; $d_v$ $e_i^j$ ← -1;
λ ← -1
```

Network Maintains Routing is every sensor node in the network maintains a routing table of size consisting of all neighbors' trail references. This routing table is built up by exchanging trail references with neighbors, and it's updated whenever the mobile sink arrives at a new trail point. Although trail references may not be global identifiers since route selection is conducted locally, they are good enough for the SinkTrail protocol. Because each trail reference has only three numbers, the size of exchange message is small. When a node has received all its neighbors' trail references, it calculates their distances to the destination reference, then greedily chooses the node with the smallest distance as next hop to relay data. If there is a tie the next hop node can be randomly selected.

SinkTrail Protocol is the proposed SinkTrail protocol can be readily extended to multi sink scenario with small modifications. When there is more than one sink in a network, each mobile sink broadcasts trail messages follows. Different from one sink scenario, a sender ID field, mgs ID, is added to each trail message to distinguish them from different senders. Algorithms executed on the sensor node side should be modified to accommodate multi sink scenario as well. Instead of using only one trail reference, a sensor node maintains multiple trail references that each corresponds to a different mobile sink at the same time. When a trail message arrives, a sensor node checks the mobile sink's ID in the message to determine if it is necessary to create a new trail reference. The moving pattern of a mobile sink can affect the energy consumption for data collection, as directional

Algorithm 3. Greedy data forwarding algorithm for multiple mobile sinks

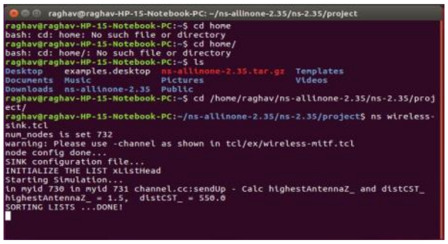
```
/*——Start a timer——*/
**if** All elements of the trail reference are updated **then**
    Start timer $T_i$ = $T_{init}$ - μ × $e_i^{d_v}$
    Exchange trail references with neighbors
**end if**
/*——When timer expires——*/
Set destination as [($d_v$ – 1), . . . , 2, 1, 0]
/*——Probe mobile sink——*/
**if** a mobile sink is within radio range **then**
    Send data to the mobile sink directly
```

```
else
    Compare neighbors trail references with destination reference in already established logical coordinates
    Choose the neighbor closest to any mobile sink as the next hop
    Forward all data to next hop
end if
```

SinkTrail: A Proactive Data Reporting Protocol for Wireless Sensor Networks change in a mobile sink's movement is unavoidable due to occasional obstacles depicted. To numerically model the moves conducted by a mobile sink, we trace the moving trail of a mobile sink on a plain and measure the directional change at each trail point. Specifically, suppose at some time the mobile sink arrives at trail point we define the angular displacement as the angular variation of moving directions.

5 SIMULATION RESULTS

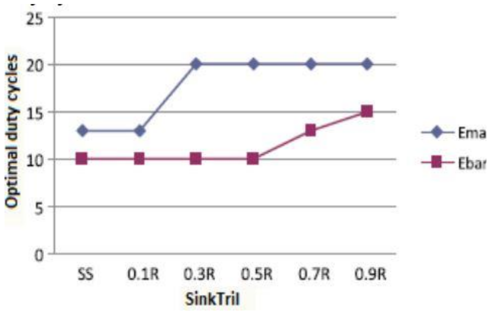
Our simulation shows that a sinkTrial can potential reduce Emax compared to Ebar at the center of the sensor field in particular for longer duty cycle.



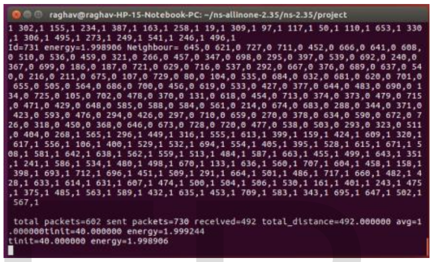
```
raghav@raghav-HP-15-Notebook-PC: ~/ns-allinone-2.35/ns-2.35/project
raghav@raghav-HP-15-Notebook-PC:~$ cd home
bash: cd: home: No such file or directory
raghav@raghav-HP-15-Notebook-PC:~$ cd home/
bash: cd: home/: No such file or directory
raghav@raghav-HP-15-Notebook-PC:~$ ls
Desktop    examples.desktop  ns-allinone-2.35.tar.gz  Templates
Documents  Music             Pictures                 Videos
Downloads  ns-allinone-2.35  Public
raghav@raghav-HP-15-Notebook-PC:~$ cd /home/raghav/ns-allinone-2.35/ns-2.35/proj
ect/
raghav@raghav-HP-15-Notebook-PC:~/ns-allinone-2.35/ns-2.35/project$ ns wireless-
sink.tcl
num_nodes is set 732
warning: Please use -channel as shown in tcl/ex/wireless-mitf.tcl
node config done...
SINK configuration file...
INITIALIZE THE LIST xListHead
Starting Simulation...
in myid 730 in myid 731 channel.cc:sendUp - Calc highestAntennaZ_ and distCST_
highestAntennaZ_ = 1.5,  distCST_ = 550.0
SORTING LISTS ...DONE!
```

Fig .sink configuration

The constant duty cycling the Emax ratio exhibits convex behaviors with various. Exceptions are the extreme duty cycling values, where there is less influence of the Emax ratio. For constant SinkTrail, the Emax ratio also has a convex shape with a clearly visible optimal range for the duty cycle value.



The optimal duty cycle value of the nodes in general increases monotonically with the mobility radius of the sinkTrail.



```
raghav@raghav-HP-15-Notebook-PC: ~/ns-allinone-2.35/ns-2.35/project
1 302,1 155,1 234,1 387,1 163,1 258,1 19,1 309,1 97,1 117,1 50,1 110,1 653,1 330
,1 306,1 495,1 273,1 249,1 541,1 246,1 496,1
Id=731 energy=1.998906 Neighbour= 645,0 621,0 727,0 711,0 452,0 666,0 641,0 608,
0 510,0 536,0 459,0 321,0 266,0 457,0 347,0 698,0 295,0 397,0 539,0 692,0 240,0
367,0 699,0 186,0 187,0 721,0 629,0 716,0 537,0 292,0 667,0 376,0 689,0 637,0 54
0,0 216,0 211,0 675,0 107,0 729,0 80,0 104,0 535,0 684,0 632,0 681,0 620,0 701,0
 655,0 505,0 564,0 686,0 700,0 456,0 619,0 533,0 427,0 377,0 644,0 483,0 690,0 1
34,0 725,0 105,0 702,0 478,0 370,0 131,0 618,0 454,0 713,0 374,0 373,0 479,0 715
,0 471,0 429,0 648,0 585,0 588,0 584,0 561,0 214,0 674,0 683,0 288,0 344,0 371,0
 423,0 593,0 476,0 294,0 426,0 297,0 710,0 659,0 270,0 378,0 634,0 590,0 672,0 7
26,0 318,0 450,0 368,0 646,0 673,0 728,0 720,0 477,0 538,0 503,0 293,0 323,0 511
,0 404,0 268,1 565,1 296,1 449,1 316,1 555,1 613,1 399,1 159,1 424,1 609,1 320,1
 617,1 556,1 106,1 400,1 529,1 532,1 694,1 554,1 405,1 395,1 528,1 615,1 671,1 5
08,1 581,1 642,1 638,1 562,1 559,1 513,1 484,1 587,1 663,1 455,1 499,1 643,1 351
,1 241,1 586,1 534,1 480,1 498,1 670,1 133,1 636,1 560,1 707,1 604,1 458,1 158,1
 398,1 693,1 712,1 696,1 451,1 509,1 291,1 664,1 501,1 486,1 717,1 660,1 482,1 4
28,1 633,1 614,1 631,1 607,1 474,1 500,1 504,1 506,1 530,1 161,1 401,1 243,1 475
,1 375,1 485,1 563,1 589,1 432,1 635,1 453,1 709,1 583,1 343,1 695,1 647,1 502,1
 567,1

 total packets=602 sent packets=730 received=492 total_distance=492.000000 avg=1
.000000tinit=40.000000 energy=1.999244
tinit=40.000000 energy=1.998906
```

Fig.Energy Calculation

In terms of Exam, the energy-optimal duty cycle value increased from around 13% for a sinktrail to around 20% for a sinktrial at a optimal duty cycle.

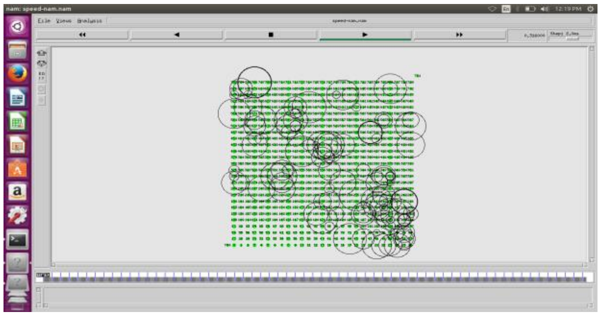


Fig. node sends data to neighborhood node

6 CONCLUSIONS

We have reviewed what has been researched in SinkTrail and its improved version, SinkTrail-S protocol, two low-complexity, proactive data reporting protocols for energy-efficient data gathering. SinkTrail uses logical coordinates to infer distances, and establishes data reporting routes by greedily selecting the shortest path to the destination reference. In addition, SinkTrail is capable of tracking multiple mobile sinks simultaneously through multiple logical coordinate spaces. It possesses desired features of geographical routing without requiring GPS devices or extra landmarks installed. SinkTrail is capable of adapting to various sensor field hopes and different moving patterns of mobile sinks. Further, it eliminates the need of special treatments for changing field situations. We systematically analyzed energy consumptions of SinkTrail and other representative approaches and validated our analysis through extensive simulations. The results demonstrate that SinkTrail finds short data reporting routes and effectively reduces energy consumption. The impact of various design parameters used in SinkTrail and SinkTrail-S are investigated to provide guidance for implementation.

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