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RESEARCH ARTICLE

DYNAMIC DATA GATHERING PROTOCOL IN WIRELESS SENSOR NETWORKS

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Abstract— Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation, and wireless communications capabilities. Recent advances in wireless communications technology and microelectro mechanical systems have enabled the development of low cost, low power, network-enabled, and multifunctional micro sensors. The potential applications of wireless sensor networks (WSNs) span a wide spectrum in various domains, due to their ease of deployment, re-liability, scalability, flexibility, and self-organization. Generally there are three models of WSN: time, on-demand and event driven. In this paper, we propose a hybrid data-gathering protocol which uses the advantages of both the event-driven and time-driven data-reporting schemes. The main aim of our approach is to detect an event of interest in the near future by using adaptive transmission based data-reporting process. Without requiring observer intervention the data from neighboring areas are gathered proactively. The proposed protocol analyzes the environmental changes accurately using moderate resource consumption. The proposed protocol is implemented in network simulator and analyzes its behaviors using synthetic environments that model the occurrence of a fire.

Key Terms: - Adaptive algorithm; embedded software; wireless application protocol; wireless sensor networks

I. INTRODUCTION

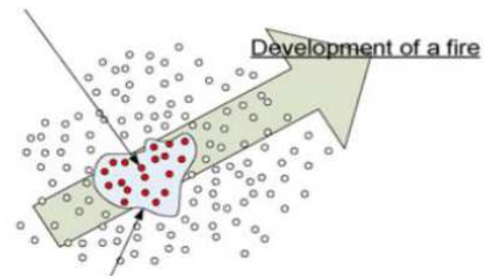
A sensor network is composed of a large number of nodes which are deployed densely in close proximity to the phenomenon to be monitored. Motivated by military applications such as battlefield surveillance, WSNs are becoming increasingly common, in which environmental and technical requirements may differ significantly. Examples of representative WSN applications are military applications [3], environmental monitoring [2], home and office intelligence, and medical care [16].

The purpose of deploying a WSN is to collect relevant data for processing and reporting. In particular, based on data reporting, WSNs can be classified as time-driven, the sensor nodes periodically sense the environment and transmit the data of interest continuously over time, or as on demand, the sensor nodes send data only when they receive a request from the access point or as event-driven, the sensor nodes react immediately to sudden and drastic changes in the value of a sensed attribute due to the occurrence of a certain event [10]. As communication energy is a major contributor to total energy consumption which is determined by the total amount of data and transmission distance, the event-driven data-reporting scheme may lead to reduced energy consumption and thus, prolong the network lifetime. As the amount of received data determines the accuracy level, use of the time-driven data-reporting scheme is more appropriate when higher accuracy is required.

To make a tradeoff between accuracy level and resource consumption, we proposed a hybrid data-gathering protocol that dynamically switches between the time-driven data-reporting scheme and the event-driven data-reporting scheme. The protocol behaves as event driven, from the point at which an event occurs to the point at which the event becomes invalid, and it behaves as time driven, when the sensor nodes detecting the event continuously and send data to an observer, thereby enabling accurate analysis of the environment. This enables the data from potentially relevant areas to be gathered without requiring observer intervention (Fig. 1). Many real-time WSN applications will benefit from the proposed data-gathering protocol, since the proposed protocol accurately analyzes the environment being monitored using only moderate consumption of valuable resources. For our analysis, we consider a forest fire detection system. As soon as a firing occurs, it is immediately reported to an observer because the sensor nodes in the burning area react to the rapid increase in temperature. By continuously receiving raw temperature data from both firing and non-firing neighboring areas, an observer is able to accurately identify where the fire originated, forecast where it may be heading, and determine where the fire extinguishing operation should focus. The same idea can be used in an earth-quake detection system to gather advance readings of seismic waves produced both at the epicenter and in surrounding areas and quickly raise an alarm for earthquake-prone buildings.

The rest of the paper is organized as follows. Section 2 discusses the general approaches of the existing data-gathering techniques in sensor nodes. In Section 3 discusses the proposed scheme, and highlights the schemes that will be then described in detail in the following sections. In Section 4 the experimental of the proposed protocol is discussed. Finally, conclusions and open issues are discussed in Section 5

Sensor nodes with temperature >100^{o}C

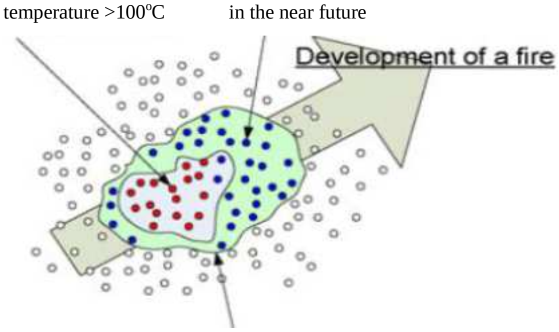


Sensor nodes that are engaged in data reporting process

Fig.1.Event driven data dissemination

Sensor nodes with temperature >100^{o}C

Sensor nodes that will have temperature >100^{o}C in the near future



Sensor nodes that are engaged in data reporting process

Fig .2.Hybrid data dissemination

Fig. 1 and 2 represents the difference in the space domain between a pure event-driven WSN and a proposed hybrid WSN; sensor nodes react when the temperature surpasses 100 °C. (a) Pure event-driven WSN. (b) Proposed hybrid WSN.

II. Related Work

Most of the existing data-gathering techniques used in WSNs focus on routing messages in an energy-efficient manner. To minimize energy consumption, routing protocols proposed in the literature for WSNs employ some well-known routing tactics as well as tactics specific to WNSs, e.g., data aggregation and in-network processing, clustering, different node role assignments, and data-centric methods [3].

A typical WSN consists of hundreds to thousands of sensor nodes deployed over an area; the dense deployment of sensor nodes leads to high correlation of the data sensed by the neigh-boring nodes. Hence, the main idea of data aggregation and in-network processing is to combine the data from different nodes en route by eliminating redundancy, thereby minimizing the number of transmissions. This process ultimately saves energy and prolongs the network lifetime. Examples of routing protocols based on this approach include [5], [6], [11], [18].

Cluster-based routing divides the entire system into distinct clusters, compresses data arriving from nodes that belong to the respective clusters, and sends an aggregated message to the base station. Challenges faced by such a clustering-based approach include how to select the cluster heads and how to organize the clusters. In particular, as it is more likely that cluster heads will drain their batteries faster than cluster members, leading to non-uniform depletion of energy in the sensor network, many studies [7], [9], [14], [15], [19] propose interesting algorithms and mechanisms to handle the different node role assignments. Extensive lists of existing WSN routing protocols can be found in [3] and [10].

An important difference between this work and the above-mentioned research is that we focus on dynamic switching between different data-reporting schemes rather than energy-efficient data dissemination for a given data-reporting scheme in WSNs. Therefore, proposed work can be further enhanced by the use of existing power-aware routing protocols. For instance, data aggregation and in-network process can significantly reduce energy consumption, particularly when many sensor nodes use a time-driven data-reporting scheme.

With regard to the dynamic switching of data-reporting schemes, APTEEN [16] and SINA are previous studies that are closely related to the current research. APTEEN uses a hard and a soft threshold that allow sensor nodes to transmit data only when the sensed attribute is within the range of interest. It also parameterizes the maximum time period between two successive reports sent by a sensor node (i.e., count time) so that the node is forced to transmit sensed data if it has not done so for a long period of time. As such, APTEEN combines reactive and proactive data-reporting schemes. However, in APTEEN, only a parameter in the time domain determines when a proactive data-reporting scheme is used. As a consequence, every sensor node in the network participates in a proactive data-reporting process regardless of its relevance to an event of interest. On the other hand, our approach considers variables in the space and time domains to make such decisions. In doing so, sensor nodes that detect an event of interest or those nodes that are likely to detect the event in the near future become engaged in a proactive data-reporting process.

III. PROPOSED WORK

The features of the hybrid data-gathering protocol proposed in this paper are: 1) it switches dynamically between the event-driven and the time driven data-reporting scheme, and 2) sensor nodes will detect the events in the near future, and also engaged in the time-driven data-reporting process. Under normal conditions, sensor nodes respond only when the temperature is above 100 °C. When the sensor nodes realize that the abnormal condition is not transient (e.g., at tp and tx), they switch to the time-driven data-reporting scheme and continuously broadcast temperature data to an observer. Also, they monitor the changes of other nodes so that neighboring nodes continuously broadcast data as well. The nodes switch back to the event-driven data-reporting scheme, when the temperature goes below 100 °C (e.g., at tq and ty),

In order to determine the switching between the two data-reporting schemes and which sensor nodes to involve in the time-driven data-reporting process, we need a mechanism. Depending on the above mentioned requirements, in this paper, two algorithms are presented: the parameter-based event detection (PED) algorithm and the parameter-based area detection (PAD) algorithm.

<u>Algorithm:</u>

Step 1: Set the threshold value α, Initialize the current and previous threshold values over the corresponding time intervals (Scurr, Sprev)

Step 2: Choose the mode of operation (event or time driven)

<u>For Event driven</u>:

Step 3: If the threshold variable over current time window is greater than or equal to α and pervious value counter variables p&q are incremented by one, or If Scurr is greater than or equal to α and less than pervious value then only q is incremented by one.

Step 4: Otherwise initialize the counter values p & q as zero.

Step 5: If both the counter variables are greater than starting values of their corresponding values then switch to “Time driven mode”.

<u>For Time driven</u>:

Step 3: If the threshold variable over current time window is less than α and pervious value counter variables p&q are incremented by one, or if Scurr is less than α and less than pervious value then only q is incremented by one.

Step 4: Otherwise initialize the counter values p & q as zero.

Step 5: If both the counter variables are greater than stop values of their corresponding values then switch to "Event driven mode".

```
PED{ α , pstart, Qstart , Pstop, Qstop }
{
If(current mode is event driven)
{
 if (Scurr≥Sprev)
{
if  (scurr≥α)
else P=0;
q++;
}
else
p=q=0;
switch to "continuous" mode
if((p>pstart) or (q>Qstart))
switch to continuous mode
}
else
if (Scurr< α)
if (Scurr≤<Sprev) p++
else p=0;
q++;
}
else
 p=q=0;
if((p>Pstop) or (q >Qstop)
switch to "event driven" mode
}
}
```

Fig.3.Proposed Algorithm

3.1. PED Algorithm:

The PED algorithm in Fig. 3 is given a threshold vale and two pairs of parameters controlling the level of aggressiveness for changes in data dissemination schemes. When the cluster numbers are the sensor nodes that actually sense the physical conditions, the threshold value determines what percentage of sensor nodes within the same cluster detects the event. Otherwise the percentage of lower level clusters reporting in a continues manner is used for the threshold value. Each pair of parameter (Pstart,Qstart) and (Pstop,Qstop), is used to determine when to start or stop the continuous data dissemination, respectively. Start denotes maximum number of time intervals with an increasing slop of the threshold variable, and Qstart denotes the maximum number of time interval that the threshold is exceeded, regardless of the slope. Similarly, when Pstart and Qstart are used a decreasing slop of the threshold variable and the time intervals that do not exceed the threshold variable are applied respectively.

3.2. PAD Algorithm:

Once a sensor node decided to switch the data dissemination scheme the next decision to make is which sensor node must be affected by that decision in our approach the pad algorithm deals with the cluster members as a whole. In other words when the data dissemination scheme is selects by a cluster head then all of the sensor nodes within the cluster will be directed to report data in that manner. Our simple approach is based on the argument that the closer a sensor node is located to the sensor nodes that detect an event ,the more likely it is that the sensor node is relevant to that event in the near future, as clusters are typically form according to proximity. For instance the current temperature measured by sensor nodes located close to the fire , say may not be high enough to trigger an event but would be much higher than those of nodes tens of miles away from the fire therefore the possibility that those sensor nodes soon trigger the event becomes high. But this approach may not work very well in some cases for instance if sensor nodes detecting an event are located at the border between cluster those nodes in other clusters can be included only when enough clusters at the same level have initiated continuous data dissemination.

Once a sensor node switches to the time-driven data reporting scheme, it broadcasts its change to engage neighboring sensor nodes in the continuous data dissemination. The range of the neighborhood is determined by the PAD algorithm, which is based on two configurable parameters: time-to-live (TTL) and valid time (VT). TTL represents the number of hops within which sensor nodes must switch to the time-driven data-reporting scheme. The use of TTL in the PAD algorithm is similar to that in computer network technology, where TTL specifies the number of hops that a message can travel to before it should be discarded. When a sensor node receives a broadcast message containing a TTL value that is greater than zero, it switches to the time-driven data-reporting scheme and rebroadcasts a TTL value decremented by one. This process continues until the TTL value becomes zero. This approach is based on the argument that the nearer a sensor node is located to the sensor nodes that detect an event, the more likely it is that the sensor node will be relevant to that event in the near future since sensor nodes are formed according to proximity. For instance, the current temperature measured by sensor nodes located close to the fire may not be high enough to trigger an event, but it would be much higher than those of nodes tens of miles away from the fire. Therefore, the possibility that the closely located sensor nodes will detect an event in the near future increases. VT is the other important parameter of the PAD algorithm, and it specifies how long a sensor node should use the time driven data-reporting scheme regardless of the result of its PED algorithm. Note that VT is used only for those sensor nodes that are switched to the time-driven data-reporting scheme by TTL. The necessity of VT arises from the fact that sensor nodes in the vicinity of the area where an event occurs may not yet detect the event. Therefore, without VT, they could immediately switch back to the event-driven data reporting scheme, losing the chance to acquire important information in advance.

This approach behaves well in multiple event-detection environments, in which sensor nodes are capable of sensing different attributes through simple modification of the PAD algorithm. For instance, a sensor node executes the PED algorithm for each sensed attribute and broadcasts its switching to the time-driven data-reporting scheme to neighboring nodes accordingly. By sending not only TTL and VT but also the type of attribute that caused the switching, the sensor node allows neighboring nodes to determine what type of data they need to collect in a time-driven manner.

IV. EXPERIMENTAL RESULTS

In order to evaluate the effectiveness of our approach, the hybrid data-gathering protocol on a JProwler network simulator [12], an event-driven wireless network simulator written in Java is implemented. The simulator can operate in either the deterministic mode to produce replicable results while testing an application or in the probabilistic mode to simulate the nondeterministic nature of the communication channel and the low-level communication protocol of the sensor nodes. The simulation was performed on a network of 100 sensor nodes and a fixed base station. The nodes were placed randomly in the network, and it was assumed that they do not change position.

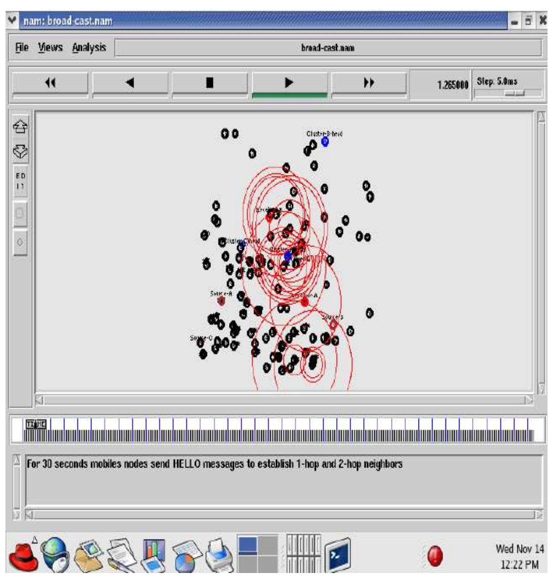


Fig .4 Generation of nodes

Fig 4 represents the simulation results for generating 100 nodes for 30 seconds to send hello message to establish 1- hop and 2-hop neighbors.

Fig 5 shows the comparison results of the performance of hybrid and event driven data dissemination schemes.

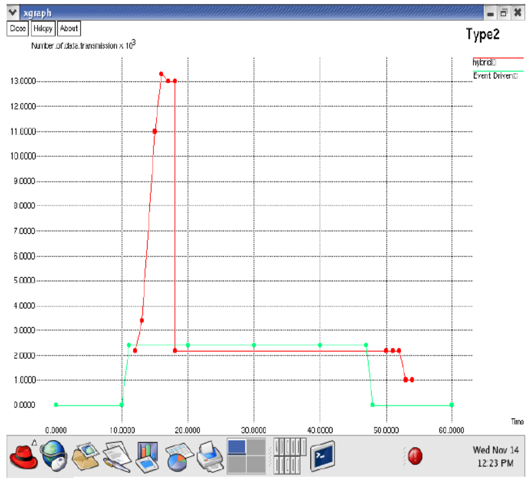


Fig.5 Comparison of data dissemination scheme

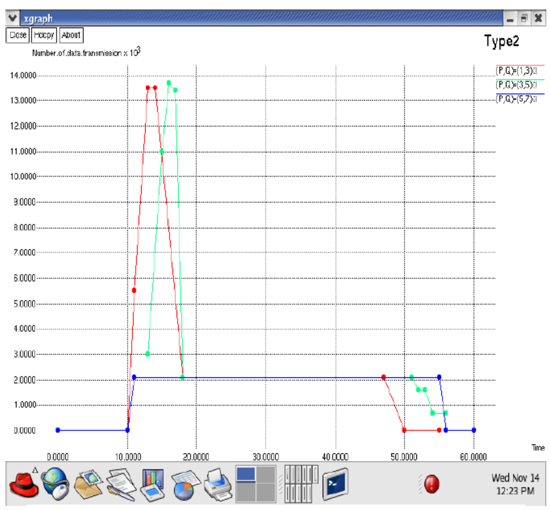


Fig.6 Comparison of data dissemination scheme with various p & q values

Fig 6 represents the data transmission schemes for various p and q values.

V. CONCLUSION AND FUTURE WORK

In this paper we propose a hybrid data dissemination system that dynamically switches between a continuous data dissemination scheme and an event driven data dissemination scheme. The benefit of the system is that it enables fast and accurate analysis of the environment being monitored with moderate consumption of energy. The hybrid algorithm achieves data achieves data accuracy and adequate data for detailed analysis at moderate resource consumption. Based on the application requirement, the threshold for the switching between event driven and time driven can be adjusted. The future work lies in several areas first we plan to investigate the validity of our approach using simulation in addition the pad algorithm has some limitations. Therefore one of our future research objectives is to develop adaptive algorithm to overcome such limitations.

REFERENCES

[1] Byoung-Dai Lee and Kwang-Ho Lim "An Energy-Efficient Hybrid Data-Gathering Protocol Based on the Dynamic Switching of Reporting Schemes in Wireless Sensor Networks" IEEE Systems Journal 2011.
[2] I. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks: A survey," IEEE Comput. Netw., vol. 38, no. 4, pp. 393–422, Mar. 2002.
[3] J. Al-Karaki and A. Kamal, "Routing techniques in wireless sensor networks: A survey," IEEE Wireless Commun., vol. 11, no. 6, pp. 6–28, Dec. 2004.
[4] S. Bilouhan and R. Gupta, "Optimization of power consumption in wireless sensor networks," Int. J. Sci. Eng. Res., vol. 2, no. 5, pp. 1–5,May 2011.
[5] D. Braginsky and D. Estrin, "Rumor routing algorithm for sensor networks," in Proc. 1st Workshop Sensor Netw. Applicat., 2002, pp. 22– 31.
[6] M. Chu, H. Haussecker, and F. Zhao, "Scalable information-driven sensor querying and routing for ad hoc heterogeneous sensor networks," Int. J. High Performance Comput. Applicat., vol. 16, no. 3, pp. 293–313, 2002.
[7] Q. Fang, F. Zhao, and L. Guibas, "Lightweight sensing and communication protocols for target enumeration and aggregation," in Proc. 4th ACM Int. Symp. Mobile Ad Hoc Netw. Comput., 2003, pp. 165–176.
[8] A. Goldsmith and S. Wicker, "Design challenge for energy-constrained ad hoc wireless networks," IEEE Wireless Commun., vol. 9, no. 4, pp. 8–27, Aug. 2002.
[9] W. Heinzelman, A. Chandrakasan, and H. Balakrishnam, "Energy efficient communication protocol for wireless microsensor networks,"in Proc. 33rd Hawaii Int. Conf. Syst. Sci., 2000, pp. 10–19.
[10] M. Iiayas and I. Mahgoub, Eds., Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems. Boca Raton, FL: CRC Press,2005.
[11] C. Intanagonwiwat, R. Govindan, and D. Estrin, "Directed diffusion: A scalable and robust communication paradigm for sensor networks," in Proc. ACM Int. Conf. Mobile Comput. Netw., 2000, pp. 102–114.
[12] JProwler Network Simulator [Online]. Available: http://www.isis. vanderbilt.edu/projects/nestjprowler/index.html
[13] J. Kulik and W. Balakrishnan, "Negotiation-based protocols for disseminating information in wireless sensor networks," Wireless Netw., vol. 8, nos. 2–3, pp. 169–185, 2002.
[14] Q. Li, J. Aslam, and D. Rus, "Hierarchical power-aware routing in sensor networks," in Proc. DIMACS Workshop Pervasive Netw., May 2001.
[15] S. Lindsey and C. Raghavendra, "PEGASIS: Power-efficient gathering in sensor information systems," in Proc. IEEE Aerospace Conf., Mar. 2002, pp. 1125–1130.
[16] A. Manjeshwar and D. Agarwal, "ATEEN: A hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks," in Proc. Int. Symp. Parallel Distrib. Process., 2002, pp. 195– 202.
[17] G. Pottie and W. Kaiser, "Wireless integrated network sensors," Commun. ACM, vol. 33, no. 5, pp. 51–58, 2000.
[18] A. Rasheed and R. Mahapatra, "An energy-efficient hybrid data collection scheme in wireless sensor networks," in Proc. 3rd Int. Conf. Intell. Sensors, Sensor Netw., Inform., 2007, pp. 703–708.
[19] V. Rodoplua and T. Meng, "Minimum energy mobile wireless networks," IEEE J. Sel. Areas Commun., vol. 17, no. 8, pp. 1333–1344, Aug. 1999.

