Energy Efficient Routing Using Sleep Scheduling and Clustering Approach for Wireless Sensor Network

G.Premalatha[1], T.K.P.Rajagopal[2]
Computer Science and Engineering Department, Kathir College of Engineering
Neelambur,Coimbatore-641062.

Abstract: Providing reliable and efficient communication under fading channels is one of the major technical challenges in wireless sensor networks (WSNs), especially in industrial WSNs (IWSNs) with dynamic and harsh environments. In the development of various large-scale Wireless Sensor Network, a challenging problem is how to dynamically organize the sensors network and route sensed information from the field sensors to a target system. A target tracking system is required to continuous monitoring, 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. The motivation of the work proposed to develop an energy efficient target tracking schemes. Toward this objective, the project uses a new energy-efficient dynamic optimization-based sleep scheduling and target prediction technique for large scale sensor networks. A probability-based prediction sleep scheduling protocol (PPSS) and Clustering approach is proposed to improve energy efficiency. A cluster-based scheme is used for optimization-based sleep scheduling. Finally, the effectiveness of the proposed approach is evaluated and compared with the other protocols.

Keywords*:* Clusters, Energy efficiency, Industrial wireless sensor networks (IWSNs), Sleep Scheduling, Target Tracking.

I. INTRODUCTION

A Wireless Sensor Network (WSN) consists of spatially distributed are deployed to monitor the sensing field and gather information from physical or environmental condition, such as temperature, sound, vibration, pressure, motion or pollutants and to co-operatively pass their data through the network to a main location.

Traditionally, two approaches can be adopted to accomplish the data collection task: Direct communication, and Multi-hop forwarding. In the sensor nodes upload data directly to the sink through one-hop wireless communication, which may result in long communication distances and degrade the energy efficiency of sensor nodes. On the other hand, with multi-hop forwarding, data are reported to the sink through multiple relays, and the communication distance is reduced. However, since nodes near the sink generally have a much heavier forwarding load, their energy may be depleted very fast, which degrades the network performance.

The applications of WSNs can be found in diverse areas such as military (e.g., battle field surveillance), environmental protection (e.g., habitat monitoring), healthcare (e.g., telemonitoring of human physiological

ISSN: 2278 – 7798

data), and home automation. Sensor nodes in a WSN constitute a wireless ad-hoc network, with one or a few sink nodes as the collection point(s) and bridge(s) to the base station(s). Every node in the network may create data periodically, on demand of base stations, or triggered by events. At the same time, every node may forward data that it receives toward sink nodes, which are often multiple hops away.

II.BACKGROUND INFORMATION

This chapter mainly reviews the background information on energy efficiency, target tracking using probability prediction, and sleep scheduling.

A. Target Tracking

As one of the most important applications of WSNs, target tracking was widely studied from many perspectives. First, tracking was studied as a series of continuous localization operations in many existing efforts. Secondly, target tracking was sometimes considered as a dynamic state estimation problem on the trajectory, and Bayesian estimation methods, e.g., particle filtering, were used to obtain optimal or approximately optimal solutions.

Thirdly, in some cases, target tracking was considered as an objective application when corresponding performance metrics, e.g., energy efficiency or real-time feature, were the focus. Fourthly, a few efforts were conducted based on real implementation, and emphasized the actual measurement for a tracking application. Finally, a few target tracking efforts did not explicitly distinguish tracking from similar efforts, such as detection and classification.

B. Target Prediction

Typical techniques for target prediction include kinematics-based prediction, dynamics-based prediction and Bayesian estimation methods.

Kinematics and dynamics are two branches of the classical mechanics. Kinematics describes the motion of objects without considering the circumstances that cause the motion, while dynamics studies the relationship between the object motion and its causes. In fact, most of past work about target prediction uses kinematics rules as the foundation, even for those that use Bayesian estimation methods.

C. Energy Efficiency

Since energy efficiency is a critical feature of WSNs, it has been extensively studied either independently or jointly with other features. Besides these efforts, energy efficiency is also considered as a constraint when designing algorithms or protocols for WSNs.

In the authors proposed, analyzed and evaluated the energy consumption models in WSNs with probabilistic distance distributions to optimize grid size and minimize energy consumption accurately. The models were also used to study variable-size grids, which can further improve the energy efficiency by balancing the relayed traffic in wireless sensor networks

D. Sleep Scheduling

In the past, there were many existing research efforts about sleep scheduling to prolong the network lifetime of WSNs. But since the first dissertation problem focuses on sleep scheduling for energy efficient target tracking, we mainly review those efforts that integrate sleep scheduling and target prediction.

ISSN: 2278 – 7798

III. EXISTING SYSTEM

Reliable Reactive Routing Enhancement (R3E) is used to increase the resilience to link dynamics for WSNs/IWSNs. This design inherits the advantages of opportunistic routing, thus achieving shorter end-to-end delivery delay, higher energy efficiency, and reliability. R3E is designed to augment existing reactive routing protocols to combat the channel variation by utilizing the local path diversity in the link layer. It propose a simple yet effective cooperative forwarding scheme. Along the discovered virtual path, data packets can be greedily forwarded toward the destination through nodes' cooperation without utilizing location information.

In this work, Reliable Reactive Routing Enhancement (R3E) to increase the resilience to link dynamics for WSNs/IWSNs. R3E is designed to enhance existing reactive routing protocols to provide reliable and energy-efficient packet delivery against the unreliable wireless links by utilizing the local path diversity. Specifically, we introduce a biased backoff scheme during the route-discovery phase to find a robust guide path, which can provide more cooperative forwarding opportunities. Along this guide path, data packets are greedily progressed toward the destination through nodes' cooperation without utilizing the location information.

R3E remarkably improves the packet delivery ratio, while maintaining high energy efficiency and low delivery latency. This design inherits the advantages of opportunistic routing, thus achieving shorter end-to-end delivery delay, higher energy efficiency, and reliability. R3E is designed to augment existing reactive routing protocols to combat the channel variation by utilizing the local path diversity in the link layer.

IV. PROPOSED SYSTEM

Our proposed work, present 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.

In spite of the diverse applications, WSNs face a number of unique technical challenges due to their inherent energy and bandwidth limitations, ad hoc deployment, and unattended operation, etc.,. Unfortunately, very little previous works on distributed systems can be applied to WSNs, since the underlying assumptions have changed dramatically. Therefore, innovative energy-aware, scalable, and robust algorithms for distributed signal processing in WSNs are highly required. A problem that is closely related is the localized topology control, which maintains energy-efficient network connectivity by controlling the transmission power at each node, or selecting a small subset of the local links of a node.

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. Target tracking in WSNs has been studied extensively. Due to the limited sensing capability and limited resources for communications and computation, collaborative resource management is required to trade-off between the tracking accuracy. Therefore, energy-efficient target tracking should improve the tradeoff between energy efficiency and tracking

ISSN: 2278 – 7798

performance—e.g., by improving energy efficiency at the expense of a relatively small loss on tracking performance. For target tracking applications, idle listening is a major source of energy waste. To reduce the energy consumption during idle listening, duty cycling is one of the most commonly used approaches. The idea of duty cycling is to put nodes in the sleep state for most of the time, and only wake them up periodically. In certain cases, the sleep pattern of nodes may also be explicitly scheduled, i.e., forced to sleep or awakened on demand. This is usually called sleep scheduling.

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. Based on target prediction, it is possible 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 but not achieve that much target performance.

A.PPSS Design

PPSS is designed based on proactive wake up: when a node (i.e., alarm node) detects a target, it broadcasts an alarm message to proactively awaken its neighbor nodes (i.e., awakened node) to prepare for the approaching target. To enhance energy efficiency, we modify this basic proactive wake-up method to sleep schedule nodes precisely. Specifically, PPSS selects some of the neighbor nodes (i.e., candidate node) that are likely to detect the target to awaken. On receiving an alarm message, each candidate may individually make the decision on whether or not to be an awakened node, and if yes, when and how long to wake up. We utilize two approaches to reduce the energy consumption during this proactive wake-up process:

1. Reduce the number of awakened nodes.
2. Schedule their sleep pattern to shorten the active time.

First, the number of awakened nodes can be reduced significantly, because:

1) Those nodes that the target may have already passed during the sleep delay do not need to be awakened;

2) Nodes that lie on a direction that the target has a low probability of passing by could be chosen to be awakened with a low probability. For this purpose, we introduce a concept of awake region and a mechanism for computing the scope of an awake region.

Second, the active time of chosen awakened nodes can be curtailed as much as possible, because they could wake up and keep active only when the target is expected to traverse their sensing area. For this purpose, we present a sleep scheduling protocol, which schedules the sleep patterns of awakened nodes individually according to their distance and direction away from the current motion state of the target.

B. Clustering Approach

Besides, a cluster-based scheme is proposed, where sensors are statically divided into clusters, and each cluster consists of a single Cluster Head (CH) and a bunch of slave sensors. At every sampling instant, only one

ISSN: 2278 – 7798

cluster of sensors is triggered to track the target. Resource consumption of the network is thus restricted to the activated cluster, where intra cluster communication is dramatically reduced so achieves optimization based sleep scheduling. Therefore, the cluster activation phase has a great importance not only in minimizing resource consumption but also in tracking accuracy. First, all the CHs need to measure the distances between the target and themselves at every sampling instant; then, a comparison among them is required to choose the nearest one. When a target enters the wireless sensor network, the CH that detects the target becomes active while other nodes are in sleep mode. Then the active CH selects sensor nodes of its members for tracking in which one node is selected as Leader node. The selected nodes sense the target and current target location is calculated.

In this approach sensor nodes are selected each time in which nodes calculates its distance from the moving object and sends the data to the leader node. The localization of the moving object is done by leader node whereas in previous methods it's done by CH. Using prediction based clustering method energy consumed in the network will be reduced since the transmission power of the nodes is directly proportional to the distances. The nodes selected for tracking are close to each other, thus the energy consumed for sending a data between the nodes is lower than sending a data from one of the selected nodes to its CH.

In this work, a system is developed in such a way that target tracking in WSN is done in efficient way using an energy efficient prediction- based clustering algorithm. Energy efficient prediction based Clustering algorithm, reduces the average energy consumed by sensor nodes and thereby increase the lifetime of the network. The tracking of the moving object is accurately done.

V. PERFORMANCE METRICS

- Packet drop = Number of packets sent – Number of packets received
- Packet delivery ratio = (Number of packets received/ Number of packets sent)*100
- Energy consumption = Average energy consumption on idle, sleep, transmit & received/ Total energy consumed
- Throughput = Number of packets at destination side at a particular time.
- Delay = (Interval of 1^{st} packet delivery time & 2^{nd} packet delivery time)/ Total data packet delivery time

VI. SIMULATION RESULTS

The simulation analyses for PPSS-R3E while the data transmission and certificate revocation based security is implemented using Network Simulator NS2. The simulation is done by comparing the PPSS-R3E protocol with the AODV and R3E protocols. The simulation is done for Packet delivery ratio, Packet Drop, End-to-End Delay, Energy Consumption, and Throughput using PPSS-R3E whose results are shown in Figure 1, 2, 3, 4 & 5 respectively.

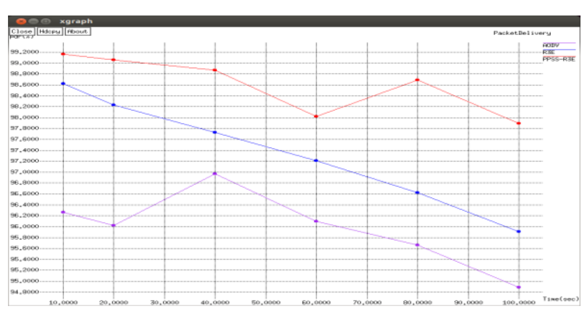

Fig. 1 Packet Delivery Ratio

ISSN: 2278 – 7798

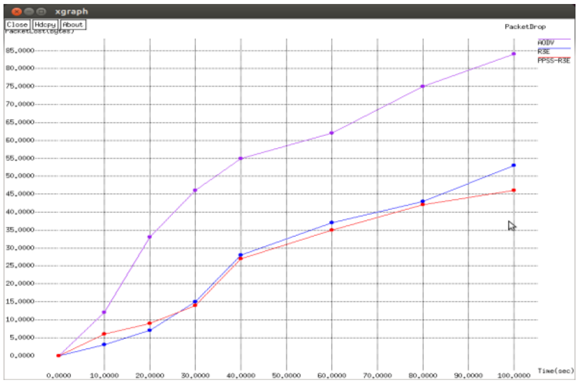

Fig. 2 Packet Drop

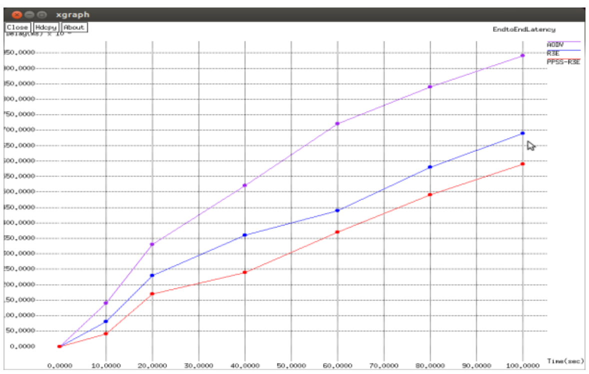

Fig. 3 End-to-End Latency

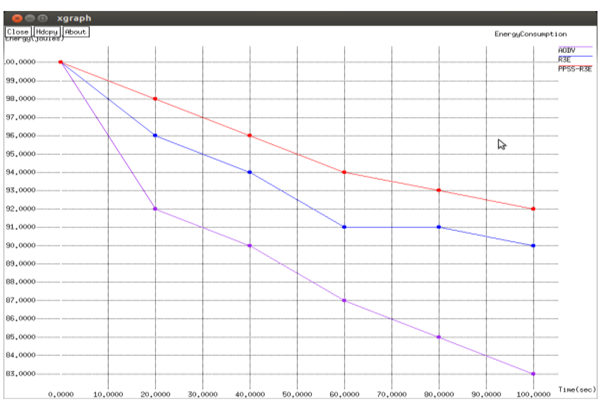

Fig. 4 Energy Consumption

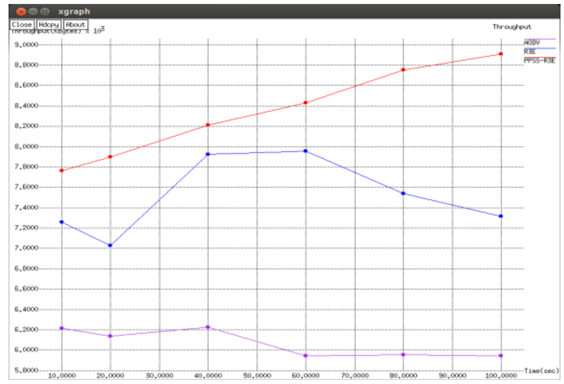

Fig. 5 Throughput

VII. CONCLUSION AND FUTURE WORK

In this project a system is developed in such a way that target tracking in WSN is done in efficient way using an energy efficient prediction based sleep scheduling algorithm. In a duty-cycled sensor network, proactive wake up and sleep scheduling can create a local active environment to provide guarantee for the tracking performance. By effectively limiting the scope of this local active environment (i.e., reducing low value-added nodes that have a low probability of detecting the target), PPSS improves the energy efficiency with an acceptable loss on the tracking performance. Given some limitations in tracking accuracy, the potential future work includes optimization-based sleep scheduling and target prediction for abrupt direction changes. We improve Energy efficiency with an acceptable loss on the tracking performance and increase the through put, packet delivery ratio and reduce the packet drop so in future we can further optimize the PPSS protocol to increase the through put and tracking performance. In this work, a system is developed in such a way that target tracking in WSN is done in efficient way. The proposed protocol reduces the average energy consumed by sensor nodes and thereby increase the lifetime of the network.

ISSN: 2278 – 7798

In future enhancement, we will study to optimize the number of levels to efficiently consume the energy of all nodes and improve the network lifetime. We can further optimize the PPSS protocol to increases the throughput, decreases the drop packets and increases the packet delivery ratio and tracking performance ratio.

REFERENCES

[1] Akyildiz .I.F, Su .W, Sankarasubramaniam .Y, and Cayirci.E, (2002) "Wireless Sensor Networks: A Survey," Computer Networks, vol. 38, no. 4, pp. 393-422.
[2] Brownfield .M.I, Mehrjoo.K, Fayez .A.S, and Davis IV .N.J (2006) "Wireless Sensor Network Energy-Adaptive MAC Protocol" IEEE Communications Society subject matter experts for publication in the IEEE CCNC proceedings.
[3] Cao .Q, Yan .T, Stankovic .J, and Abdelzaher .T, (2005) "Analysis of Target Detection Performance for Wireless Sensor Networks," Proc. Int'l Conf. Distributed Computing in Sensor Systems (DCOSS), pp. 276-292.
[4] Fuemmeler .J and Veeravalli.V, (2008) "Smart Sleeping Policies for Energy Efficient Tracking in Sensor Networks," IEEE Trans. Signal Processing, vol. 56, no. 5, pp. 2091-2101.
[5] Gui.C and Mohapatra.P, (2004) "Power Conservation and Quality of Surveillance in Target Tracking Sensor Networks," Proc. 10th Ann. Int'l Conf. Mobile Computing and Networking, pp. 129-143.
[6] Gu.Y and He.T, (2007) "Data Forwarding in Extremely Low Duty-Cycle Sensor Networks with Unreliable Communication Links," Proc. Fifth Int'l Conf. Embedded Networked Sensor Systems (SenSys '07), pp. 321-334.
[7] Meenakshi Diwakar1and Sushil Kumar2, „AN ENERGY EFFICIENT LEVEL BASED CLUSTERING ROUTING PROTOCOL FOR WIRELESS SENSOR NETWORKS‟, Vol 2, No.2, April 2012.
[8] Bo Jiang, Student Member, Binoy Ravindran, Senior Member, and Hyeonjoong Cho, Member, „Probability-Based Prediction and Sleep Scheduling for Energy-Efficient Target Tracking in Sensor Networks‟,VOL. 12, NO. 4, APRIL 2013
[9] Network simulator [Online]. Available: http://www.isi.edu/nsnam/ns/
[10] "Hart Specification," [Online]. Available: http://www.hartcomm.org
[11] "Isa-100, Wireless Systems for Automation," [Online]. Available: http://www.isa.org/isa100

ISSN: 2278 – 7798