iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 1 **Issue:** IV **Month of publication:** November 2013

DOI:

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AND ENGINEERING TECHNOLOGY (IJRASET)

Maximizing Network Lifetime of Wireless Sensor Network-A Review

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Abstract

Wireless sensor networks are becoming increasingly important in recent years due to their ability to detect and convey real-time information for many civilian and military applications. Wireless sensor network deployed thousand of nodes in not easily accessible places that operate with batteries. It can be difficult or impossible to replace or recharge the batteries of the sensor nodes. So to maximize the network lifetime has become a big challenge in the Wireless network. This paper presents a brief survey on various techniques employed for maximizing network lifetime of a wireless sensor networks. We also address some other challenges related to network lifetime of wireless sensor networks that need to be considered in future designs.

Keywords: Wireless Sensor Networks (WSN), Battery allocation, energy efficient, LEACH, Genetic Algorithm (GA), Global Positioning System (GPS).

I.INTRODUCTION

A Wireless sensor network is composed of tens to thousands of sensor nodes which are densely deployed in a sensor field and have the capability to collect data and route data back to base station. Wireless Sensor Network is used in many application now a days, such as detecting and tracking troops, tanks on a battlefield, measuring traffic flow on roads, measuring humidity and other factors in fields, tracking personnel in buildings. A key challenge in Wireless Sensor Networks (WSNs) is that of extending the lifetime of these networks while maintaining certain coverage goals. Some of the other challenges of wireless networks are:

1 Power Management.

2 Localization.

3 Routing.

4 Deployment techniques.

A.Power Management

A sensor network is composed of large number of sensors nodes that are densely deployed either inside the environment or close to it. The position need not be predetermined. Application of WSN are Military, natural calamities, health and more. Sensor network compared to ad hoc network, are limited in power, computational capacity and memory.

B. Localization

Determining the location of sensors is a challenge. Location information is used to detect and record event or to route packets using geometric aware routing. Manual configuration of location is not feasible for large scale network or network where sensor may move. Providing each sensor with localization hardware GPS is expensive in terms of cost and energy consumption more reasonable solution to the localization problem is to allow some nodes to have location information at all times and allow other nodes to infer their location by exchanging information with seeds.

C. Routing

Routing techniques are required for sending data between sensor nodes and the base stations for communication. Routing protocols might differ depending on the application and network architecture.Different routing protocols are proposed for wireless sensor network. These protocols are classified according to different parameters.

D. Deployment techniques

Node deployment in wireless sensor network affects the complexity of problem and it also extends the lifetime of network by minimizing energy computation. Random and deterministic node deployments are done under following metrics: coverage, energy computation and message transfer delay.

II. Network lifetime

Network lifetime can be defined as the capability of a network to serve its design purpose or the lifetime of the network is defined as the amount of time that the network can satisfy its coverage objective, i.e., the amount of time that the network can cover its area or targets of interest. Having all the sensors remain "on" would ensure coverage but this would also significantly reduce the lifetime of the network as the nodes would discharge quickly. There can be mainly two approaches to maximizing network lifetime. An indirect approach to minimize energy consumption. Another one is direct approach to maximizing network lifetime.

A. Indirect approach

This approach focuses on minimize energy consumption, and help in extending the network lifetime but it does not precisely address the problem of maximizing lifetime. Recharging of a node battery is generally possible. Although solar and wind energy can be used, such energy supplies are not reliable. So we use indirect methods by reducing energy consumption. Scheduling the sensing activity mean when to activate a sensor activity for sensing and when to keep it idle. One approach based on the sensor activity scheduling techniques is to divide all sensors into disjoint sensor subsets or sensor covers and each sensor cover need to satisfy the coverage constraints. Only one sensor cover is to activate to provide the functionality and the remaining sensor covers are in the sleeping mode.

1. Packet based model

In this model we assume that power only consumed when transmitting packets in Wireless network. Wireless nodes are powered to receive incoming packets and decode to decide if the packet should be accepted; forwarded or discarded. Although many packets turn out to be simply discarded, their reception has already consumed a significant amount of energy. In packet based model network lifetime is considered as number of packet that can be delivered by the network.

2. Time based model

This model states the energy is also consumed in overhearing and idle periods. In some extreme cases where Wireless nodes stay idle and no communication happens at all energy is consumed in idle period on a per time unit basis. So we need to turn off as many transceivers as much as possible. To put it off means to switch to sleep mode. In sleep mode we can avoid energy in overhearing and idle state. Communication is done by a backbone composed of nodes that are not in sleep mode .A sleeping node awakes when needed, that part of energy consumption can be handled by packet based model. In this model network lifetime is defined as the time until no such backbone can be formed.

B. Direct approach

This approach directly focus on maximize network lifetime by considering battery allocation.WSN lifetime depends on the distribution of power among nodes in addition to average power consumption. The locations of sensor nodes are often carefully controlled in real deployment in order to reduce the cost. It is feasible to equip nodes with battery packs with different capacities based on their computation and communication requirements. In [3] author proposed the motivation towards battery allocation for WSN with arbitrary topologies, node configuration and power distribution.

WSN lifetime depends on the distribution of power among nodes in addition to average power consumption. There is a large body of work on reducing node power consumption. The most frequently described techniques are power state

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control [2], hardware –software co-design [4], as well as clustering and compression [6].Work attempting to spatially balance power consumption and communication tasks more evenly among sensor nodes. However real WSN deployment may use heterogeneous sensor nodes. For example Hou.et. al [16] deployed heterogeneous sensor nodes to construct a two tier infrastructure to prolong WSN lifetime. Furthermore the locations of sensor nodes are often carefully controlled in real deployment in order to reduce the cost. It is feasible to equip nodes with battery packs with different capacities, based on their computation and communication requirements.

III. Related Work

A. Scheduling

Scheduling is done to minimize energy consumption. Minimizing energy in highly dense WSN needs to maximize off duty nodes. Scheduling is when to activate a sensor node and when to keep it idle. One approach based on sensor activity scheduling is to divide all sensors into disjoint sensor subset or sensor cover and each sensor cover need to satisfy the coverage constraints. Only one sensor cover is active to provide the functionality and the remaining sensors are in the sleeping mode.

Once the active sensor runs out of energy then another sensor cover is selected to enter the active mode and provide the functionality and remaining sensor nodes are in the sleeping mode. The network activity can be divided in rounds, and at the beginning of each round active sensor nodes are decided. The objective was to minimize the number of active nodes in each time period. A Genetic Algorithm [7] is introduced for point coverage problems. An enhanced GA is proposed, aiming at solving disjoint set cover s problem for maximizing the lifetime. The Schedule Transition Hybrid Genetic Algorithm (STHGA) can be applied to both point coverage and area coverage disjoint set cover problem for maximizing lifetime of network. STHGA has a special feature that it adopts a forward encoding scheme for the representation of chromosomes in the population and uses some effective genetic and sensor schedule transition operations.

B. Energy efficient routing

Extensive research has been done on energy efficient data gathering and information dissemination in sensor networks. Some well-known energy efficient protocols were developed, such as Directed Diffusion [17] and LEACH [18]. Recently, a clustering architecture is used to improve the lifetime of two-tiered sensor networks. The proposed approximation algorithm [9] starts with an arbitrary tree. And iteratively reduces the load on overloaded nodes. Constructing data gathering trees in both grid and general graphs was studied in [19]. Authors proposed a Minimal Steiner Tree based algorithm which provides a constant approximation ratio for grid graphs, and a randomized algorithm which guarantees a poly logarithmic performance bound for general graphs.

C.On/off scheduling

Another important technique used to prolong the lifetime of sensor networks is the introduction of switch on/off modes for sensors. The best method for conserving energy is to turn off as many sensors as possible, while still keeping the system functioning. An analytical model was proposed in [14] to analyse network capacity and data delivery delay, against the sensor dynamics in on/off modes. The proposed algorithm [9] achieves 0.73 of the maximal lifetime. The on/off scheduling was studied in target (point) coverage in wireless sensor networks. The problem is to find the maximum number of subsets of sensors (a sensor can appear in several subsets), such that each subset can sufficiently cover all targets in the region.

Existing work has studied scheduling sensors into a sleep-sense cycle based on simple greedy criteria or by using centralized optimization techniques. The improved distributed algorithms can be designed by paying attention to the inherent dependency that exists between different cover sets since they share sensors in common. These heuristics represent a 20-30% increase in the network lifetime over the existing work which uses greedy criteria to make scheduling decisions. In [5] a node scheduling scheme is proposed which can reduce system overall energy consumption by turning off some redundant nodes.

A framework [10] is proposed to maximize the lifetime of the wireless sensor network (WSN) by using a mobile sink when the underlying applications tolerate delayed information delivery to the sink. Within a prescribed delay tolerance level, each node does not need to send the data immediately as they become available. Instead, the node can store the data temporarily and transmit them when the mobile sink is at the most favourable location for achieving the longest WSN lifetime. To find the best solution within the proposed framework, we formulate optimization problems that maximize the lifetime of the WSN subject to the delay bound constraints, node energy constraints and flow conservation constraints.

IV. Conclusion

In this paper we have highlighted the challenges of wireless sensor networks. Maximizing lifetime is one of the major issues in these networks. We have studied the network lifetime can be considered as the time model, or as packet model. In this paper we also reviewed some of the various direct and indirect approaches for maximizing network lifetime.

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