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ENERGY CONSERVATION OF WSNS THROUGH DIFFERENT CLUSTERING ALGORITHMS

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Abstract: Wireless sensor network (WSN) needs an energy conservation communication protocols to reduce the energy consumption as much as possible. But the lifetime of sensor network greatly affected due to the battery of a node. Radio irregularity and fading in multihop WSN also affect lifetime of a sensor. Various cluster-based schemes are proposed as a solution for this problem. The proposed schemes focus on the clustering of network for conserve the energy of a network. The performance of the proposed system is evaluated in terms of energy efficiency and reliability**.**

Keywords: Cluster, Wireless sensor networks, Energy parameter, Node, Cluster head.

INTRODUCTION

Wireless sensor networks are one of most challenging topics in computer science, and biotechnology research. Wireless sensor networks are networks in which thousands of small and battery powered nodes communicate with each other through their sensing capabilities. Energy is a major design constraint in sensor networks. Due to this constraint the sensing capability of sensor nodes reduces and their bandwidth limit. Channel fading and radio irregularity further pose big challenge on the design of energy efficient communication protocols in wireless network [2].

These networks can contain hundreds or thousands of sensing nodes. It is desirable to make these nodes as cheap and energy-efficient as possible and rely on their large numbers to obtain high quality results. So protocols must be designed to achieve fault tolerance in the presence of individual node failure while minimizing energy consumption. In addition, since the limited wireless channel bandwidth must be shared among all the sensors in the network [3].

In order to save energy, it is common for sensor nodes to self-organize into clusters periodically, in which one sensor is selected as cluster head. The cluster head is responsible for the organization of the cluster, data collection and aggregation within the cluster, as well as transmission of the aggregated data to the sink [4].

PEGASIS protocol presented in [5] form a chain including all nodes in the network using greedy algorithm so that each nodes transformed to and received from a neighbor. In each round, randomly selected node takes turns to transmit the aggregated information to the base station. Nodes in TEEN and APTEEN are designed to respond to sudden changes in the sensed attribute when node exceed a user defined threshold. They assume that position of the base station is fixe and every node in the network directly communicates to base station. OEDSR is an demand protocol for wsns that minimizes a different link cost factor which is defined using available energy, end to end delay, and distance from to a base station.

The main idea of LEACH protocol is that all nodes are chosen to be the cluster heads periodically, and each period contains two stages with construction of clusters as the first stage and data communication as the second stage [7]. MIMO systems can dramatically reduce the transmission energy consumption in wireless fading channels .In those schemes, multiple individual single-antenna nodes cooperation information transmission and/or reception for energy efficient communications [8]. This paper is organized as follows: Section II describes the various clustering protocols. Finally section III concludes the paper.

RELATED WORK

WSN is regarded as an emerging technology that combines the concept of wireless network with sensors [11]. Significant advances in microelectronics technology, computing and wireless communications reduce the energy consumption, improve the ability of communication and extend functions of WSNs continuously, which also reflect the basic characteristics of WSNs. Wireless sensor network comprises of hundreds to thousands of small nodes employed in a wide range of data gathering applications such as military, environmental monitoring and many other fields [2]. There are many factors which affect the energy consumption of wireless sensors networks. Because the concept of wireless sensor networks is based on a simple equation:

Sensing + CPU + Radio = Thousands of potential applications.

When wireless sensor networks sense the data it consumes energy. When C.P.U processes the data it consumes energy. So there are various techniques and protocols purposed for reducing the energy consumption. MIMO systems can dramatically reduce the transmission energy consumption in wireless fading channels [2]. Cooperative transmission and reception of data among sensors is known to diminish the per-node energy consumption, increasing the network lifetime [10]. In these schemes, multiple individual single antenna nodes cooperate on data transmission and reception for energy efficient communication.

However cooperative MISO performs only single hop transmission and does not prolong the network lifetime. To overcome these draw backs, the proposed model modifies the LEACH protocol [1] and allows cluster heads to form a multihop backbone and incorporates the cooperative MIMO scheme on each single hop transmission by utilizing a set of sending and receiving cooperative nodes in each cluster. For the proposed model, the energy consumed and the number of nodes alive for each round of data transmission is evaluated. Due to the limited energy and difficulty to recharge a large number of sensors, energy efficiency and maximizing network lifetime have been the most important design goals for wireless sensor networks (WSNs). However, channel fading, interference, and radio irregularity pose big challenges on the design of energy efficient communication in the WSNs [2]. Cooperative MIMO schemes have been proposed for WSNs to improve communication performance [2]. In those schemes, multiple individual single-antenna nodes cooperate on information transmission and/or reception for energy efficient communications.

Reducing Energy Consumption Based on Geographic Adaptive Fidelity (GAF)

Y. Xu, J. Heidemann, and D. Estrin presented a GAF protocol [12]. It is an energy-aware routing protocol primarily proposed for MANETs, but can also be used for WSNs because it favors energy conservation. The design of GAF is motivated based on an energy model [13, 14] that considers energy consumption due to the reception and transmission of packets as well as idle (or listening) time when the radio of a sensor is on to detect the presence of incoming packets. GAF is based on mechanism of turning off unnecessary sensors while keeping a constant level of routing fidelity (or uninterrupted connectivity between communicating sensors). In GAF, sensor field is divided into grid squares and every sensor uses its location information, which can be provided by GPS or other location systems [13], to associate itself with a particular grid in which it resides. This kind of association is exploited by GAF to identify the sensors that are equivalent from the perspective of packet forwarding.

Reducing Energy Consumption Based on Geographic and Energy-Aware Routing (GEAR)

GEAR [20] is an energy-efficient routing protocol proposed by Y. Yu, R. Govindan, and D. Estrin for routing queries to target regions in a sensor field, In GEAR, the sensors are supposed to have localization hardware equipped, for example, a GPS unit or a localization system [20] so that they know their current positions. Furthermore, the sensors are aware of their residual energy as well as the locations and residual energy of each of their neighbors. GEAR uses energy aware heuristics that are based on geographical information to select sensors to route a packet toward its destination region. Then, GEAR uses a recursive geographic forwarding algorithm to disseminate the packet inside the target region.

Reducing Energy Consumption Based on Linked Cluster Algorithm (LCA)

Linked Cluster Algorithm (LCA) LCA [15, 17], was one of the very first clustering algorithms developed by A. Amis, R. Prakash, T. Vuong, and D. Huynh,. It was initially developed for wired sensors, but later implemented in wireless sensor networks. In LCA, each node is assigned a unique ID number and has two ways of becoming a clusterhead. The first way is if the node has the highest ID number in the set including all neighbor nodes and the node itself. The second way, assuming none of its neighbors are cluster heads, then it becomes a clusterhead.

Reducing Energy Consumption Based on Linked Cluster Algorithm (LCA2)

Linked Cluster Algorithm 2 (LCA2) [15], [16]: LCA2 was proposed by P. Tsigas to eliminate the election of an unnecessary number of clusterheads, as in LCA. In LCA2, they introduce the concept of a node being covered and non-covered. A node is considered covered if one of its neighbors is a clusterhead. Clusterheads are elected starting with the node having the lowest ID among non-covered neighbors.

Reducing Energy Consumption Based on Highest-Connectivity Cluster Algorithm

Highest-Connectivity Cluster Algorithm presented by P. Tsigas [15]: This algorithm is similar to LCA. In this scheme the number of node neighbors is broadcast t o the surrounding nodes. The result is that instead of looking at the ID number, the connectivity of a node is considered. The node with the highest connectivity (connected to the most number of nodes) is elected clusterhead, but in the case of a tie, the node with the lowest ID prevails.

Reducing Energy Consumption Based on Max-Min D-Cluster Algorithm

With Max-Min D cluster, A. Amis, R. Prakash, T. Vuong, and D.Huynh [18] propose a new distributed clusterhead election procedure, where no node is more than d (d is a value selected for the heuristic) hops away from the clusterhead. This algorithm provides load balancing among clusterheads. The clusterhead selection criteria are developed by having each node initiate 2d rounds of flooding, from which the results are logged. Then each node follows a simple set of rules to determine their respective clusterhead. The 1st d rounds are called flood max, used to propagate the largest node ids. After this is complete, the 2nd d rounds of flooding occur. This round is called floodmin, used to allow the smaller node ids to reclaim some of their territory. Then each node evaluates the logged entries following the rules listed below [18]:

- Rule 1: Each node checks to see if it has received its own id in the 2nd d rounds of flooding. If it has, then it can declare itself the clusterhead and skip the other rules. Otherwise it proceeds to Rule 2.
- Rule 2: Each node looks for node pairs. Once this is complete, it selects the minimum node pair to be the clusterhead. If a node pair does not exist, they proceed to Rule 3.
- Rule 3: Elects the maximum node id in the 1st d rounds of flooding as the clusterhead for this node.

Reducing Energy Consumption Based on low Energy Adaptive Clustering Hierarchy Algorithm

W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan purposed a Low-Energy Adaptive Clustering Hierarchy (or LEACH) protocol. It was one of the first major improvements on conventional clustering approaches in wireless sensor networks. Conventional approaches algorithms such as MTE (Minimum-Transmission-Energy) [] or direct-transmission do not lead to even energy dissipation throughout a network. LEACH provides a balancing of energy usage [18] by random rotation of clusterheads. The algorithm is also organized in such a manner that data-fusion can be used to reduce the amount of data transmission. The decision of whether a node elevates to clusterhead is made dynamically at each interval. The elevation decision is made solely by each node independent of other nodes to minimize overhead in clusterhead establishment [24]. This decision is a function of the percentage of optimal clusterheads in a network (determined a priori on application), in combination with how often and the last time a given node has been a clusterhead in the past. The threshold function is defined as

$$T(n) = \begin{cases} \frac{P}{1-P*(r mod \frac{1}{P})} & \text{if n} \in \text{G} \\ 0 & \text{otherwise} \end{cases}$$

Where n is the given node, P is the a priori probability of a node being elected as a clusterhead, r is the current round number and G is the set of nodes that have not been elected as clusterheads in the last 1/P rounds. Each node during clusterhead selection will generate a random number between 0 and 1. If the number is less than the threshold (T(n)), the node will become a clusterhead. Following elevation to clusterhead, the new clusterhead will broadcast its status to neighboring nodes. These nodes will then determine the optimal clusterhead (in terms of minimum energy required for transmission) and relay their desire to be in that particular cluster.

Reducing Energy Consumption Based on Two level low Energy Adaptive Clustering Hierarchy Algorithm:

Two-Level Hierarchy LEACH (or TLLEACH) is a proposed extension to the LEACH algorithm. V. Loscri, G. Morabito, and S. Marano utilized two levels of cluster heads (primary and secondary) in addition to the other simple sensing nodes. In this algorithm, the primary cluster head in each cluster communicates with the secondaries, and the corresponding secondaries communicate with the nodes in their sub-cluster. Data-fusion can also be performed as in LEACH. In addition, communication within a cluster is still scheduled using TDMA time-slots. The organization of a round will consist of first selecting the primary and secondary cluster heads using the same mechanism as LEACH, with the a priori probability of being elevated to a primary cluster head less than that of a secondary node. Communication of data from source node to sink is achieved in two steps [20]:

1) Secondary nodes collect data from nodes in their respective clusters. Data-fusion can be performed at this level.

2) Primary nodes collect data from their respective secondary clusters. Data-fusion can also be implemented at the primary cluster head level. The two-level structure of TL-LEACH reduces the amount of nodes that need to transmit to the base station, effectively reducing the total energy usage [20].

CONCLUSION

The various power management protocols illustrated by many researchers as explained above have been suggested to improve the performance of battery for sensor nodes. They presented various characteristics of wireless sensor networks to improve the performance which makes them reliable and stable. The parameters which are basically included energy, sensing.. These protocols are used in many applications of wireless sensors networks.

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