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Multi-hop Sub-clustering Approach for Energy Saving in Wireless Sensor Network

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Abstract

Clustering is an efficient technique for prolonging the lifetime of wireless sensor networks. This paper proposes a multi hop Sub clustering algorithm (MHSC) for energy saving in wireless sensor networks. In MHSC each cluster is further divided into sub-cluster and now in every sub-cluster, there should be a sub-cluster head. The node which is far away from the cluster head will now transmit data to the sub cluster head and from the sub-cluster head to the cluster head and then to the sink..

Keywords: Clustering, Cluster-heads, Multi Hop sub-clustering, Network-lifetime, Energy-efficiency, Network throughput, Connectivity and Wireless Sensor network

1. Introduction

Wireless sensor network is an emerging field for research in today's world. Wireless sensor networks have vast potential for usage of sensor networks in different areas like military area, disaster management, sensing environment conditions such as temperature, humidity etc. In wireless sensor networks, as no. of sensor nodes are used for communication which mainly forms a sensing field and sink (Base station).

A Wireless Sensor Network or WSN is supposed to be made up of a large number of sensors and at least one base station. The sensors are autonomous small devices with several constraints like the battery power, computation capacity, communication range and memory. They also are supplied with transceivers to gather information from its environment and pass it on up to a certain base station, where the measured parameters can be stored and made available for the end user.

In most cases, the sensors forming these networks are deployed randomly and left unattended to and are expected to perform their mission properly and efficiently. As a result of this random deployment, the WSN has usually varying degrees of node density along its area. Sensor networks are also energy constrained since the individual sensors, which the network is formed with, are extremely energy-constrained as well. The communication devices on these sensors are small and have limited power and range.

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1.1 ROUTING PROTOCOLS IN WSN

Many routing protocols have been proposed for WSNs. These have been classified into

three categories, namely:

- Data-centric protocols

- Hierarchical protocols

- Location-based protocols

Data-centric protocols are query-based and use the concept of naming of desired data to eliminate many redundant transmissions.

Hierarchical protocols cluster the nodes so that cluster heads can aggregate and reduce the data to save energy.

Location-based protocols use position information to send the data to only desired regions rather than to the whole network. The more important ones among these are SPIN,

LEACH, LOAD BALANCING, TEEN and APTEEN.

1.2 ADVANTAGES OF WSN

1) They can store a limited source of energy.

2) They have no hassle of cables and have mobility.

3) It can work efficiently under harsh conditions and has large deployment capacity.

4) It can be accessed through a centralized monitor.

5) It can accommodate new devices at any time.

6) It's flexible to go through physical partitions.

7) Sensor networks allow a system to be extended from one with basic functions to one

that can receive and act on data about the environment it operates in.

8) Easy to use the same Internet connection for more than one PC.

2. Literature Survey

In [1] Tavleen and Jaspreet described that wireless sensor networks have become an important research area in the field of computers and electronics in the last decade .The original motivation for the development of wireless sensor networks was military applications such as battlefield surveillance. However there are number of other applications of wireless sensor networks such as healthcare monitoring, forest fire detection, environment monitoring, home automation..

In [2] I. F. Akyildiz et al describe the surveys recent routing protocols for sensor networks and presents a classification for the various approaches pursued. The three main categories explored in this paper are data-centric, hierarchical and location-based. Each routing protocol is described and discussed under the appropriate category. Moreover, protocols using contemporary methodologies such as network flow and QoS modeling are also discussed. The paper concludes with open research issues...

In [3] In WSN, it is too difficult to initialize the sensor nodes and manage the sensor networks due to the large number of sensor nodes, which may number tens of thousands. Moreover, in order to save energy, sensor nodes carry out data aggregation and compression before sending data to the base station, and execute energy efficient routing. So in this research work Amit Sharma Dr. S. N. Panda et al analyzed that cluster based routing technique is the best energy efficient routing technique comparing to any other techniques.

In [4] Hanh Le, Audrey Mbogho et al described that A wireless sensor network (WSN) consisting of a large number of tiny sensors can be an effective tool for gathering data indiverse kinds of environments. The data collected by each sensor is communicated to the base station, which forwards the data to the end user.

Clustering is introduced to WSNs because it has proven to be an effective approach to provide better data aggregation and scalability for large WSNs.

In [5] Yajie Ma, Yike Guo et al. proposed an –local spatial clustering algorithm for sensor networks. By measuring the spatial correlation between data sampled by different sensors, the algorithm constructs a dominating set as the sensor network backbone used to realize the data aggregation based on the information description/summarization performance of the dominators. In order to evaluate the performance of the algorithm a pattern recognition scenario over environmental data is presented.

DATA AGGREGATION

In [6] it is more important in the case of Wireless Sensor Networks (WSNs) where collected data often requires in-network processing and collaborative computing. In this paper, Arijit Ukil analyzes a scenario where data aggregation needs to be done in privacy- preserved way for distributed computing platform. There are number of data sources which collect or produce data. The data collected or produced by the sources is private and the owner or the source does not like to reveal the content of the data. But the collected data from the source is to be aggregated by an aggregator, which may be a third party or part of the network, where the data sources belong.

In [7] the data aggregation is a widely used energy-efficient mechanism in wireless sensor Networks (WSNs), by avoiding the redundant data transmitting to base station. The privacy of a sensor data ensures, it is known only to itself and the integrity guarantees sensor data has not tampered during data aggregation. The Integrity Protecting Privacy preserving Data Aggregation (IPPDA) protocols ensures robust and accurate results at thebase station.

In [8] Jyoti and naveen analyzed that Wireless Sensor Network Data Aggregation is an important technique to achieve power efficiency in the sensor network. In some application such as: wireless sensor network, data mining, cloud computing data aggregation is widely used. Because sensor node has limited battery power so data aggregation techniques have been proposed for wireless sensor networks. In this survey paper they described various protocols for securing aggregated data in wireless sensor networks.

LEACH PROTOCOL

In [9] Wendi Rabiner Heinzelman et al propose LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station.

In [10] Jamal N. Al-Karaki Ahmed E Kamal explained that LEACH randomly selects afew sensor nodes as cluster heads(CHs) and rotate this role to evenly distribute the energy load among the sensor in the network. In LEACH, the cluster head nodes compress data arriving from nodes that belong to the respective cluster, and send the aggregate data to BS in order to reduce the amount of information that must be transmitted to base station. Although LEACH is able to increase the network lifetime .there are still number of issues about the assumptions used in the protocol.

- LEACH is not suitable for networks deployed in large areas.

- On the other hand, in LEACH, the aggregation of data is centralized and is performed periodically. However, in some cases, the periodic transmission of data may not be necessary, which exhausts rapidly the limited energy of sensors.

- Data is send to base station at every round. so power consumption is high

In [11] to improve the limitations of LEACH, Yassein, M.B., Al-zoubi, proposed a new version of LEACH, called LEACH-M. In this, members of cluster may be more of a leap from their corresponding cluster-head and communicate with it in multi-hop fashion. However, this proposed version requires each sensor must be able to aggregate data, which increase the overhead for all sensors.

The LEACH considers all nodes are homogeneous with respect to energy, which is not realistic approach. In particular round uneven nodes are attached to multiple Cluster-head; in this case cluster-head with large number of member ode will drain its energy as compare to cluster-head with smaller number of associated member nodes. Furthermore mobility support is another issue with LEACH routing protocol, to mitigate these issues, M-LEACH is proposed [10].

In [12] Salim EL KHEDIRI Nejah NASRI et al described the LEACH-C. It is similar to LEACH protocol. In this, instead of nodes randomly self- selecting as a CH, the in LEACH performs a centralized algorithm. The sink collects location data from the nodes and they broadcast its decision of which nods are to act as CH. The overall performance

LEACH is better than LEACH.

But once the energy cost of communicating with the sink becomes higher than the energy cost for cluster formation, LEACH-C no longer provides good performance. Sinks may be located far from the network in most WSN applications.

In [13] Abdulsalam, H.M., Ali, B.A proved that Weighted Low Energy Adaptive Clustering Hierarchy Aggregation (W-LEACH), is a centralized data aggregation algorithm. As in LEACH, W-LEACH is consists of two phases.

1) Sep-up phase

2) Steady-state phase

In the setup phase, W-LEACH first calculates a weight value, wi, and assigns it to each sensor. The selection of CH is based on the calculated weights, such that the higher the weights the better the chance for them to be CHs. unlike LEACH, W-LEACH does not take into consideration whether or not this sensor was a CH for previous near rounds In steady-state phase, the candidates for sending data to CHs are also chosen based on their weights, such that sensors with less weight are better candidates to send data to their CHs to make sure that the areas with low densities and far from their CHs are covered.

In [14] New version of LEACH protocol has been proposed, the cluster contains; CH (responsible only for sending data that is received from the cluster members to the BS), vice-CH (the node that will become a CH of the cluster in case of CH dies), cluster nodes (gathering data from environment and send it to the CH). Cluster nodes data will always reach the BS; no need to elect a new CH each time the CH dies. This will extend theoverall network life time.

LOAD BALANCING PROTOCOL:

In [15] Hetal Rana et.al explained that the area of Wireless Sensor Networks (WSNs) is one of the fast growing and emerging field in the scientific and engineering world. It is an ad-hoc network that consists of small nodes with sensing, computing and communicating wireless abilities. These sensor nodes are densely deployed in the sensor field environments. The environment can be an Information Technological framework, a physical world, or a biological system. The main objective of WSN is to sense the crucial information from the environment depending on the type of application for which it is deployed and send this information to its Base Station (BS) so that it can take corrective actions. These Sensor Nodes communicate with each other via various Routing Protocols. Protocols in WSNs are broadly classified as Flat, Hierarchical and Location Based routing protocols.

This paper presents hierarchical routing protocol, Power Efficient Gathering in Sensor Information Systems (LOAD BALANCING) and a comparative study on various versions of Load balancing protocols.

In [16], Stephanie Lindsey and Cauligi S. Raghavendra described PEGASIS, a greedy chain protocol that is near optimal for a data-gathering problem in sensor networks. Load balancing outperforms LEACH by eliminating the overhead of dynamic cluster formation, minimizing the distance non leader-nodes must transmit, limiting the number of transmissions and receives among all nodes, and using only one transmission to the BS per round. Nodes take turns to transmit the fused data to the BS to balance the energy depletion in the network and preserves robustness of the sensor web as nodes die at random locations. Distributing the energy load among the nodes increases the lifetime and quality of the network. Simulations show that Load balancing performs better than LEACH by about 100 to 300% when 1%, 20%, 50%, and 100% of nodes die for different network sizes and topologies. Load balancing shows an even further improvement as the size of the network increases.

In [17], Wenjing Guo, Wei Zhang, Gang Lu proposes a routing protocol for the applications of Wireless Sensor Network (WSN). It is a protocol based on the Load balancing protocol but using an improved ant colony algorithm rather than the greedy algorithm to construct the chain. Compared with the original Load balancing, this one, PEGant, can achieve a global optimization. It forms a chain that makes the path more even-distributed and the total square of transmission distance much less. Moreover, in the constructing process, the energy factor has been taken into account, which brings about a balance of energy consumption between nodes. In each round of transmission, according to the current energy of each node, a leader is selected to directly communicate with the base station (BS). Simulation results have shown that the proposed protocol significantly prolongs the network lifetime.

In [18] Chauhan et al. proposes the responsibility of a cluster head among other CH nodes. For this, they used heuristic approach and bilt an algorithm that is capable of dividing the workload of network efficiently and equally among all the cluster heads as well as non- cluster heads. The results of the proposed approach shown that energy of the nodes was utilized in a balanced way and there was a substantial increase in the network lifetime as well.chnique is the best energy efficient routing technique comparing to any other techniques.

3.Methodology

As mentioned earlier, the main aim of this paper is to propose a solution to save power in Wireless sensor network. In terms of WSN cost effective is completely depend upon the lifetime how longer they live and how longer they transmit data

Each cluster is further segregated into sub-cluster now in every sub-cluster there should be a sub-cluster head in that way the node which is far away from the cluster head and whose energy is been depleted early because they have to transmit data to a long distance to make sure that information must deliver to the cluster head.

Now we have a sub-cluster head which is closure to the node and it takes less energy to transmit data to the neighbourhood sub-cluster head now responsible is to transmit data to the cluster head is upon the shoulder of the sub cluster head in that way a network will be more energy-efficient and load will be more balanced

4. Conclusion and future enhancement

Recently, there has been an increase in the use of wireless sensor networks for monitoring environmental information (temperature, sound levels, humidity etc.) across an entire physical space. In sensor networks, sensor nodes are used to gather local data and communicate with other nodes. Wireless sensor network (WSN) is built of several nodes (from a few to several hundreds or even thousands), where each node is connected to one (or sometimes several) sensors. The main challenging task in this network is lifetime.

There are different types of protocols in WSN used to increase network lifetime. Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is one of the best hierarchical protocols that utilize the probabilistic model to manage the energy consumption of WSN.
With our novel implementation, our network will be capable to reconfigure itself in very dynamic environment by balancing load and energy efficiently.

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