Enhanced Chain Based Data Collection Sensor Network Technique

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Abstract

Wireless sensor networks (WSNs) have received tremendous attention in recent years because of the development of sensor devices, as well as wireless communication technologies. WSNs make it easier to monitor and control physical environments from remote locations and present many significant advantages over wired sensor networks for a variety of civilian and military applications [1,2] .A WSN is usually randomly deployed in inaccessible terrains, disaster areas, or polluted environments, where battery replacement or recharge is difficult or even impossible to be performed. For this reason, network lifetime is of crucial importance to a WSN. To prolong network lifetime, efficient utilization of energy is considered with highest priority. In this paper, we propose an Enhanced chain based data collection sensor network, which ensures maximum utilization of network energy .Also, enhances the reliability of the network. This method gives a good compromise between energy efficiency and latency.

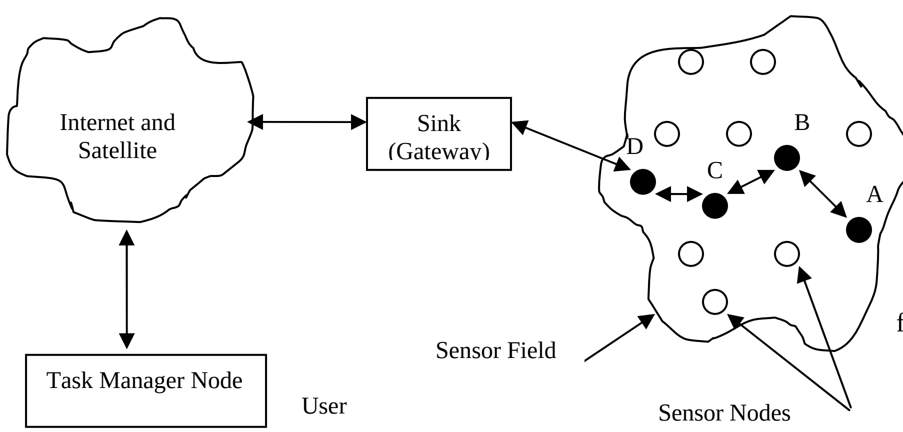
Keywords: *chain, Energy Consumption, Wireless, Sensors, Efficiency.*

1. Introduction

A typical WSN contains a large number of sensor nodes, which send collected data via radio transmitter to a sink.

The decrease in both the size and the cost due to the development of MEMS has led to smart disposable micro sensors, which can be networked through wireless connections to the Internet. Fig. 1 shows architecture of communications in a WSN.

Sensor nodes are capable of organizing themselves, and collect information about the phenomenon and route data via neighboring sensors to the sink. The gateway in Fig. 1 could be a fixed or mobile node with an ability of connecting sensor networks to the outer existing communication infrastructure, such as Internet, cellular and satellite networks.



The unique features of

the WSNs pose challenging requirements to the design of the underlying algorithms and protocols. Several ongoing research projects in academia as well as in industry aim at designing protocols that satisfy these requirements for sensor networks [4, 5, 6].

Some of the important challenges are presented as

• *Sensor nodes are limited in energy, computational capacities and memory:*

Sensor nodes are small-scale devices with volumes approaching a cubic millimeter in the near future. Such small volumetric devices are very limited in the amount of energy that the storage element such as batteries can store. Hence the batteries with finite energy supply must be optimally used for both processing and communication tasks. The communication task tends to dominate over the processing task in terms of energy consumption. Thus, in order to make optimal use of energy, the amount of communication task should be minimized as much as possible. In practical real-life applications, the wireless sensor nodes are usually deployed in hostile or unreachable terrains, they cannot be easily retrieved for the purpose of replacing or recharging the batteries, therefore the lifetime of the network is usually limited. There must be some kind of compromise between the communication and processing tasks in order to balance the duration of the WSN lifetime and the *energy density* of the storage element.

• *Sensor nodes in the WSN are ad hoc deployed and distributed for processing and sensing:*

Sensor nodes are either placed one by one in the vicinity of the phenomenon or deployed in an ad hoc fashion by air or by some other means. Once the sensor nodes are deployed, the WSNs would not have any human intervention to interrupt their operations. The sensor nodes must be able to configure themselves to form connections to set up the network to meet the application requirement. In case of any changes in the operating conditions or environmental stress on the sensor nodes that causes them to fail leading to connectivity changes, this requires reconfiguration of the network and re-computation of routing paths. Another point to take note is that using a WSN, many more data can be collected as compared to just one sensor. Even deploying a sensor with great line of sight, it could still have obstructions. Thus, distributed sensing provides robustness to environmental obstacles. Because there are many sensor nodes densely deployed, neighbor nodes may be very close to each other. Hence, multi hop communication in WSNs is expected to consume less power than the traditional single hop broadcast communication because the transmission power levels can be kept low. Additionally, multi hop communication can also effectively overcome some of the signal propagation effects experienced in long-distance wireless communication.

• *Network and communication topology of a WSN changes frequently:*

When the sensor nodes are deployed, the position of sensor nodes is not predetermined. This means that the sensor nodes must be able to configure themselves after deployment. They must possess some means to identify their location either globally or with respect to some locally determined position. Once the network is set up, it is required that the WSN be adaptable to the changing connectivity (for e.g., due to addition of more nodes, failure of nodes, etc.) as well as the changing environmental conditions. Unlike traditional networks, where the focus is on maximizing channel throughput or minimizing node deployment, the major consideration in a sensor network is to extend the system lifetime as well as the system robustness. The functionalities of the WSN are highly dependent on the amount of energy that is available to be expended by each of the sensor node in the network. Other issues that can be taken care of include scalability, fault tolerance, self –organization, node deployment, latency etc.

Here, we propose a chain formation method that aims to provide efficient, more stable and long lasting paths from source to destination his methods forms one higher level chain and number of lower level chains. In this we have used a MAC layer concept for energy conservation. In every chain one sensor node is selected as a leader based on some proposed criteria for an optimal number of rounds. All nodes in the lower level chain send data to lower level leader and all lower level leader than send information to higher level leader .the higher level leader is the node that transmit the information to the base station. Due to multiple chain structure , this protocol require less time and energy as compared to other protocols.

2. Related Work

A number of routing protocols have been proposed which try to maximize the lifetime of sensor network of constrained resources. We review some of the most relevant designs [7-9]. In LEACH [7], sensor nodes are organized into clusters with one node in each cluster working as cluster-head. The cluster-head receives data from all other sensors in the cluster, aggregates the data, and then transmits the aggregated data to the BS. LEACH rotates the cluster-head in order to evenly distribute the energy consumption. The operation of LEACH is organized into rounds. Each round begins with a set-up phase followed by a steady-state phase. During the set-up phase, each node decides whether it becomes a cluster-head or not according to a predefined criterion. After that, the rest sensor nodes decide the cluster-head they will belong to for that round.
The cluster-head then creates a TDMA schedule for all the number nodes in its cluster. During the steady-state phase, each member node transmits data to the cluster-head within its assigned time slot. LEACH has some drawbacks. Firstly, the cluster set-up and TDMA scheduling overhead in every round is significant. Secondly, the distance between the cluster-head and member node can be long causing large transmission delay and energy consumption. Proxy-Enable Adaptive Clustering Hierarchy for wireless sensor network (PEACH) [8] improved LEACH by selecting a proxy node which can assume the role of the current cluster-head of weak power during one round of communication. It is based on the consensus of healthy nodes for the detection and manipulation of failure of any cluster-head. It allows considerable improvement in the network lifetime by reducing the overhead of re-clustering.
PEGASIS [9] forms a chain covering all nodes in the network using a greedy algorithm so that each node communicates with only the neighboring nodes. In each round of communication, a randomly selected node in the chain takes turn to transmit the aggregated information to the BS to save the energy. Also, the elimination of cluster set-up phase allows considerable energy saving. However, the communication delay can be large due to long single chain. When the network size is relatively large, the delay might be intolerable. Also, as the nodes in the chain cannot be relocated, the inter-node distance gets larger as the network size grows, which causes increased energy consumption.
Considerable amount of research has been done on chain based protocols and number of schemes have been devised .Like [10] diamond shaped pegasis is proposed which increase reliability of data packets for securing data transmission .In [11] concentric clustering scheme which consider the location of the base station to enhance its performance and to prolong the life time of the network. In this clusters are formed by dividing the sensor field in the form of concentric circles, considering base station outside the wireless sensor network.
CRBCC [12] gives a good compromise between energy consumption and delay. Chains are formed based on simulated annealing (SA) algorithm. Clusters are formed based on y co-ordinate and chain leaders are formed on x co-ordinates.
A new routing and data gathering approach [13] in which , clusters are formed and cluster head is selected using LEACH approach and then in clusters, chains are formed using shortest path first. Clusters and chain construction occurs only once and the cluster head rotates locally inside the clusters without re clustering.

3. Proposed Plan

The protocol operates in two phases: Chain formation phase and data transmission phase.

In chain formation phase node of different levels are formed and in data transmission phase information is transmitted along with the designated paths. In chain formation phase: one chain of higher energy level and other of low energy level chains are formed. In each chain one node is selected as a leader based on some criteria .Lower level leaders are responsible to collect data from lower level chains and send data to higher level leader who is responsible to send data to base station.

Chain formation phase:

We assume that a position from a base station to every node is known based on the received radio signal strength. This protocol form several lower level chains. A chain formation algorithm is discussed below in figure 2. All chains are of fixed length say L.A source node can broadcast a route request message containing threshold energy level.

Node selection procedure

A source node S broadcast a route request message containing threshold energy value t*h.*

At neighbor node N

If En>E*th*, A node will take part in chain formation
Else *if En < Eth a node will not take part in this process* where, *En* is the energy level of the node, *Eth* is a pre-defined threshold,.

At the source node *S a*ll received *ACTIVE_REP* messages are scanned. The neighbour with shortest active route is selected for forwarding the data.

Chain formation procedure:

For an N Node network where each chain contain L nodes .The number of chains formed are N/L.A node in a chain selects the nearest node that is not already selected based on the criteria discussed above. This way chain formation continues until all the active nodes are grouped into chains. After fixing the chain the next target is to find out the leader node in a chain. This protocol will choose leader based on the remaining energy levels in each sensor of the chain. Once the leaders are selected, a higher level leader is selected based on the criteria that a node having highest residual energy and shortest distance (metrics energy*distance) will be selected as higher level leader .It is the responsibility of the higher level node to pass aggregated data onto the base station.

Since in this, we have selected only those nodes that have their energy level greater than threshold. The chain formation will take place when 30% of the nodes die away. As the result the leader formation will also be delayed. The benefits of using a slight larger duration between leader selections rather than selecting leaders in every round are 1) less communication overhead 2) reduction in time in selection of leaders.

Data transmission phase:

After the formation of the chain and selection of leader, the data transmission phase starts. We assume that sensors always have data to send to the BS so data is aggregated at each level before transmission .The same token passing mechanism will be followed as in PEGASIS.
As discussed in figure 2 , after receiving these data, the neighbor node aggregates them with their own data and transmits these data to its neighbor node. In this, node c2 is the leader, and it will pass the token along the chain to node co. Node co will pass its data towards node c2. After node c2 receives data from node cl, it will pass the token to node c4, and node c4 will pass its data towards node c2.

(leader)

$$\mathrm{co} \rightarrow \mathrm{c1} \rightarrow \mathrm{c2} \leftarrow \mathrm{c3} \leftarrow \mathrm{c4}$$

$$\downarrow$$

BS

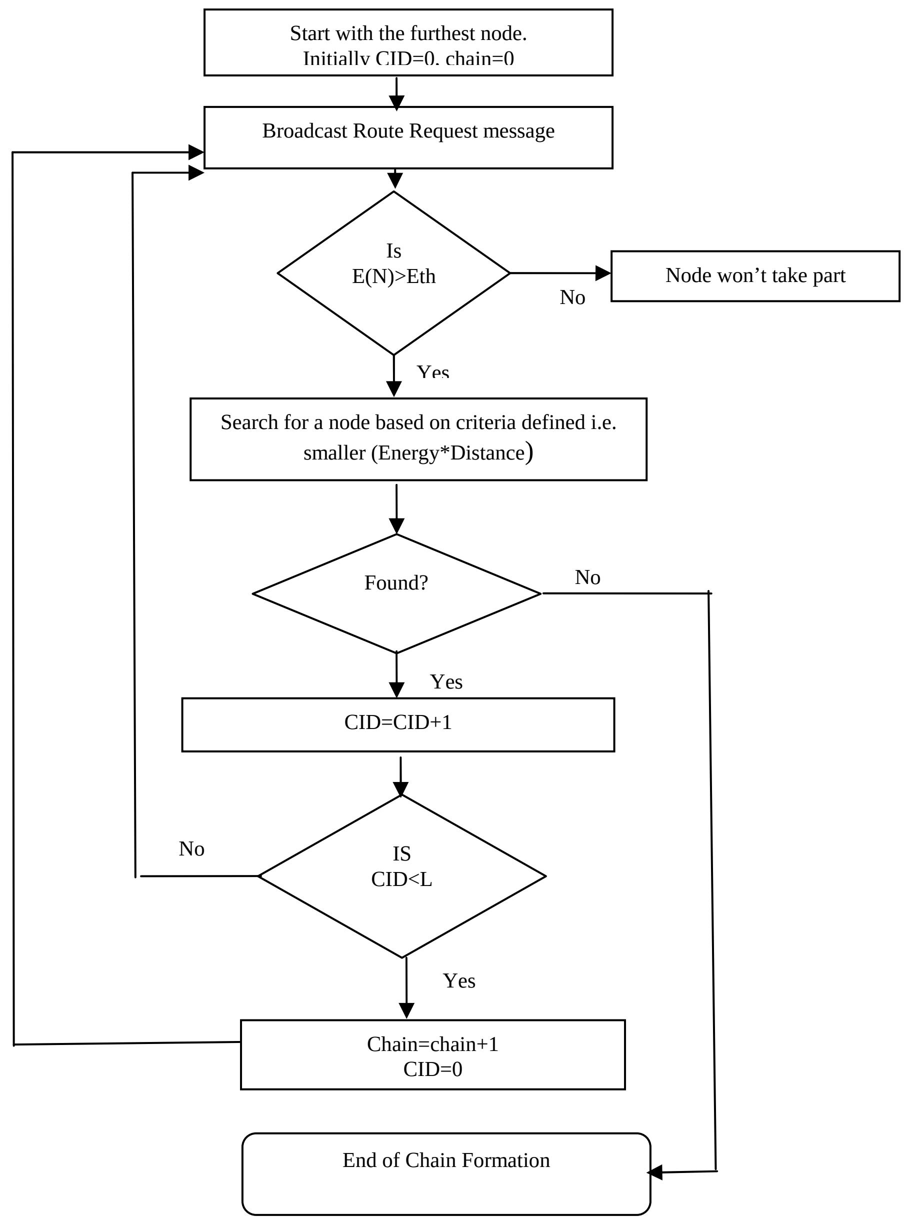


Fig 2: Chain Formation Algorithm

4. Conclusion

In this paper we have proposed a protocol for information collection based on some energy level criteria. In this chains are formed to reduce latency. To improve further chains are re constructed only when 30-40% of node dies away. This process even reduces energy consumption as leaders gets elected after optimal number of rounds .Considering all these factors ,the protocol shows a remarkable improvement over existing protocols. In future work ,We will be implementing this proposed work and can extend this to multiple layer hierarchical chain based protocol. This can be enhanced further by including issues of MAC layers.

5. References

[1] Ritu Sharma, Yogesh Chaba ,” Analysis of Security Protocols in Wireless Sensor Network”, Int. J. Advanced Networking and Applications Volume: 02, Issue: 03, Pages: 707-713 (2010).

[2] Carlos F. García-Hernández, Pablo H. Ibargüengoytia-González ,” Wireless Sensor Networks and Applications: a Survey”, IJCSNS ,VOL.7 No.3, March 2007.

[3] Chong C. & Kumar S.P. (2003). Sensor Networks: Evolution, Opportunities, and Challenges, *Proceeding of the IEEE, Sensor Networks and Applications*, vol.91, no.8, pp.1247-1256, 2003

[4] M. Kuorilehto, M. Hannikainen & T.D. Hamalainen (2005). A survey of application in wireless sensor networks, *EURASIP Journal on Wireless Communications and Networking*, vol.2005, no.5, pp.774-788, 2005.

[5] M. Tubaishat & S. Madria (2003). Sensor networks: an overview, *IEEE Potentials*, vol.22, pp.20-23, 2003.

[6] I.F. Akyildiz, W.L. Su, S. Yogesh & C. Erdal (2002). A Survey on Sensor Networks,*IEEE communications Magazine*, vol.40, no.8, pp.102-114, 2002.

[7] W.R.Heinzelman, A.Chandrakasan, and H. Balakrishnan, “Energy-Efficient communication Protocol for Wireless Micro-sensor Networks,” In Proceedings of the Hawaii International Conference on System Science, Maui, Hawaii, 2000.

[8] K.T. Kim and H.Y. Youn, “PEACH: Proxy-Enable Adaptive Clustering Hierarchy for Wireless Sensor network,” Proceeding of the 2005 International Conference on Wireless Network, June 2005, pp. 52-57.

[9] S. Lindsey, C. Raghavendra, and K. Sivalingam, “Data gathering algorithms in sensor networks using energy metrics,” IEEE Transactions on Parallel and Distributed Systems, Vol. 13, 2002, pp. 924-935.

[10] Jung-Eun Lee Keecheon Kim, “Diamond shaped Routing method For Reliable Data Transmission in WSN”,ISPA,IEEE-2008,pp.799-801

[11]Min Jung,Young-Ju Han, “ The Concentric clustering scheme for efficient energy consumption in PEGASIS”,ICACT Feb 12-14,2007 Pp.260-265.

[12] Zheng ,Hu-Zhengbing, “ Chain Routing based on Co-ordinates- oriented strategy in WSN” ,IEEE 2009

[13] Jae Duck,Kyung, “An Efficient Chain –Based Clustering Routing Protocol for WSNs”, International conference on advanced Information and application Workshops,IEE-2009.

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